NATIONAL EDUCATION POLICY-2020

Sri Dev Suman Uttarakhand University, Badshahithaul,

Tehri Garhwal

Common Minimum Syllabus for all Uttarakhand State Universities and Colleges for Five Years of Higher Education

STRUCTURE OF UG & PG -
ZOOLOGY SYLLABUS

2023

Proposed & Recommended
By
Department of Zoology
Pt. L.M.S. Campus Rishikesh, Sri Dev Suman Uttarakhand University
(BoS in Zoology held on 11 July 2023)

Board of Studies (BoS) Member
Department of Zoology
Pt. Lalit Mohan Sharma Campus, Rishikesh
Sri Dev Suman Uttarakhand University

S. No.	Name	Designation & Address	Sign.
1.	Prof. G.K. Dhingra	Dean, Faculty of Sciences	

S. No.	Name	Designation	Sign.
1.	Prof. D. M. Tripathi	Professor & Head	
2.	Prof. Surman Arya	Professor	
3.	Prof. Ahmad Pervez	Professor	
4.	Prof. Smita Badola	Professor	

Director from Research Institute

S. No.	Name	Designation & Address	Sign.
1.	Prof. Anita Rawat	Director, USERC, Dehradun	

Subject Experts

S. No.	Name	Designation & Address	Sign.
1.	Prof. Naresh Agarwal	Head & Professor, H. N. B. G. University, S. R. T. Campus, Badshahithaul	
2.	Prof. M. S. Rawat	Principal, Pt. Lalit Mohan Sharma Campus, Rishikesh Sri Dev Suman Uttarakhand University	

Invited Principal from Govt. Post Graduates College

S. No.	Name	Designation & Address	Sign.
1.	Prof. Pushpa Negi	Principal, Govt. P.G. College, Tehri	
2.	Prof. Pankaj Pant	Principal, Govt. P.G. College, Nagnath Pokhari	
3.	Prof. Kuldeep Negi	Principal, Govt. P.G. College, Khanpur, Haridwar	

Theory and Practical Examination Pattern

Theory (External) each theory paper carrying maximum marks 75 and shell consists two sections A and B. Examination duration shall be 03 hours.

a) Section A: (short answers type, 200 words).
   Section A will consist of 08 questions, each of 6 marks in which 5 have to be answered.
   Total: 6×5 = 30

b) Section B: (long answers type, 500 words).
   Section B will consist of 05 questions, each of 15 marks in which 3 have to be answered.
   Total: 3×15 = 45

For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period. Total marks allotted to internal assessment shall be 25(assignment 10 marks, written test / viva 10 marks and regularity 5, marks). The evaluated answer sheets/ assignment have to be retained by the Professor In-charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets. The marks obtained by the students shall be submitted to the head of the concerned department/ the Principal of the college for uploading on to the University examination portal.

Practical: The laboratory work of the students has to be evaluated periodically.
The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/ home assignment and attendance) of total 10 marks per each semester shall be conducted during the semester.
All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students.
In each semester practical examination of 75 marks has to be conducted by two examiners (external and internal) having duration of 4 hours. The total number of the students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to head of the concerned department/ the Principal of the college. The Head of the department/ the Principal of the college will make necessary arrangement for uploading the marks on to the University examination portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, New Tehri.

The breakup of marks for practical examination for each semester would be as follows:

Practical exam:	50 Marks (Exercises)
Lab Record and Collection:	15 Marks
Viva voce:	10 Marks
Sessional (Internal):	25 Marks
Total:	100 Marks (each semester)

YEAR	SEMESTER	PAPER CODE	PAPER TITLE	CREDITS TH+PR
Certificate course in Clinical Diagnostics & Biochemistry				
1	I	ZOO101T	Animal Physiology and Biochemistry	4+2
	II	ZOO201T	Genetics and Cell Biology	4+2
	I &II	Minor Elective	Environmental science and Basic concepts of Ecology	4+2
Diploma in Molecular Sciences & Clinical Microbiology				
2	III	ZOO301T	Molecular Biology, Toxicology & Histology	4+2
	IV	ZOO401T	Microbiology and Animal Behaviour	4+2
	III & IV	Minor Elective	Bio-Instrumentation, Bioinformatics and Biostatistics	4+2
Degree in Bachelor of Zoology				
3	V	ZOO501T	Diversity of Non-Chordata	4+1
		ZOO503T	Diversity of Chordata	4+1
		Industrial Training/Survey/ Research Project/ Vocational course/ Entrepreneurship skills	Aquaculture/ Apiculture	04
	VI	ZOO601T	Developmental Biology	4+1
		ZOO603T	Basic mammalian Endocrinology	4+1
		Industrial Training/Survey/ Research Project/ Vocational course/ Entrepreneurship skills	Fish hatchery operation/ Vermiculture	04
Bachelor (Research) in Faculty				
4	VII	PAPER- I	Fundamentals of Immunology	4+1
		PAPER- II	Applied Immunology	4+1
		PAPER- III	Animal Ecology	4+1
		PAPER- IV	Medical Laboratory Techniques	4+1
		Industrial Training/ Survey/Research Project	With reference to Major Papers of Semester-VII	04
	VIII	PAPER- I	General Ichthyology	4+1
		PAPER- II	Applied Ichthyology	4+1
		PAPER- III	Limnology	4+1
		PAPER- IV	Nanotechnology and Computer Application	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-VIII	04
	VIIor VIII	Minor Elective	Chronobiology or Applied Zoology or General Biotechnology	4+1

Master in Faculty (Zoology)				
5	IX	PAPER- I	Systematics And Applied Entomology	4+1
		PAPER- II	Biology Of Insects (Morphology, Physiology & Development)	4+1
		PAPER- III	Economic Zoology and Vermicology	4+1
		PAPER- IV	Wildlife conservation	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester- IX	04
	X	PAPER- I	Animal Biotechnology (Animal Cell Culture)	4+1
		PAPER- II	Animal Biotechnology (Transgenics, Cloning And IPR	4+1
		PAPER- III	Evolutionary Biology and Taxonomy	4+1
		PAPER- IV	Research Methodology and Biostatistics	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-X	04

Course Objective (CO):

- The programme in Zoology aims to equip students with recent advances in Zoology from organismic to reductionist biology.
- It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Behavior and Biological time keeping, Cancer Biology, Microbiome and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc.
- It also offers students to a series of elective courses so that they can choose to specialize in the specific area of their interests in Zoology.
- The open elective has been chosen to attract students from diverse interdisciplinary areas of sciences, such as Immunology, Biotechnology, Nanotechnology, Computer Application, Anthropology, Evolutionary Biology, Entomology, Ichthyology, Limnology, Vermicology, Biostatistics, Taxonomy, Environmental studies, and Biomedical Sciences.
- This course is designed to ignite the inquisitive mind to enter in to research in interdisciplinary areas. The fourth semester offers a total of 16 elective courses, which for logistics of program management, are divided in to four streams, where a student has to choose a stream.
- In the entire course, the major emphasis is on skill-based training into socially relevant areas of Zoology.
- It is expected that a student after successfully completing the programme would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas.
- They would have plethora of job opportunities in the education, environment, agriculture- based, and health related sectors.
- The bright and ignited mind may enter into research in the contemporary areas of Zoological/Biological Sciences.
- The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences.

Programme Objective (POs):

PO 1	It will enhance the basic knowledge about the different systems of an organism and the clinical study of biomolecules.
PO 2	It will help students to pursue the initial fundamentals required for future projects and higher studies.
PO 3	It will help to inculcate the evolutionary basis of various animals and their development. It will also address the present situation of animal diversity.
PO 4	It will help students to identify the concepts about various Applied sciences, Immunology, Ichthyology and Medical laboratory techniques related to concerned area.
PO 5	It will help to develop the knowledge on taxonomy of insects and Biotechnology. Also, the conservation of wild animals to enhance the economy gained by the zoological content present in the environment. Knowledge of research methodology and Biostatistics will help students in their research career.
PO 6	All the above POs will lead to a mind that can develop modern technologies to address the problems and to give solution to it.

