

West Bengal State University



Draft UG syllabus for **Zoology as Minor** (Credit values given within brackets)

Semester	Course structure/code	Name of paper	Credits	Classes	SEC
Semester I	MA-1 (5)	Animal Diversity	3	45	
		Animal Diversity Lab	2	30	
Semester II	MA - 2 (5)	Physiology and Biochemistry Physiology	3	45	
		and Biochemistry Lab	2	30	
Semester III	MA - 3 (5)	Insect, Vectors and Diseases Insect,	3	45	SECZOO1
		Vectors and Diseases Lab	2	30	
Semester IV	MA - 4 (5)	Applied Zoology	3	45	SECZOO2
		Applied Zoology Lab	2	30	
Semester V	MA - 5 (5)	Aquatic Biology	3	45	SECZOO3
		Aquatic Biology Lab	2	30	
Semester VI	MA - 6 (5)	Environment and Public Health	3	45	SECZOO4
		Environment and Public Health Lab	2	30	
Semester VII (for 4year Honours/ Honours with Research)	SM-1 (5)	Bio-Instrumentation and Techniques in Biology	3	45	
		Bio-Instrumentation and Techniques in Biology Lab	2	30	
	SM-2 (5)	Ecology and evolution	3	45	
		Ecology and evolution Lab	2	30	

Semester 1

MA-1 (5): Animal Diversity

Course Objective

This will form an introduction of details into animal diversity. Students will learn about the overview of the general classification of the animal kingdom with life cycle of an example species. The course does not intend to deal with very much details which will be higher compared to the standard of class 12 but much simpler than its counterpart courses in the Major section.

Course Outcome

The student shall get an entry level detailed idea of animal kingdom. Enough to teach in schools, act as a keeper of animal specimens, help in identification of species. The student will be able aid in research acting as an assistant.

Theory (Credits 3) Class 45

Unit-1 Kingdom Protista

General characters and classification of Subkingdom Protozoa up to Phylum (Levine et al., 1980);
Locomotory Organelles and locomotion in Protozoa 3

Unit-2 Phylum Porifera

General characters and classification up to classes; Canal System in Sycon 3

Unit-3 Phylum Cnidaria

General characters and classification up to classes; Polymorphism in Hydrozoa 3

Unit-4 Phylum Platyhelminthes

General characters and classification up to classes; Life history of Taenia solium 3

Unit-5 Phylum Nematoda

General characters and classification up to classes; Life history of Ascaris lumbricoides and its parasitic adaptations 3

Unit-6 Phylum Annelida

General characters and classification up to classes; Nephridia in Annelida 3

Unit 7 Phylum Arthropoda

General characters and classification up to classes; Vision in insect, Metamorphosis in Insects 5

Unit-8 Phylum Mollusca

General characters and classification up to classes; Respiration in Pila 3

Unit-9 Phylum Echinodermata

General characters and classification up to classes; Water-vascular system in Asterias 4

Unit-10 Protochordates

General features; Feeding in Branchiostoma 2

Unit-11 Agnatha

General features and classification up to classes (Young, 1981) 2

Unit-12 Pisces

General features and Classification up to Subclasses (Romer, 1959); Osmoregulation in Fishes 3

Unit-13 Amphibia

General features and Classification up to living orders (Duellman & Trueb, 1986); Metamorphosis in Toad 3

Unit-14 Reptiles

General features and Classification up to living Subclass (Young, 1981); Poisonous and non-poisonous snakes, Biting mechanism in snakes 4

Unit-15 Aves

General features and Classification up to orders (Young, 1981); Flight adaptations in birds 3

Unit-16 Mammals

Classification up to Subclasses (Young, 1981); Origin & distribution of Cranial nerves in Cavia 3
Suggested Readings [Consult Latest Editions]

1. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
2. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.
3. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
4. Kent, G.C. & Carr, R.K. (2001). Comparative anatomy of theVertebrates. 9thEd. McGraw Hill.
5. Romer, A.S. & Parsons, T.S.(1986).The vertebrate body. 6thEd. Saunders College Pub.
6. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
7. Young, J. Z.(2004).The Life of Vertebrates. III Edition. Oxford university press.

ZOOGCOR01P: Animal Diversity Lab (Credits 2)

1. Spot identification of the following specimens:

Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Euspongia,, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Passer, Psittacula, Alcedo, Sorex, Pteropus, Funambulus, Suncus

2. Study of the following permanent slides: Transverse section of male and female Ascaris

3. Identification of poisonous and non-poisonous snakes (Photograph only)

4. An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

Semester II

MA - 2 (5) : Physiology and Biochemistry

Course Objective

This will form as an introductory level of detailed study for topic associated with physiology (higher vertebrates) and biochemistry. A simple approach to understand in mammalian physiology into various principle lives's supporting process eg. nervous system, respiration, digestive system etc. The biochemistry part will mainly introduce to structure and metabolism of protein, carbohydrate and lipids. The course does not intend to deal with very much details which will be higher compared to the standard of class 12 but much simpler than its counterpart courses in the Major section.

Course Outcome

The knowledge will be in the level of entry graduate level, Enough to teach in schools, act as a keeper of animal specimens, help in identification of species. Exposure to practical classes shall enable the student to perform the specified regular laboratory processes. The student will be able aid in research acting as an assistant.

Theory (Credits 3) Class 45

Unit-1 Nerve and muscle 8

1. Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres.
2. Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction.

Unit-2 Digestion 5

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit-3 Respiration 5

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit-4 Excretion 5

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit-5 Cardiovascular system 6

Composition of blood, Homeostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit-6 Reproduction and Endocrine Glands 7

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal

Unit 7 Carbohydrate: Structure and Metabolism 8

Introduction to Carbohydrates, Structure & Types of Carbohydrates, Isomerism, Introduction to Intermediary metabolism: Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Electron transport chain

Unit-8 Lipid: Structure and Metabolism 5

Introduction to Lipids: Definitions; fats and oils; classes of lipids; Lipoproteins; Biosynthesis and β

oxidation of palmitic acid

Unit-9 Protein: Structure and metabolism 5

Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids.

Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. Transamination, Deamination and Urea Cycle.

Unit-10 Enzymes 4

Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

Suggested Readings

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co.
2. Chatterjea, MN and Shinde, R (2012) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi
3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
6. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
7. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
8. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology, XI Edition., McGraw Hill
9. Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.

MA - 2P: Physiology and Biochemistry Lab (Credits 2)

1. Preparation of haemin crystals
2. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, kidney
3. Qualitative tests to identify functional groups of carbohydrates in given solutions: Glucose (Benedict's test), Sucrose (Iodine test)
4. Quantitative estimation of total protein in given solutions by Lowry's method.
5. Study of activity of salivary amylase under optimum conditions.

Semester III

MA - 3 (5): Insect, Vectors and Diseases

Course Objective

This course has two distinct parts, the first dealing with insect classification (basic level not as detailed as in Major) of Insects, the second part is dedicated in understanding in the part that the insects act as vectors and the disease they cause. More emphasis is laid on second part that is vector biology as that is the more important part in recent times.

Course Outcome

Insect biology is of great interest and importance in our country. Entomologist are being recruited in rural areas to conduct both survey and awareness programs to control vector borne diseases. This knowledge may allow them to participate in these surveys as assistants. The knowledge can be used for participation in mass awareness programs.