Programme Specific Objective (PSO):

CERTIFICATE COURSE IN CLINICAL DIAGNOSTICS & BIOCHEMISTRY	
YEAR 1	This will helps students to generate employment in the field of clinical & medical lab/institutions/gene bank/stem cell culture/Pharma companies etc.
DIPLOMA IN MOLECULAR SCIENCES & CLINICAL MICROBIOLOGY	
YEAR 2	This will help students to develop the scientific ability in the field of toxicological, Histological, Microbiological, Molecular labs, various Zoological Parks, National Parks, Wildlife Sanctuaries.
BACHELOR OF SCIENCE (ZOOLOGY)	
YEAR 3	This will help students to develop the basis of Animal diversity and its development, which can generate various academic/Research jobs and various other jobs in the field of In-vitro labs, case study of endocrinology in medical labs etc.

BACHELOR (RESEARCH) IN FACULTY	
YEAR 4	It will help students to pursue career in Fisheries, various health related departments and medical laboratories. It is beneficial for students as they can work in different Chrono-centre as per demands for biological clock management to travel across continents (both public and private sector). It will also provide opportunities and scope for Nanotechnology and Computer Applications.
MASTER IN FACULTY (ZOOLOGY)	
YEAR 5	It will help students to improvise the Agro-Pest relationship, forensic Entomology & its implication it helps to conserve the environment & Ecology also at the same time students will be equipped to explore jobs in Zoological Research i. e. CTB, CSB, ZSI, WII etc. Students will also be benefitted from the knowledge of Research Methodology and Biostatistics during their research career.

Syllabus

First Year
Semester I
Animal Physiology & Biochemistry

Physiology

Nutrition and Digestion: Food constituents, intracellular and extracellular digestion, Digestive System of humans, Digestion and absorption of carbohydrate, fat and protein.

Respiration: Types of respiration, respiratory pigments, gaseous transport and control of respiration. With reference to dissociation of oxyhaemoglobin.

Excretion: Ammonotelic, guanotelic, uricotelic and ureotelic animals, mechanism of urine formation and excretion in mammals.

Blood vascular system: Haemopoiesis, composition and functions of blood, blood coagulation. A brief account of lymphatic system. Types of heart, origin and conduction of heart beat. Cardiac Cycle

Nervous system: Types of Neurons, Resting and action potential of nerves, synapse and transmission of nerve impulse. Neurotransmitters.

Muscular system: Types of Muscles, Molecular and chemical basic of Muscle contraction and its Mechanism. A brief idea of tetanus and fatigue.

Biochemistry

Introduction to biomolecules: Classification, structure, functions and significance of Proteins, Amino acids, Carbohydrates and Lipids.

Metabolism of Carbohydrates. Glycolysis, Krebs cycle, Gluconeogenesis, Glycogenesis Glycogenolysis

Enzymes and Vitamins: Mechanism of Enzyme Action, Kinetics, Inhibition & Regulation Vitamins, Types & source, deficiencies.

Practicals

- Determination of blood pressure.
- Determination of Blood clotting and Bleeding time.
- Preparation of haemin crystals.
- Determination of haemoglobin content.
- Determination of the Red Blood Corpuscles (RBC) Count.
- Determination of White Blood Corpuscles (WBC) Count.
- Determination of blood group (ABO system).
- Test for Fructose, glucose, sucrose, and starch,
- Test of enzyme salivary amylase (Ptyalin), pepsin on protein, albumin, lipids and ketones.
- Separation of amino acids using paper chromatography

Suggested books:

1. Ganong: Review of Medical Physiology, Lang Medical Publ.
2. Guyton and Hall, Textbook of Medical Physiology WB Saunders.
3. Keel et al: Sampson Wright's Applied Physiology, Oxford Press.
4. C.C. Chatterjee: Human Physiology.
5. Nielson: Animal Physiology, Cambridge.
6. Jain A.K.: Textbook of Physiology, Avical Publishing Company.
7. Conn And Stumpf: Outlines of Biochemistry, John Wiley.
8. Pandey B.N: Zoology Series- Biochemistry, Physiology, Endocrinology, Tata McGraw Hill Edu Pvt Ltd, New Delhi.

Semester- II

Genetics and Cell Biology (4+2 Credits) = 6 Credits

Genetics

Pre-Mendelian experiments, symbols and terminologies, Mendelian Laws and their exception.

Linkage: Coupling and repulsion hypothesis, Morgan's view of linkage, kinds of linkage, chromosome theory of linkage. Gene-map

Crossing over: Somatic and germinal crossing over, kinds of crossing over, theories of the mechanism of crossing over, significance.

Eukaryotic chromosomes- Structure, types, chemical composition, classification. Structure and functions of polytene and lampbrush chromosomes.

Determination of sex: chromosome mechanism, Genic balance theory, External environment and sex determination. Theory of germplasm.

Sex linked inheritance: Inheritance of X-linked gene (Colour blindness and haemophilia in man), Sex linkage in Drosophila.

Mutation: Historical background, chromosomal mutation (Chromosomal aberrations), gene mutations and their interpretation.

Cell Biology

Introduction: Prokaryotic and Eukaryotic cells; Ultrastructure of eukaryotic cell;

Plasma membrane: Ultrastructure, chemical composition, models, specialization and functions.

Structure and functions of cell organelles: Mitochondria, Ribosomes, Lysosomes, Centrioles, Golgi Complex, Endoplasmic reticulum, Nucleus and nucleolus.

Cell division: Cell cycle, Mitosis (Process of mitosis, mitotic poisons and significance of mitosis), Meiosis (Process of meiosis, structure and functions of synaptonemal complex, significance of meiosis).

Cancer: An idea of cell transformation and cancer.

Practical

- Demonstration of Monohybrid Cross, dihybrid Cross, Lethal Gene, Epistatic Gene, Complementary Gene, and Duplicate Gene through charts and models.
- Study of types of chromosomes with the help of prepared slides.
- Construction a gene map in *Drosophila*.
- Study of linkage and gene-mapping using the data.
- Study of human karyotypes (normal and abnormal)
- Study of Polytene chromosomes in chironomus larva.
- Demonstration of morphological study and mutants of *Drosophila*
- Study of cell organelles using charts, models and permanent slides.
- Demonstration of Mitosis and the Cell Cycle in Onion Root-Tip Cells.
- Demonstration of Meiosis in the grasshopper's testis cells.

Suggested books:

1. Strickberger: Genetics, Prentice hall.
2. Principles of Genetics, Snustad and Simmons,John Wiley & Sons, USA.
3. Modern Genetics Anaysis: Integrating Genes and Genomes, Griffith, J.F., Gelbart, M., Lewontin, C and Miller, W.H. Freeman and Company, New York, USA.
4. Genetics, J Russell, Benjamin- Cummings Publishing Company, San Francisco, California, USA.
5. Lodish-el al, Molecular Biology
6. P.K. GUPTA, Cell Biology and Genetics.

Minor/Elective

Environmental science and Basic Concepts of Ecology

(4 CREDIT)

Environmental science

1. Introduction of environmental Science: Definition, principles and scope of environmental science, structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.

Natural resources: Renewable and Non-renewable resources: land resources and land use change, land degradation soil erosion and desertification.

Environmental Pollution: Types, causes, effects and controls, air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management-Control measures of urban and industrial waste. Pollution case studies.

Environmental Policies & Practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environmental laws- Environmental Protection Act- Air (Prevention & Control of Pollution) Act. Water (Prevention & Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

Basic Concepts of Ecology

Definition of ecology, environment and its relation to human beings.
Concept of ecosystem: Abiotic, biotic and edaphic factors. Pond, Grassland, Forest & River ecosystems. Energy flow in ecosystem. Pyramids of number, biomass and energy.
Biogeochemical cycles: Water, Carbon and Nitrogen cycles.
Population: Definition and characteristics: density, natality, mortality, migration, emigration and immigration. Dispersion and aggregation. Commensalism, mutualism, predation, competition and parasitism.

Practical

1. Study based on models of different ecological aspects.
2. Population and Community studies of available terrestrial animals.
3. Study of an ecosystem and its biotic components.