Theory (Credits 3) Class 45

Unit-1 Introduction to Insects 6

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habit

Unit-2 Concept of Vectors 6

Brief introduction to Vectors (mechanical and biological), Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity

Unit-3 Insects as Vectors 8

Detailed features of insect orders as vectors – Diptera, Siphonoptera, Siphunculata, Hemiptera

Unit-4 Dipteran as Disease Vectors 14

Study of important Dipteran vectors – Mosquitoes, Sand fly, Houseflies

Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes

Unit-5 Siphonaptera as Disease Vectors 6

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit-6 Siphunculata as Disease Vectors 4

Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse

Unit-7 Hemiptera as Disease Vectors 6

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

MA - 3 P: Insect Vectors and Diseases Lab (Credits 2) List of Practical

1. Mounting and Study of different kinds of mouth parts of insects
2. Spot identification of following insect vectors through permanent slides/photographs: Aedes, Culex, Anopheles, Pediculus humanus corporis, Pediculus humanus scapitis, Phthirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica
3. Study of different diseases transmitted by above insect vectors

4. Submission of a project report on any one of the insect vectors and disease transmitted

Suggested Readings

1. Anathakrishnan : Bio resources Ecology 3rdEdition
2. Goldman : Limnology, 2ndEdition
3. Odum and Barrett : Fundamentals of Ecology, 5thEdition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition
5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rdedition
8. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

Semester IV

MA - 4 (3) Applied Zoology

Course Objective

The course deals with the knowledge of animal science in three parts primarily as parasites and roles in disease causing or spreading, secondly as an introductory to the science of epidemiology and finally of animals which help humans in commerce. More emphasis is laid on second part that is disease causing as that is the more important to man.

Course Outcome

Health science is huge part of a countries economy. This course makes aware and sensetises students to the science of parasitism and epidemiology. This knowledge may allow them to participate in epidemiological surveys as assistants. The knowledge can be used for participation in mass awareness programs.

Theory (Credits 3) Class 45

Unit-1 Introduction to Host-parasite Relationship 3
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit-2 Epidemiology of Diseases 7
Transmission, Prevention and control of diseases: Tuberculosis, Typhoid

Unit-3 Rickettsia and Spirochetes 3
Brief account of Rickettsia prowazekii, Borrelia recurrentis and Treponema pallidum.

Unit-4 Parasitic Protozoa 6
Life history and pathogenicity of Entamoeba histolytica, Plasmodium vivax and Trypanosoma gambiense

Unit-5 Parasitic Helminthes 4
Life history and pathogenicity of Ancylostoma duodenale and Wuchereria bancrofti

Unit-6 Insects of Economic Importance 8
Biology, Control and damage caused by Helicoverpa armigera, Pyrrilla perpusilla and Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum

Unit-7 Insects of Medical Importance 8
Medical importance and control of Pediculus humanus corporis, Anopheles, Culex, Aedes, Xenopsylla cheopis

Unit-8 Animal Husbandry 3
Preservation of semen and artificial insemination in cattle

Unit-9 Poultry Farming 4
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

MA - 4 (2) Applied Zoology Lab Credits 2

Applied Zoology, Lab (Credits 2) (any 3)

1. Study and Identification of Plasmodium vivax, Entamoeba histolytica, Ancylostoma duodenale and

Wuchereria bancrofti and their life stages through permanent slides/photomicrographs or specimens.

2. Study and Identification of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.

3. Study and Identification of insect damage to different plant parts/stored grains through damaged products/photographs.

4. Identifying features and economic importance of *Nilaparvata lugens*, *Apion corchori*, *Scirpophaga incertulus*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*

5. Visit to poultry farm/ animal breeding centre/ vector biology/ parasitology Centre. Submission of visit report

6. Maintenance of freshwater aquarium.

Semester V

MA - 5 (3) Aquatic Biology

Course Objective

This course introduces a student to the aquatic biomes and fresh water ecosystem. The objective of the course is to enable the student to understand the science of aquatic biology and participate in it. Topics on freshwater Biology, marine Biology, management of aquatic resources enables the student to learn how aquatic biology can be used for economic purpose.

Course Outcome

Apart from the theoretical knowledge the student learns about measures of aquatic parameters which influence animal growth and culture in it. Also a introduction to basic Instruments used in limnology and the project report preparation on a Sewage treatment plant/Marine bio reserve/ Fisheries Institutes empowers the student in jobs offered by NGOs, Aquaculture industries, or set up their own systems related to these.