Suggested books:

1. Odum, E.P: Fundamental of Ecology, Saunders Co. Publ. Indian Ed.
2. Chapman & Reiss: Ecology.
3. Smith, R.L: Ecology & Field Biology.
4. Singh & Kumar: Ecology and Environmental Science, Vishal Publ.
5. Odum, E.P: Fundamental of Ecology, Saunders Co. Publ. Indian Ed.
6. Ecology and Environment by P.D. Sharma.

Second Year

Semester- III

Molecular Biology, Toxicology & Histology (4+2 Credits) = 6 Credits

Molecular Biology

Nucleic acids: Structural components and types of RNA and DNA, Watson and Crick DNA double helix model, identification of DNA as genetic material. Genetic and non-genetic RNAs. **Clover leaf model of tRNA**

Elementary knowledge of genetic code. **DNA Replication, transcription and transcription in prokaryotes and eukaryotes.**

Lac operon concept. Mechanism of DNA damage & repair

Toxicology

Toxicology: Introduction and General principles.

Environmental toxicology: Types and sources of toxic agents- animal toxins, plant toxins toxicology, metals, pesticides and food additives.

Dose response relationship: Frequency and cumulative responses, determination of TLm values, $LD_{50,}$ LC_{50}, margin of safety, threshold limits.

Histology

Histology: Light microscopy of epithelium, connective tissue, cartilage, bone, smooth, striped and cardiac muscles and nervous tissue.

Histological structure of gonads, liver, lung, pancreas and kidney in mammals.

Practical

- Study of DNA, t-RNA, ATP through charts and models.
- Isolation of chromosomal DNA from the bacterial cells.
- Estimation of DNA from diphenyl amine method.
- Demonstration of different doses of toxicant on opercular movement of fish.
- Estimation of LC_{50} of the given toxicant on the fish.
- Estimation of LD_{50} of the given toxicant on the insects.
- Estimation of uncertainty and variability in pesticide residue analysis.
- Studies on dissipation of pesticides from soil and half-life estimation.
- Pesticide residue analysis of contaminated soil, vegetable and water using TLC, GLC and HPLC.
- Preparation of histological slides of various tissues.
- Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone and cartilage.

Suggested books:

1. Molecular Cell Biology, Lodish et al., W.H. Freeman and Company, New York, USA.
2. Molecular Biology of the Cell, Alberts et al., Garland Science, Taylor and Francis Group, New York, USA.
3. De- Robertis- Cell and Molecular Biology.
4. Verma, P.S. and Agrawal, V.K. Molecular Biology
5. Tortora- Microbiology and Introduction.
6. Parija- Textbook of Microbiology.
7. Pelczar: Microbiology, Tata McGraw Hill.
8. Davis: Microbiology Harper & Row, Publ. Inc.
9. Textbook of Toxicology By Balram Pani.
10. "Casarett & Doull's Essentials of Toxicology", 2nd Ed. Edited by Curtis A. Klaassen & John B. Watkins III, published by McGraw Hill-Lange
11. "Handbook of Toxicology", M.J.Derelanko & C.S.Auletta, 3rd Ed. CRC Press
12. Principles of Biochemical Toxicology" by J.A.Timbrell

Semester- IV

Microbiology and Animal Behaviour (4+2 Credits) = 6 Credits

Microbiology

Introduction to Microbiology: Types of microbes, Typical structure of a bacterium, Gram positive and Gram negative bacteria, Virus with reference to COVID and a brief knowledge of AIDS.

Microbes of medical importance: Bacteriophages, Mycobacterium, Rickettsia, Actinomycetes and Mycoplasma.

Environmental use of microorganisms: Nutrient cycle, Metal recovery, petroleum recovery, pest management, waste water treatment and Bioremediation.

Industrial Microbiology- Food production, dairy products, fermented food, alcoholic beverages, microbial spoilage, and food preservation. Introduction to Antibiotics.

Animal Behaviour

Patterns of behaviour: Stereotype and innate behaviour: Kinesis, Taxes and Reflexes. Concepts of (i) Fixed action patterns (ii) Sign or key stimulus or releasers and (iii) Innate releasing mechanism, Instinctive behaviour. Learned behaviour: Habituation, Conditioned reflexes, Selective learning, Insight learning, Imprinting, Song learning in birds. Hormonal control of Behaviour

Communication: Olfactory, Visual, Auditory, Electric and Tactile, Dance language of honey bees, Biological clocks. Bird migration with particular reference to the mechanisms of navigation. Introduction to Socio-biology: Social structure in primates

Practical

- Study of microoganisms in the sample of river and pond water.
- Culture of Paramecium in laboratory condition.
- Sterilization using an autoclave.
- Isolation and culture soil microbes by Serial Dilution Method.
- Demonstration of simple staining in bacteria.
- Demonstration of different types of bacteria present in the milk sample.
- Demonstration of milk quality using Reductase Test.
- Demonstration of bacteria present in the curd.
- Preparation of Culture Media (broth) for the cultivation of bacteria.
- Streak plate method for isolation of pure culture.
- Demonstration of motility of bacteria
- Demonstration of Antibiotic Sensitivity Test.
- Water quality test using coliforms.
- Study of phototaxis and geotaxis behaviour in Earthworm
- Chemotactic behaviour of *Paramecium*.
- Courtship and mating behaviour in *Drosophila*.
- Courtship behaviour in birds and other insects.
- Schooling behaviour of fishes in response to a dummy fish.
- Demonstration of Pavlov's Classical conditioning behaviour in dogs

Suggested books:

1. Mechanism of Animal Behaviour Peter Marlar & J. Hamilton.
2. Animal Behaviour by David McFarland.
3. Animal Behaviour John Alcock.
4. Pelczar Microbiology
5. Davies Microbiology

Minor/Elective

BioInstrumentation, BioInformatics and Biostatistics(4+2 Credits)

BioInstrumentation

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

Centrifugation – Basic Principles of Sedimentation, Types of Centrifuges,

Ultracentrifugation, Differential and Rate Zonal Separations, Organellar Separation and Flow Cytometry.

Principle & Applications of Ph Meter, Spectroscopy UV- Vis, Mass Spectrometry (MS) and X-Ray Crystallography.

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

Electrophoresis: Capillary, Agarose, SDS & Native PAGE, Pulse Field, Immuno-Electrophoresis and Paper Electrophoresis.

PCR & Thermal Cyclers, Nucleic Acid Hybridization: Southern & Northern Blotting, Western Blotting, Autoradiography. ELISA and RIA.

Bio Informatics

Introduction to Computers, Computer Fundamentals (Hardware & Software), Input, Output Devices and Storage Devices, Web Browsers, Search Engines, Flow Charts, Methods and Types of Networks, Intra and Internet, Introduction to MS-Office.

Introduction to Bioinformatics, Scope and Application of Bioinformatics, NCBI Data Model, DNA and Protein Sequence Database, Motif Analysis, Structural Database, Structural Viewers (Rasmol, Rastop, Cn3D, CSHF Chimera, Swiss PDB Viewer, Pymol), Sequence Submission to Database, Literature Database (Pubmed, Biomed Central, Medline), Internet and Biologist. Online Study *E. coli, D. melanogaster*, Human Genome, Mice Genome. DNA Chips and their Replications.

Biostatistics

Introduction to Biostatistics, Terminology and Symbols, Research and Types of Research, Applications of Statistics in Biological Research, Data, Collection and Representation of Data (Pie Chart, Bar Diagram, Histogram, Frequency Polygon and Gantt Chart), Measures of Central Tendency (Mean, Median, Mode), Variance, Coefficient of Variation, Standard Deviation, Standard Error of Mean, Analysis of Variation (ANOVA), One Way ANOVA and Two Way ANOVA. Measures of Dispersion, Distribution Patterns (Binomial, Poisson & Normal), Tests of Significance ('T' Test, 'F' Test & Chi-Square Test), Probability, Correlation and Regression Analysis, Introduction to Statistical Software and Handling (SPSS And Excel Data Sheets).

Practical Suggested books:

1. Introduction to Biostatistics by Dr. Pranab Kr. Banarjee.
2. Bioinstrumentation by L. Veerakumari

3. Bioinformatics: Sequence And Genome Analysis by David W. Mount.
4. Basic Bioinformatics by S. Ignacimuthu Published by Narosa Publishing House New Delhi.

Third Year

Semester- V

Diversity of Non-Chordata– (4+1 Credits) = 5 Credits

Salient features and outline classification (up to orders) of various Non-chordate Phyla.

Protozoa: *Paramecium*: Locomotion, nutrition, osmoregulation and reproduction.

Porifera: *Sycon*: Structure, reproduction and development. Canal system and affinities of Porifera.

Coelenterata: *Aurelia*: Structure, reproduction and development. Polymorphism in Coelenterata. Corals and Coral reefs.

Helminthes: Taxonomy, Morphology (including adaptations), life cycle, pathogenicity and control measures of *Fasciola*. Parasitic adaptations in Helminthes. **Concept of parasitism.**

Annelida: *Nereis*: External features, excretory organs and reproduction. Metamerism in Annelida, its origin and significance. Trochophore larva and its significance. Parasitic adaptations in *Hirudinaria*.

Arthropoda: *Palaemon*- External features and reproduction.

***Peripatus*- Distribution and importance.**

Mollusca: *Pila*: External features, Organs of Pallial complex, Reproduction. Torsion in Gastropoda.

Echinodermata: Asterias- External features. Water vascular system. Mode of feeding and reproduction. Larval stages of echinoderms.

Practical

Study of museum specimens/slides (WM/TS/LS) of: Protozoa to Echinodermata.

Kingdom Protista: *Amoeba, Euglena*, *Plasmodium* and Paramecium.

Phylum Porifera: *Sycon, Hyalonema* and *Euplectella.*

Phylum Cnidaria: Obelia, Physalia, Aurelia, Tubipora, Metridium.

Phylum Platyhelminthes: *Fasciola hepatica* and *Taenia solium*, and their life stages.

Phylum Nemathelminthes: *Ascaris*

Phylum Annelida: *Aphrodite, Nereis, Pheretima, Hirudinaria*.

Phylum Arthropoda: *Palaemon, Cancer, Limulus, Palamneus, Scolopendra, Julus, Apis, Peripatus*

Phylum Mollusca: *Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus*.

Phylum *Echinodermata: Pentaceros, Ophiura, Echinus, Cucumaria* and *Antedon*.

Preparation of temporary and permanent slides of material provided.

Microscopic demonstration and identification of protozoans from pond water, ditches and soil.

Diversity of Chordata– (4+1 Credits) = 5 Credits

Salient features and outline classification (up to order) of Chordata.
Protochordata: Salient features of body organisation and systematic position of *Balanoglossus, Herdmania* and *Amphioxus* and its affinities.
Agnatha: External features of *Petromyzon*. Pisces: Scales and fins in fishes. Parental care in fishes. Fishes in relation to man.
Amphibia: General characters and affinities of Gymnophiona. Parental care in Amphibia.
Reptilia: Poisonous and non- poisonous snakes. Poison apparatus of snake. Snake venom and anti-venom. Adaptive radiation in reptiles. Adaptations of reptiles to desert life. Extinct reptiles. Chelonia, Crocodilia, Rhyncocephalia.
Aves: Flightless birds and their distribution. Flight adaptations in birds. Migration in birds.
Mammalia: General organisation, distribution and affinities of Prototheria. Economic importance. Adaptive radiation in aquatic mammals.
Introduction to skeletal systems of *Varanus*, fowl and rabbit.
Practical
Protochordata: *Balanoglossus, Herdmania, Branchiostoma,*
Agnatha: *Petromyzon*
Pisces: *Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla*, Hill stream fishes.
Amphibia: *Icthyophis, Salamandra, Bufo, Hyla, Racophorus, Rana*, Axolotl larva
Reptilia: *Chelone, Hemidactylus, Chameleon, Draco, Vipera, Naja, Crocodylus, Gavialis*.
Key for identification of nonpoisonous and poisonous snakes.
Aves: Study of six common birds from different orders.
Mammalia: *Funumbulus*, Bat, *Echinus*
Osteology:
Disarticulated skeleton of fowl, *Varanus*, and rabbit.
Carapace and plastron of turtle/ tortoise.
Mammalian skulls: One herbivorous and one carnivorous animal.

Suggested books:

1. Barnes: Invertebrate Zoology (4th ed.), Holt- Saunders, 1980.
2. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th) ed Times-mirror, Mosby
3. Kotpal R.L: Modern Textbook of Zoology: Invertebrates. Rastogi
4. Nigam: Biology of Non-Chordates, Nagin Chand.
5. Parker TJ & Haswell WA: Textbook of Zoology Vol I & II, Mcmillan.
6. Hyman L: Invertebrate Series, Academic Press

Aquaculture– (4 Credits)

Unit I

Aquaculture: Definition and Scope, commercially important cultivable finfish species in freshwater, brackish water and marine water environments; Types of farming systems: extensive, semi-intensive and intensive culture; Cage culture; Integrated fish farming.

Unit II

Fish ponds: types and their management; Fish polyculture with special reference to indigenous & exotic major carps; Induced breeding: Hypophysation and use of synthetic hormone, significance of Induced breeding .

Unit III

Prawn culture, ornamental fish culture and its significance; Commercially important fresh water and marine ornamental fish species; Maintenance of aquaria; Farming of pearl oyster [10 Hours]

Unit IV

Fish feed: Fish feed ingredients; Type of feeds and feeders used in Aquaculture; Commonly occurring diseases in aquaculture and their control. Field visit to fish farm, hatchery complex, and onsite interactions with progressive fish farmers.

SUGGESTED READINGS

1. A Textbook of Fish Biology and Fisheries, 3rd Edition by S.S. Khanna and H.R. Singh, NPH, Delhi (2014)
2. Aquaculture by John E. Bardach, Wiley India Pvt Ltd (1974)
3. Aquaculture: Principles and Practices by T.V.R. Pillay, Wiley India Pvt Ltd (2011)
4. Introduction to Aquaculture by Matthew Landau, Wiley (1991)
5. Textbook of Fish Culture by Marcel Heut, Fishing News Books Ltd (1972)

Apiculture– (4 Credits)

Unit I.

Biology of Bees: History, classification and biology of honey bees; Species of honey bees (*Apis dorsata*, *Apis cerana* indica, *Apis florea*, *Apis mellifera, Melipona irridipennis*; Specific Characteristics and suitability for geographic condition; Climatic requirement of different bee species; Social organization of honey bee colony

Unit II

Rearing of Bees. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth; Flora for apiculture; Selection of Bee Species for Apiculture; Modern method of apiculture – Tools and appliances for modern method.Enemies and diseases of Honey bee, Control and Preventive measures.

Unit III

Harvesting, Processing and Preservation of Honey & Economic Importance. Methods of harvesting honey; Processing of honey; Preservation of honey; Indigenous method for extraction of honey . Honey, Bees Wax, Propolis etc.- Production, Chemical composition of Honey bee wax; Economic, nutritional and medicinal value.

Unit IV

Entrepreneurship in Apiculture. Bee keeping industry – Requirements of Commercial Bee Keeping, Recent efforts, Government sponsored scheme, Modern method in employing honey bees for cross pollination in horticultural gardens.
Field Visit & Interaction with Bee Keepers and other Support Agencies.

SUGGESTED READINGS

1. Bisht D.S. (2016). Apiculture, ICAR Publication
2. Gupta, JK. (2016). Apiculture ICAR PDF Book
3. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
4. Singh S. (1962). Beekeeping in India, Indian council of Agricultural Research, New Delhi

Semester- VI

Developmental Biology (4+1 Credits) = 5 Credits

Gametogenesis: Spermatogenesis and Oogenesis including structure, differentiation and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs.
Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy.
Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage, totipotency.
Blastulation and Gastrulation: A complete study in frog and chick.
Fate maps, their formation and significance.
Foetal membranes: Their formation and functions in chick.
Introduction to Metamorphosis. Retrogressive metamorphosis in ascidian.
Regeneration: Morphallaxis and Epimorphosis, Blastema and its significance, mechanisms as exhibited by invertebrates (*Hydra* and *Planaria*) and Vertebrates (Limb regeneration in Amphibia).
Placentation in mammals.
Embryonic Induction: Origin, structure and significance of primary organizer.