Theory (Credits 3) Class 45

Unit-1 Aquatic Biomes 10

Brief introduction to the aquatic biomes: Fresh water ecosystem(lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs

Unit-2 Freshwater Biology 20

Lakes:Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous).

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

Unit-3 Marine Biology 10

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

Unit-4 Management of Aquatic Resources 10

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment; Water quality assessment- BOD and COD.

Suggested Readings

1. Anathakrishnan : Bio resources Ecology 3rdEdition
2. Goldman : Limnology, 2ndEdition
3. Odum and Barrett : Fundamentals of Ecology, 5thEdition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition
5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rdedition
8. Chaudhuri, S. (2017). Economic Zoology, New Central Book Agency

MA - 5 P Aquatic Biology Lab (Credits 2)

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of transparency, Dissolved Oxygen, and Free Carbon dioxide, in water collected from a nearby lake / water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a Sewage treatment plant/Marine bio reserve/ Fisheries Institutes.

Semester VI

MA - 6 (3) Environment and Public Health

Course Objective

The final part of the course involves the fall out of anthropogenic activities on environment. The effect of such anthropogenic activities on climate change, pollution and ultimately diseases will be dealt with in this course. The student shall be scientifically aware of the consequences of environmental perturbations and its effect on nature and ultimately on human health.

Course Outcome

Environment, its assessment and understanding are an essential to human survival. It's a topic endorsed by policy makers as well as industries and local administrative bodies. Employment on the basis of its assessment and survey is carried by NGOs, industries, research agencies and local administrative bodies.

Theory (Credits 3) Class 45

Unit 1: Introduction

Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose response evaluation, Exposure assessment 10

Unit 2: Climate Change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health 10

Unit 3: Pollution

Air, water, noise pollution sources and effects, Pollution control 5

Unit 4: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants. 15

Unit 5: Diseases

Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis 10

Suggested Readings [Consult Latest Editions]

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
3. Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
4. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003.
5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.
6. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

MA - 6 P Environment and Public Health Lab (Credits 2)

1. To determine pH, Cl, SO₄, NO₃ in soil and water samples from different locations.

Semester VII

SM-1 Bio-Instrumentation and Techniques in Biology Credit 3 Classes 45

Course Objective

Students perusing 4 year Honours or Honours with Research, will be expected to abreast with the latest Techniques and principals associated with biological research. This course gives the students a substantial exposure to the various modern bioinstrumentations and techniques employed in current research.

Course Outcome

The student will learn about the different instrumentations and techniques ulized in biological research. This will help in various National Level Examinations like NET, GATE etc.. This exposure shall also enable the student to face interviews as JRF/Technical Assistant in various projects.

Unit 1 BioInstrumentation Principles and Techniques of Microscopy 10 Classes

Magnification and Resolution Parameters of Light, Fluorescent Phase Contrast Scanning, Transmission Electron Microscopy, Tunneling Microscopy and Inverted Microscope, Micrometry, Colony Counting and Microtomy.

Unit 2: Centrifugation 5 Classes

Basic Principles of Sedimentation, Types of Centrifuges, Ultracentrifugation, Differential and Rate Zonal Separations, Organellar Separation

Unit 3 : Common Instruments 10 Classes

Principle & Applications of Ph Meter, Flow Cytometry, Spectroscopy UV- Vis, PCR & Thermal Cyclers, Western Blotting, Autoradiography. ELISA and RIA.