Practical

General Endocrinology (4+1 Credits) = 5 Credits

Introduction to Autocrine, Paracrine, and Endocrine secretion.

Structure and functions of endocrine glands: Hypothalamus, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovary.

Types and nature of Hormones. Mechanism of hormonal action.

Endocrinological disorders: Dwarfism, Gigantism, Acromegaly, Diabetes insipidus, Diabetes mellitus, Goitre, Cretinism, Myxoedema and Addison's disease.

Practical

1. Examination of permanent histological sections of mammalians Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal gland.
2. Study of different endocrine diseases with the help of charts and photographs.
3. Study of prepared slides of embryology of frog and birds.
4. Microtomy of endocrine glands: Pancreas, testes and ovary of Fish.

Suggested books:

1. Gilbert: Development Biology Sinauers Ass. Publ. Massachusetts.
2. Wolpert: Analysis of Biological development, Oxford.
3. Kolthoff, Analysis of Biological development, McGraw- Hill Science, New Delhi, India.
4. Balinsky: Introduction to Embryology Saunders co. Philadelphia and London.
5. Berill: Development Biology Tata McGraw Hill.

Vermiculture (4 Credits)

Unit I.

Introduction to vermiculture: Definition, meaning, history, economic importance; Role in bio transformation of the residues and production of organic fertilizers; The matter and humus cycle. Ground population, transformation process in organic matter; useful species of earthworms (Local species and Exotic species of earthworms).

Unit II.

The earthworm species: Biology of *Eisenia fetida* (Taxonomy, anatomy, physiology and reproduction of Lumbricidae; Vital cycle of *Eisenia fetida*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, pH, light, and climatic factors).

Biology of *Eudrilus eugeniae* (Taxonomy anatomy, physiology and reproduction of Eudrilidae; Vital cycle of

Eudrilus eugeniae: alimentation, fecundity, annual reproducer potential and limit factors).

Unit III.

Earthworm farming: Earthworm compost for home gardens; Conventional commercial composting; Earthworm Farming (Vermiculture), Extraction (harvest), vermicomposting harvest and processing; Nutritional Composition of Vermicompost for plants; Vermiwash collection, composition & use; Enemies of Earthworms, Common problems their prevention and solution.

Unit IV.

The working group experience with *E. fetida* populations comportment with farm industrial residues (frigorific, cow places, feed-lot, aviaries exploitations, and solid urban residues); Lineaments to vermicomposting elaboration projects; Considerations about economic aspects of this activity.

Fish Hatchery Operation (4 Credits)

Unit I

Freshwater fish seed resources; Natural breeding of finfishes; Historical perspective of fish seed collection; Sexual maturity, breeding season and development of gonads [10 Hours]

Unit II

Induced breeding of Indian major carps (Catla, Rohu, Mrigala) and exotic carps (Silver carp, Grass carp); Environmental factors affecting spawning; Fish pituitary gland, synthetic hormones for induced breeding of fishes; Fish brood stock management and transportation of brood fish [12 Hours]

Unit III

Different types of fish hatcheries: traditional double-walled hapa, Chinese carp hatchery, glass jar hatchery, Flow throw hatchery; Egg and embryonic developmental stages; Causes of mortality of fish eggs and spawn in hatchery operation and their treatment.

Unit IV

Spawn rearing techniques: nursery and rearing pond management; Packing and transportation of fish seed and use of anaesthetics/ disinfectants in fish breeding and transport; Cryopreservation of semen. Suggested hatcheries in Uttarakhand: Trout hatchery, Bairangna, District Chamoli; Gangori hatchery, District Uttarkashi; Koteshwar hatchery (Common carp and Masheer fish seed), Koteshwar, District Tehri; Carp hatchery, Kashipur, US Nagar

SUGGESTED READINGS

1. Broodstock Management and Quality Fish Seed Production in Freshwater Fishes by K K Marx, NPH, Delhi (2019)
2. Fish Hatchery Management by Robert G. Piper, Andesite Press (2015)
3. Induced Fish Breeding: A Practical Guide for Hatcheries by Nihar Ranjan Chattopadhyay, Academic Press; 1st edition (2016).
4. Text Book of Breeding and Hatchery Management of Carps by Gupta and Mohapatra, NPH, Delhi (2008)

Fourth Year

Semester- VII

Fundamentals of Immunology (4+1Credits) = 5 Credits

Unit - I

Introduction and Historical Background: Cells and Organs of Immune System
Immunology: Definition, branches, scope and applications. Overview of Immune System. Anatomical, Physiological and Inflammatory Barriers.
Historical aspects of major contribution in Immunology by Edward Jenner, Jacob Henle, Louis Pasteur, Joseph Lister, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Emil Von Behring, Jules Bordet, Karl Landsteiner, Jules Freund, Peter Gorer And George Snell, Tiselius & Kabat, Gerald Eldelman & Rodeny Porter, Cesar Milstein & Georges Kohler, Peter Doherty & Rolf Zinkernagel

Hematopoiesis: Formation, maturation and regulation of B & T-Lymphocytes. Cells of the Immune System- NK Cells, B-Lymphocytes, T-Lymphocytes, Granulocytes, Dendritic Cells. Primary and Secondary Lymphoid Organs and their functions, Mucosal-Associated

Lymphoid Tissue [MALT], Intraepithelial Lymphocytes [IEL], Gut Associated Lymphoid Tissue (GALT), Cutaneous-Associated Lymphoid Tissue [CALT]

Unit - II

Antigen and Immunogen, Structure and Function of Immunoglobulins, Structure and Function of MHC:

Antigen and Immunogen: Definition and Properties. Antigenecity Vs. Immunogenicity. Haptens and Adjuvants. Immunoglobulins: Classes, structure and functions. Major Histocompatibility Complex [MHC] - Structure, Types, Functions and Regulation of MHC Expression.

Unit - III

Primary and Secondary Line of Defence [Innate and Acquired Immunity], Antigen-Antibody Interactions:

Innate and adaptive Immune response - Phagocytic Barriers. Antigen Presenting Cells. Antigen Processing and Presentation. Acquired Immunity- B-Cell Mediated Immunity, T-Cell Mediated Immunity, Its Mechanism and Regulation. Memory cells.

Structure of Antibody, Antigen-Antibody reactions, affinity and avidity.

Unit - IV

Immune Effector Mechanism, Allergy and Hypersensitivity:

Cytokines: Properties, Receptors and secretions by Th1, Th2 and Th17 Subsets and their functions. Complement System: Its Components, Functions, Activation and Regulation.

Allergy and Hypersensitivity: Gell and Coombs Classification, IgE Mediated [Type I] Antibody-Mediated Cytotoxicity [Type II], Immune Complex-Mediated [Type III] and T_{DTH}- Mediated [Type IV] Hypersensitivity.

Paper II Applied Immunology (4+1Credits) = 5 Credits

Unit - I

Immune Response to Infectious Diseases:
Expression of Immune Response during Viral [Influenza, HIV], Bacterial [*Mycobacterium*] Protozoan [*Plasmodium and Giardia*] and Helminth Infections [*Ascaris*].

Unit – II

Disease of Immune System and Vaccines:

Autoimmune Diseases- Systemic Lupus Erythromatous [SLE] and Rheumatoid Arthritis. Lymphoma and Leukemia [Hodgkin and Non-Hodgkin].

Vaccines- Historical Background, Routine Vaccines, DNA Vaccines. Monoclonal Antibodies: Mechanism of Production [de novo and Salvage Pathway], Monoclonal Antibodies in Research and Health.

Unit - III

Immunotechnology

Separation of Immune Cells by Flow cytometry [FACS]: Its Principle and Application. Principle and Application of Immunoprecipitation. Functioning and Application of Microscopes: Immunofluorescence and Confocal. Principle and Application of *in-Situ* Hybridization Technology-FISH [Fluorescence *In-Situ* Hybridization] and GISH [Genome *in-Situ* Hybridization]. Principle, Methodology and Application of Following Techniques- ELISA [Enzyme Linked Immunosorbent Assay], RIA [Radio Immuno Assay], Western Blotting. Allergy Evaluation: Principle and Methodology of Skin Prick Test for Allergy.

Unit - IV

Transplantation Immunology:

Transplantation- History, Graft Vs. Host Rejection, Hyperacute, Acute and Chronic Rejections and their mechanisms.
Immunosuppression- Definition, drugs used in immunosuppression and its mechanism of action. -
Xenotransplantation- definition and its application. HLA typing, Lymphoproliferation Assay. Blood Group [ABO] and Blood Transfusion.

Practical (Immunology)

- Cell viability test using chicken or got spleenocyte. [Methylene blue dye exclusion test]
- Determination of ABO blood group.
- Ouchterloney's didiffusion immunoassay.
- Study of primary and secondary lymphoid organs through microphotograph or models or chart.
- Use of flowcytometry to separate specific immune cells [separation of T-cells, B-cells, Stem cells etc. [Dry lab exercise in case lab facility is not available].
- Immunoprecipitation dry lab exercise.
- Performance of ELISA test [Dry lab exercise in case lab facility is not available].
- Immunohistochemistry [Dry lab exercise in case lab facility is not available].
- Western blotting [Dry lab exercise in case lab facility is not available].

Paper III Animal Ecology (4+1Credits) = 5 Credits

Unit-I

Ecology: Branches and Scope.
Habitat and Niche: Concept of Habitat and Niche, Niche width and overlap, Fundamental and Realized Niche, Resource Partitioning.
Structure and Function of Ecosystem: with reference to Forest, Grassland, Lake, Fresh Water, Marine and Estuarine.

Primary and Secondary Productivity, Movement of Energy and Materials, Energy Efficiency thermal stratification and Circulation and Lake's typology.

Unit-II

Limiting Factors: Laws of Limiting Factors, Impact of Temperature, Moisture and pH on organisms.

Population Ecology: Characteristics, Growth Curves and Regulation of population, Life History Strategies (r and k Selection), Concept of Meta- Population – Demes and Dispersal, Interdemic Extinctions, Age Structured.

Altruism (Hamilton's Rule).

Community Ecology: Community Attributes namely dominance, Diversity Indices (Lincoln Peterson Index, Simpson Index, Shannon Weiner Index, Berger Parker Index and Brillouin Index). Similarity coefficient and Niche concept, Community nomenclature. Lotka-Voltera model of species competition.

Unit-III

Water pollution: Point and Non-Point Sources of Pollution, Bio-monitoring (Phytoplankton, Zooplankton and Zoo Benthos), Environmental Impact Assessment (EIA). Eutrophication. Indicators of Pollution and Eutrophication.

Species interactions: types of Interactions, Interspecific Competition.

Unit-IV

Ecological Succession: types, mechanisms, changes, concept of climax.

Biogeography: Major terrestrial biomes, Theory of Island Biogeography, Bio-Geographical Zones of India.

Environmental Pollution, Global Environmental Change, Global Conventions on Environmental Pollution (Kyoto Protocol, Montreal Protocol and Earth Summit 2002).

Conservation Biology: Principles of Conservation, Major Approaches to Management, Indian Case Studies on Conservation /Management Strategy (Project Tiger, Biosphere Reserves and Lakes).

Practical

- Calculation of similarity index between different communities
- Calculation of concentration of dominance for different communities
- Calculation of Shannon Weiner Index of diversity in different communities
- Determination of salinity and chlorinity in water samples
- Determination of moisture content and total organic matter in soil sample
- Determination of dissolved oxygen
- Determination of free CO2 in water sample
- Determination of the thermal stratification and circulation period of a water body.

Paper IV Medical Laboratory Techniques

(4+1 Credits) = 5 Credits

Unit I

Basic Laboratory Principles - Code of Conduct of Medical Laboratory Personnel. Organization and Functioning of Clinical Laboratory. Safety Measures - Safety Equipment's, Safety Symbols. Hazards in the Laboratory (Chemical Hazards, Clinical Hazards, Electrical Hazards, Biological Hazards. Waste Disposal.

Unit II

Introduction to Common Laboratory Equipment including laminar air flow, hot air oven, incubator, autoclave and centrifuge.

Microscope - Fundamentals of microscopy, resolution and magnification, light and electron microscopy, PCR machine (thermal cycler), Electrophoresis unit and UV Trans illuminator.

Unit III

Collection, processing and preservation of clinical samples including Blood, Urine, Stool, Sputum, Pus, Body Fluids and Swab and techniques involved.

Preparation of Blood Smear. Sources of Biological Variations and Pre-Analytical Variables.

Unit IV

Preparation of reagents: buffers and pH, normal, percent and molar solution, normal saline.

Clinical laboratory records, modern laboratory set up - quality control: accuracy, precision, and reference values.

Disposal of biomedical wastes.

Laboratory safety protocols and guidelines.

Practical

- Purity determination and quantitation of DNA
- Isolation of genomic DNA
- Electrophoresis of Proteins
- Electrophoresis of DNA - linear, circular and super coiled
- Southern blotting
- Western-blotting
- RFLP analysis
- Isolation of RNA
- Northern blotting.
- Nucleic acid hybridization
- Determination of Tm of nucleic acid
- Comments including principle, functioning and utility of some common instruments like laminar air flow, hot air oven, BOD Incubator, autoclave Microscopes, Microtome, Centrifuge.

Semester- VIII

Paper I General Ichthyology (4+1Credits) = 5 Credits

Unit I

Fishes: classification, habit and habitat, morphology and distribution. significance and affinities of Holocephali and Dipnoi.
Origin and evolution of fins in fishes.

Histomorphology and elementary physiology of digestive (with particular reference to food and feeding habits of freshwater fishes) and excretory systems (with particular reference to acid base balance and osmoregulation). Accessory respiratory organs in fishes.

Unit II

General survey of the marine, estuarine and inland capture Fisheries of India with particular reference to Fishery resources of Uttarakhand.

Methods of Fishing: Fishing Gears and Crafts. Cold Water Fishery, Sewage-Fed Fishery and Shell –Fish Fishery.
Fish: Nutrition and Growth including Age and growth relationship, Chemical composition of Fish flesh, length –weight relationship, natural feed and artificial feed and their roles in Fish Culture. Plankton and Benthos in Relation to Fish Production.

Unit III

Electric Organs in Fishes.

Sexual dimorphism, courtship and parental care. Migratory Instincts, Hill Stream Adaptations.
Reproduction in Major Carps- Structure of Gonad, Spawning, Early Development and Metamorphosis.
Microscopic Structure and Hormonal Functions of Endocrine Glands including Pituitary, Thyroid, Pancreas, Adrenal, Corpuscles of Stannous, Ultimobranchial Glands, Caudal Neurosecretory System and Sex Hormones. Current Trends in Induced Breeding in Fishes.

Unit IV

Sense Organs: Organs of Smell, Eyes, Hearing, Ampulla of Lorenzini, Bio-Luminescence, Sound Production and Lateral Line System.
Parental Care in Fishes. Venomous and Non-Venomous Fishes. Fish Pheromones.
Coloration in Fishes.

Paper II Applied Ichthyology (4+1Credits) = 5 Credits

Unit I

Important Cultivable Fishes and Shellfishes

Biology of Cultivated Fish and Shellfish

Unit II

Ecology and Productivity of Fish Ponds. Pollution in Relation to Fisheries.

Carp Culture: Mono Culture, Poly Culture and Composite Fish Culture. Live Fish Culture. Management Practices: Weed, Insect and Carnivorous Fishes.

Unit III

Maturation and Fecundity, Spawning and Seed Collection, Induced Breeding, Hatching Techniques and Hatcheries, Nursery Management, Packing and Transport of Fish.

Unit IV

Integrated Aquaculture: Fish-Cum Poultry, Fish-Cum Duckery, Fish-Cum Piggery, Paddy-Cum Fish Culture and Dairy-Cum Fish Culture. Induced Spawning and Hybridization. Factors Responsible for Induced Breeding, Hypophysation. Use of Different Synthetic and Natural Hormones.

Larvivorus Fishes and Public Health. Fish Diseases and Their Management. Exotic Fishes and Their Merits and Demerits, Cryopreservation of Gametes and Embryos. Ornamental Fish Culture.