Unit 4 : Chromatographic Techniques 10 Classes

Paper Chromatography, Partition Chromatography, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Ion Exchange, Affinity Chromatography and Introduction to HPLC,

Unit 5: Electrophoresis 5 Classes

Capillary, Agarose, SDS & Native PAGE,

Unit 6: Nucleic Acid Hybridization 5 Classes

Southern & Northern Blotting,

Bio-Instrumentation and Techniques in Biology Lab Credit 2 classes 30

1. Using a microscope
2. Cell counting using Haemocytometer
3. Centrifugation of cells

4. Paper chromatography demonstration
5. SDS PAGE demonstration

Reference Books

1. Bioinstrumentation by John G. Webster; Wiley (1 January 2007) ISBN-10 : 9788126513697
2. Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular Biology by Andreas Hofmann; Cambridge University Press; 8th edition (19 April 2018)

SM-2 Ecology and evolution Credit 3 Classes 45

Course Objective

The aim of the course is that the students understand nature in the context of ecosystem dynamics, ecosystem functioning and provision of ecosystem services. The course would demonstrate a broad understanding of the processes that shape the distribution and abundance of organisms from the micro-habitat to the globe; recognize that the distribution of organisms is a product of positive and negative interactions within and across trophic levels, including competition, mutualism, predation, and parasitism.. They will develop an appreciation of the natural world through direct experience with local ecosystems; learn techniques for gathering data in the field. It has been said that “Nothing in biology makes sense except in the light of evolution. Evolutionary biology is the basic framework on which rests the proper understanding of all biology. Understanding how the genotypes and phenotypes of populations change over time, and thereby species evolve and become extinct is crucial for understanding biological diversity. Hence it is important to develop clear concepts about the mechanisms of evolution.

Course Outcomes:

Students would be in a position to identify the relations between the abundance and distribution of organisms in nature. The course will make the students familiar with the variety of ways that organisms interact with both the physical and the biological environment. They would be able to analyze interactions within the context of specific habitats and judge how the habitat shapes the distribution and abundance of species. At the end of this course, students will also possess a broad knowledge about various aspects of evolution, and will know about the morphological, population genetic and molecular approaches towards understanding evolution. Students will achieve skills in developing evolutionary thinking, and be able to analyse, compare and explain evolutionary trends.

Unit 1: Introduction to Ecology

4 classes

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, biomes.

Unit 2: Ecosystem

8 classes

Food chains, Food web, Ecological pyramids, Energy flow through the ecosystem, Ecological efficiencies, Biogeochemical cycles (Nitrogen cycle and water cycle), Human modified ecosystem.

Unit 3: Applied Ecology

5 classes

Introduction to Indian ecosystems (outline idea of mangrove, desert, wetland, montane); Concept of Ramsar site; Ramsar sites of India; Ecosystem services with special reference to wetlands. Sustainable environment; SDG goals; Outline ideas and objective of Indian Environmental Laws.

Unit 4: Origin of earliest life**4 classes**

Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes, three domains of life with special reference to LUCA hypothesis

Unit 5: Historical review of evolutionary concept**5 classes**

Pre-Darwinian Concepts and theories including Lamarckism, Wallace and Darwin's Theory

Unit 9: Origin and evolution of man**4 classes**

Unique hominin characteristics contrasted with primate characteristics (including social and cultural ones), Primate phylogeny with reference to origin of man; Molecular evidences of human origin and migrations (brief outline)

Neo-Darwinian Synthesis

Unit 6: Evidences in favor of Evolution**4 classes**

Fossil records: types of fossils, geological time scale, transitional forms: examples of fossils depicting the evolutionary stages of the modern horses

Molecular (universality of genetic code and protein synthesis machinery) evidences

Ecology and evolution Lab (Practicals, 2 credits = 30 classes):

1. Determination of population density of a natural/hypothetical population. Study of species diversity of a community by quadrat or any other suitable sampling method and calculation of diversity indices.
2. Study of an aquatic ecosystem: Sampling of zooplankton, Measurements of temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), free CO₂.