Practical (Fisheries)

- Detailed study of the skeleton of a Cyprinoid and a Siluroid fish
- Permanent preparation of scales, sensory, Ampullae etc.
- Taxonomic studies of fresh water fishes
- Ecological study- Estimation of dissolved oxygen, carbon dioxide and pH of pond water
- Determination of age with the help of scales
- Calculation of Gonado-Somatic Index and Gastro-Somatic Index
- Determination of fish fecundity
- Extraction of Pituitary gland
- Sham injection of Pituitary gland extract
- Analysis of gut content
- Study of length-weight relationship

- Models on dissection of cranial nerves of fish and accessory respiratory organs.
- Determination of age with the help of scales.
- Calculation of Ganado-somatic index and Gastro-somatic index.
- Exercises on Fish habitat Ecology.
- Determination of CO2, DO, pH, turbidity, hardness of water.
- Measurement of primary productivity.
- Qualitative and quantitative analysis of phytoplankton and Zooplankton.

Paper III Basic Limnology (4+1Credits) = 5 Credits

Unit I

Introduction and Development of Limnology in India

Inland, Waters Distribution of Inland Waters: Ponds, Lakes, Streams, River

Unit II

Lakes: Thermal Classification of Lakes, Famous Lakes of India and World, Nature of Inland Water Environment. Physical Characteristics: Pressure, Compressibility, Density Mobility, Buoyancy, Movement of Water Thermal Stratification Light, Color and Turbidity.

Unit III

Chemical Characteristics: Dissolved Gases – Oxygen, Carbon Dioxide and Other Dissolved Gases Dissolved Solids and Dissolved Organic Matter Influence of Physical and Chemical Conditions on Living Organisms in Inland Water Bodies.

Plankton: Classifications of Organisms in Water, Distribution of Plankton Food.

Unit IV

Biological Productivity, Circulation of Food Material, Classification of Lakes Based on Productivity, Laws of Minimum, Biotic Potential and Environmental Resistance, Quantitative Relations in a Standing Crop.

Water Pollution, Eutrophication, Algal Blooms, Water Borne Diseases and Drinking Water Parameters.

Bioremediation of Polluted Water Bodies.

Practical

- Introduction & Drainage Basin / Lake Morphology
- Stream Habitat and Physical Limnology
- Models of lake heat and circulation
- Physical and Chemical Lake Limnology Field Trip
- Plankton Collection Field Trip
- Fish and macro-invertebrate collection

Paper IV

Nanotechnology and Computer Application (4+1Credits) = 5 Credits

Unit -I

Introduction to nanotechnology: application, scope and relevance in modern era of research, nanomedicines.

Properties of nanomaterial: physical, biological, mechanical, optical thermal, catalytic and magnetic.

Unit -II

Nanotechnology for waste water treatment: nano photocatalysts, nanomembrane/ filters, nano fertilizers, nano pesticides and nano sensors.

Nanotoxicology: types of nanomaterials, carbon nanotubes, fullerene, metal nano particles, Factors affecting nanotoxicology.

Unit -III

Introduction to Computers: Mini, micro, mainframe and super computers.

Components of a computer system (CPU, I/O units), input and output devices. Data storage device, Memory concepts.

Unit -IV

Operating systems, computer languages, Software and types of soft wares (LAN, WAN).

Introduction to MS- WORD: word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc, Introduction to

Power Point, image and data handling.

Computer applications in biology, medicine and information communications.

Introduction of Artificial Intelligence.

Practical

- Preparation of nanoparticle used in biosciences.
- Web Page design.
- working on statistical software.
- Study of networking by charts and models.

Minor/Elective

Chronobiology (4+1Credits) = 5 Credits

Introduction to chronobiology. Evolution of biological timing system, Clocks, genes and evolution, Adaptive functional significance of biological clocks.

Biological Rhythms - Ultradian, Tidal/Lunar, Circadian and Circannual rhythms, Temperature effects and compensation, Perception of natural zeitgeber signals, Geophysical environment - Seasons, proximate and ultimate factors.

Entrainment, masking and zeitgeber cycles, parametric and non-parametric entrainment, Entrainment models, Phase shift, Phase response curves (PRC) and phase transition curves (PTC), Organization of circadian system in multicellular animals, Concept of central and peripheral Clock system in multicellular animals, SCN suprachiasmatic nucleus as the main vertebrate clock, concept of core and shell.

Diversity and complexity of the clock system, Melatonin: input and output signal of the clock system. Photoreception and photo-transduction. Human Health and diseases- chrono-pharmacology, chrono-medicine and chronotherapy.

or

Applied Zoology (4+1Credits) = 5 Credits

Parasitic protozoa and Helminthes: *Ancylostoma*, *Schistosoma, Ascaris, Filaria* (including periodicity).

Detailed information on:

(a) Aquaculture
(b) Sericulture
(c) Apiculture
(d) Lac culture

Section – B

Bionomics and control measures of the common pests of fruits (*Papilio demoleus* and *Quadraspidiotus perniciosus*), Vegetables (*Thrips tabaci* and *Aulacophora foveicollis*) and stored grains (*Callosobruchus chinensis* and *Trogoderma granarium*). Polyphagous pests (Locust and Termites).

Pest management, including insect pest control and integrated pest management. A note on Bioethics.

Economic importance of birds and
mammals. Common Pests of Uttarakhand.

or

General Biotechnology (4+1Credits) = 5 Credits

Origin and definition, scope and importance of Biotechnology. Recombinant DNA technology and Genetic engineering. Restriction enzymes and cloning techniques used in recombinant DNA technology.

DNA fingerprinting. Biochips.
Biotechnological innovations in the area of medical, agricultural, industrial & forensic science

Fifth Year

Semester- IX

Paper I Systematics and Applied Entomology (4+1Credits) = 5 Credits

Unit I

Ancestry and Evolution of Insects
Classification of Insects
Principles of Construction and Use of Dichotomous Keys in Insect Identification
Methods of Collection, Preservation and Culture of Insects
Parental Care in Insects

Unit II

Brief Knowledge of Habit, Habitats and General Characters of the Following Orders With Special Reference to the Families Mentioned: Thysanura (Machilidae, Lepismatidae), Collembola, Odonata, Orthoptera (Acrididae, Tettigonidae, Gryllidae), Phase Theory in Locusts, Phithioptera (Anoplura, Mallophaga), Isoptera, Thysanoptera, Heteroptera (Pentatomidae, Belostomatidae), Homoptera (Aphidae, Coccidae), Coleoptera (Coccinellidae, Curculionidae), Lepidoptera (Noctuidae, Nymphalidae), Hymenoptera (Ichneumonidae, Formicidae), Diptera (Muscidae, Syrphidae)

Unit III

Principles and Practices of Pest Control:

Pest Control Procedures: Natural Control, Applied Control (Cultural, Biological and Insecticidal)
Modes of Action of Insecticides, Factors Affecting Toxicity of Insecticides

Non-Insecticidal Methods: Antifeedents, Attractants and Repellents, Feeding Deterrents, Chemosterilants, Pheromones and Insect Growth Regulators (IGR's)
Integrated Pest Management (IPM)

Insecticide Application Equipments: Sprayers, Dusters, Granule Applicators

Distribution, Habit and Habitats, Life-Cycle, Nature of Damage and Control of Pests of: **Stored Grains (***Sitophilus oryzae, Tribolium castaneum, Callosobruchus chinensis*), **Sugarcane** (*Pyrilla perpusilla*), **Paddy***(Leptocorisaa Acuta*, *Hieroglyphus banian*), C**otton (***Dysdercus Koengii, Pectinophora Gossypiella*), **Cereals** *(Heliocoverpa armigera,)* **Vegetables***((Raphidopalpa (Aulacophora foveicollis, Pieris Brassicae*), **Fruits** (*Papilio Demoleus*)**, Forests** (**Defoliator**: Tasar Silkworm, *Antheraea paphia*, **Sap-Sucker** Of Khamer or Gamhar. *Tingis beesoni*, **Teak Borer**, *Aeolesthes Holosericea*), and **Polyphagous Pests**(Locusts, Termites)

Unit IV

Lac Industry: Strains of Lac Insects, Lac Cultivation, Composition and Uses of Lac

Apiculture: Kinds of Honey Bees and Bee Hives, Structure of Typical Bee Hive Organization of Honey Bees, The Language of Honey Bees, Bee Keeping Methods, Economic Importance and Diseases of Honey Bees. Parasites of Honey Bee (*Varroa destructor, Varroa jacobsoni* and *Galleria mellonella*).