Text Books:

1. Ecology: Theories and Applications by Peter Stiling; Pearson 4th Ed. 2001.
2. Ecology: The Experimental Analysis of Distribution and Abundance (Indian Paperback edition) by Charles Krebs
3. Ecology: Principles and Applications by J. L. Chapman, M. J. Reiss • 1999. Cambridge University Press
4. Townsend C and Michael Begon. (2008). Essentials of Ecology. Blackwell.
5. Campbell's Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.
6. Evolution by Ridley, M. 3rd Ed. (2004) Blackwell publishing Or
7. Evolutionary Biology Douglas, J. Futuyma (1997); Sinauer Associates

Skill Enhancement Courses

Credit of each course: 3

Total Number of Courses: 3

Skill Enhancement Course (SEC)

SECZOO1: Aquarium Fish Keeping Class (Theory and Practical 3 Credits = 45 classes)

Course Objectives

The course intends to equip students with the knowledge to learn the basic principles, themes and steps needed to set-up and maintain an aquarium. The principal aim of the course is to make the students familiar with essential information of aquarium maintenance in terms of types of fishes, fish biology, fish feed and finally transportation of these sellable commodities. The course will provide students with the knowledge and training needed to approach and formulate aquarium keeping both in business and research .

Unit 1: Introduction to Aquarium Fish Keeping

12 classes

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes , problems of releasing aquarium fishes into natural habitats.

Unit 2: Biology of Aquarium Fishes

11 classes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

10 classes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

Unit 4: Fish Transportation

6 classes

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

6 classes

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

Reference books:

1. Aquarium : Fish Keeping C B L Srivastava Published by Kitab Mahal
2. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie. Published by Chelsea House Publications (1998)
3. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998)
4. The Tropical Freshwater Aquarium Problem Solver: Practical and Expert Advice on Keeping Fish and Plants Sand ford, Gina Published by Voyageur Press (MN) (1998)

5. Aquariums: The Complete Guide to Freshwater and Saltwater Aquariums, Jan 2009 by Thierry Maitre-alain (Author), Chrisitan Piednoir (Author)

Course Outcome:

Fish has been a very common pet for human household. Ornamental fish, their propagation and keeping provides as very profitable means of livelihood as these animals provide both aesthetic beauties coupled with emotional attachment and pleasure. The financial possibilities and outcome has made aquarium breeding of ornamental fish a very profitable cottage industry with scopes of growth and diversification. This technique also aids in research where fish is used as a biological model.

SEC ZOO2: Poultry Farming (Theory and Practical 3 Credits = 45 classes)

Course Objective:

This course shall familiarize a student about the various aspects of poultry farming feasible in India. The course also talks about both large and small scale poutry farming coupled with the various varieties of poultry framings. This deals with both academic and application aspects of this industry.

Unit 1: Indian Poultry Industry **6 classes**

Overview
Importance and Trends
Poultry Farming in India
Poultry Development Programmes in India

Unit 2: Types of Poultry Farms **6 classes**

Various Types of Poultry Farms
Rural Backyard Poultry Farming

Unit 3: Small Scale and Commercial Broiler Farming for meat **3 classes**

Unit 4: Small Scale and Commercial Layer Farming for eggs **6 classes**

Unit 5: Duck and Quail Farming **6 classes**

Duck Farming for Eggs and Meat
Quail Farming for Eggs and Meat

Unit 6: Poultry Breeds and Breeding **6 classes**

Breeds, Varieties and Strains of Poultry
Systems of Poultry Breeding

Unit 7: Culling and Judging of Poultry **6 classes**

Culling of Birds for Profitable Poultry Farming
Judging of Poultry for Better Performance

Unit 8: Poultry diseases and their management **6 classes**

Symptoms, treatment, prevention and control of: Ranikhet disease, avian influenza, fowl cholera, fowl

typhoid, Pullorum disease, chronic respiratory disease, gangrenous dermatitis. Significance of deworming and controlling ectoparasites.

Text Books and references:

1. The Beginner's Guide to Raising Chickens: How to Raise a Happy Backyard Flock by Anne Kuo; Rockridge Press (7 September 2021)
2. The Chicken Health Handbook, 2nd Edition: A Complete Guide to Maximizing Flock Health and Dealing with Disease by Gail Damerow
3. The Small-Scale Poultry Flock: An All-Natural Approach to Raising Chickens and Other Fowl for Home and Market Growers by Harvey Ussery
4. Storey's Guide to Raising Poultry, 4th Edition: Chickens, Turkeys, Ducks, Geese, Guineas, Game Birds by Glenn Drowns
5. <https://egyankosh.ac.in/bitstream/123456789/59739/1/Poultry%20development%20programmes%20in%20india.pdf>
6. <https://www.dahd.nic.in/related-links/central-poultry-development-organization>
7. <https://egyankosh.ac.in/bitstream/123456789/59745/1/Various%20types%20of%20poultry%20farms.pdf>

Course outcome:

Students can go for self employment as an entrepreneur. The course also talks about Government schemes for the said industry. The various aspects of breeds, types and various are integrities dealt in the course will enable the student to access the real life situation

SEC ZOO 3: Apiculture (Theory and Practical 3 Credits = 45 classes)

Course objectives:

This course shall familiarize a student about the significance of apiculture as an economically viable enterprise in India. It will help them to understand about different species of honey bees, their biology and role in pollination. They will learn about techniques of honey bee rearing, and will understand the significance of apiculture in diversification of agriculture for rural communities to increase their income, create employment opportunities and develop skills for self-employment as a bee keeper.

Unit 1: Biology of Bees

8 classes

Historical background of apiculture.

Classification and biology of honey bees.

Social organization of the bee colony, behavioral patterns: bee dance, swarming.

Unit 2: Rearing of Bees

11 classes

Artificial bee rearing in apiary, beehives – Newton and Langstroth, beekeeping equipment, bee pasturage, identification of queen cells, drone cells, brood cells, pollen cells and honey cells.

Selection of bee species for apiculture – *Apis cerana*, *Apis mellifera*.

Methods of extraction and processing of honey (indigenous and modern).

Apiary management - honey flow period and lean period, effect of pollutants on bees.

Unit 3: Diseases and Enemies

9 classes

Diseases of honey bees: protozoan, bacterial and viral (one each) – symptoms, nature of damage and control, mite infestation and its control.

Enemies of bees and their control: predatory insects and non-insects.

Unit 4: Bee Economy

9 classes

Products of apiculture – honey, bees wax, propolis, royal jelly, pollen and their uses.

Modern methods in using artificial bee hives for cross pollination in horticulture and agriculture – stationary and migratory beekeeping.

Unit 5: Entrepreneurship in Apiculture

8 classes

Bee keeping industry – recent advancements, employment opportunities.

Economics of small and large scale beekeeping, scope of women entrepreneurs in bee keeping sector.

Development programs and organizations involved in bee keeping in India.

Text Books:

1. Jaiswal AG (2019) Practical handbook of apiculture. Laxmi Book Publication.
2. Conrad R (2007) Natural beekeeping – organic approaches to modern apiculture. Chelsea Green Publishing.
3. Singh S (1962). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
4. Mishra RC (1995) Honey bees and their management in India. Indian Council of Agricultural Research, New Delhi.
5. Prost PJ (1962) Apiculture. Oxford & IBH, New Delhi.
6. Rahman A (2017) Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
7. Gupta JK (2016) Apiculture. Indian Council of Agricultural Research, New Delhi.

Course outcome:

Students can go for self-employment as an entrepreneur. The various aspects of species of honey bees, their biology and behavior, techniques involved in bee keeping, and making various products from beekeeping dealt in the course will enable a student to develop skills necessary for starting beekeeping as a livelihood.

SEC ZOO 4: Vermicompost Production (Theory and Practical 3 Credits = 45 classes)

Course objective:

The course aims to equip the student with the science of vermicompost. This modern worm farming technique and culture has gained prominence as it poses an alternative to chemical fertilizers. So this technique not only aids in soil health but also assures human health. This science draws interest in economic fronts also as fertile soil is needed in both aesthetic senses in house hold plants as well as agriculture. This science helps in protecting the environment as well as managing waste.

Unit 1

4 classes

Natural role of earthworms in soil fertility

Unit 2

4 classes

Concept of Vermicompost- the need for it

and waste.