Sericulture: Mulberry and Non-Mulberry Sericulture, Composition Processing of Silk and Silk Industry in India. Diseases of Silkworm (White Muscadine and Pebrine Disease).

Paper II Biology of Insects (Morphology, Physiology & Development) (4+1Credits) = 5 Credits

Unit I

Integument: Structure, Functions and Modifications of Insect Cuticle, Moulting and Sclerotization
Structure of an Insect Head, Thorax and Abdomen, Appendages of Head (Mouthparts and Antennae) and Thorax (Legs and Wings)
Structure of a Wing of an Insect, Types of Wings, Hypothetical Wing Venation, Wing-Coupling Mechanisms and Flight Mechanism
Structure and Modifications of Male and Female Genitalia in Insects

Unit II

Structure and Modifications of Alimentary Canal, Food and Feeding Mechanism of a Generalised Insect with Special Reference to Physiology of Digestion in Different Insects
Structure and Functions of Blood and Mode of Circulation in Insects

Principal organs of excretion of insects found in different habitats, physiology of excretion with special reference to osmoregulation in Insects.

Unit III

Structure and functioning of various types of respiratory organs, modes of respiration, physiology of respiration in terrestrial, aquatic and endoparasitic insects.
Generalized plan of nervous system in insects and its modifications.

Neuroendocrine System in insects and the role of neurosecretion in various metabolic activities, metamorphosis and development of insects.

Structure and functions of different types of visual and sound producing organs in insects

Unit IV

Structure, Function and Physiology of Mechanoreceptors and Chemo Receptors in Insects

Light Producing Organs, Mechanism and Significance of Light Production in Insects
Structure of Pheromone Producing Glands, Types of Pheromones and their Chemical Nature
Structure and Modification of Male and Female Reproductive Systems in Insects

Development: Structure of Egg, Maturation, Cleavage, Blastokinesis, Formation of Germ Layers and Segmentation, Polyembryony and Parthenogenesis in Insects

Practical (Entomology)

Candidates must produce at the time of practical examination their preparations, collection and practical record books containing a complete record of the laboratory work done during the session. The practical work shall comprise of following exercises:

- Study of models on dissection of nervous system of insects
- Permanent preparation of sting apparatus of honey bee/wasp, tympanum of locust, salivary glands of Cockroach, antennae, mouth parts, legs and wings of different insects.
- Counting of haemocytes in insects
- Modifications of insect heads on the basis of their orientation
- Identification of insects up to family of the orders prescribed in theory
- Study of the different types of adaptations found in insects
- Determination of pH of the gut contents
- Microtomy of insect tissues
- Pests of fruits, vegetables & stored grains
- Study of the structure of bee-hive
- Bioassay studies on insects using some contact poisons
- Use of dichotomous key in the identification of insects
- Study of the life-cycles of some important insect pests
- Determination of Shannon-Weiner diversity index from given data
- Exercises on insect behaviour

PAPER III Economic Zoology and Vermicology (4+1 Credits) = 5 Credits

Unit I

The General introduction of Parasites in Terms of Morphology, Mode of Transmission, Symptoms, Prevention and Control.
Types of Parasites Unicellular Parasite. Protozoans (*Entamoeba histolytica, Plasmodium*

Spp.,) *Trypanosoma* Spp. *Leishmania* sp. etc.) *Giardia* and Vector Biology.

Study: Multicellular Parasites, Platyhelminthes (Tape Worms and Liver Flukes) Aschelminthes (*Ascaris*) Nematoda.

Unit II

Pests and Parasites, Pisciculture, Dairy and Farming's Products.

Pesticides (Organchlorines, Arganophosphates, Carbanates, Pyrethroids, Triazmes, Bardeux Mixture), Mode of Action of Pesticides, Advantages and Disadvantages of Pesticides Hazards of Pesticides,

Biological Control. Integrated Pest Management.

Unit III

Earthworm Diversity: Classification Earthworm Types: White Worm Behavior of Earthworms as Indicators of Soil Fertility, Earthworms as Bioreactors, Earthworms and Plant Growth, Organic Matter-Dynamics and Nutrient Cycling, Feeding Habit and Food

Vermicomposting: Advantages of Vermicomposting, Vermicomposting in Daily Life, Vermiculture Vs. Vermicomposting, Chemical composition of Vermicompost Vermicomposting at Home and Agricultural Farm, The Business of Worms, Interaction of Vermicompost Earthworms.

Unit IV

Earthworm Biotechnology: Fundamentals of Sustainability, Enrichment of Vermicompost and Earthworms for Sustainable Production, Earthworms in Bio-Remediation, Earthworms in Alternative Medicine, Earthworm Meal Production Transgenic Earthworms.

Organic Farming: Eco-Friendly Farming System Technologies. Evaluation Study of Ecological Constraints (Climatic and Edaphic,). Appropriate Technologies, in Agro-Forestry, Natural-Management, Planted Forests, (Ranching, Farmers Perception to Organic Farming and any Case Study).

Paper IV Wildlife Conservation (4+1Credits) = 5 Credits

Unit I

Indian Wildlife: Introduction, Distribution of Wildlife in Ecological Subdivision of India. Technic in censes of Wildlife.

Protected Area: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoo in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant, Musk deer and Tiger).

Unit II

Reasons for Wildlife Depletion: Habitat Fragmentation, Habitat Destruction, Commercial Wildlife Exploitation, Overgrazing Etc.,

Wildlife Conservation: policies and Programmes, Special Projects for Endangered Species (Project Tiger, Gir Lion Sanctuary Project and Crocodile Breeding Project).

Unit III

Principle and Practice of Wildlife Management: Management of Special Habitats, Riparian Zones, Grasslands Introduction to Conservation Biology, Conservation Values and Ethics of Conservation of Natural Resources.

Conservation of Biodiversity, Patterns and Processes, Concepts of Biodiversity, Levels of Biodiversity, Genetic Diversity, Intra Specific Diversity, Species Richness, Richness of Higher Taxa. Important and crisis of biodiversity.

Unit IV

International Conventions on Conservation (Ex-Situ and in-Situ Conservation, Conservation Breeding (E.G. Vulture, Pygmy Hog, Gharial, Etc.), Institutions and their Role in Conservation (Zoo, Natural History Museums and Collections, Zoological Survey of India and Its Regional Centers.
National and International Zoological Institutes, Societies and Academic Bodies.

Brief Account of Wildlife Acts and Their Amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Semester- X

Paper I Animal Biotechnology (Animal Cell Culture) (4+1Credits) = 5 Credits

Unit I

Animal Cell Culture: Equipment and Materials. Design and Layout of Culture Room, Sterilization and Aseptic Techniques.
Culture Medium: Natural Media, Synthetic Media, Sera. Introduction to Balanced Salt Solutions and Simple Growth Medium.
Brief Discussion on the Chemical, Physical and Metabolic Functions of Different Constituents of Culture Medium, Role of Carbon Dioxide, Serum and Supplements in Animal Cell Culture.
Characteristics of Cells in Culture: Contact Inhibition, Anchorage Dependence and Cell-Cell Communication.

Unit II

Mechanical and Enzymatic Disaggregation of Tissue and Setting up of Primary Cultures, Candling of Eggs, Preparation of Chick Fibroblast, Culture of Lymphocytes for Chromosomal Studies. Roller and Suspension Culture Techniques.
Large-Scale Production of Cells Using Bioreactors, Micro- Carries and Perfusion Techniques. Measurement of Viability and Cytotoxicity. Biological Characterization of the Cultured Cells, Karyotyping, Cryopreservation and Revival. Detection of Contaminants in Cell Cultures.

Unit III

Fermentation Technology in cell culture (Bioreactors, Hollow Fiber Reactors, Air-Lift Fermentors, Chemostats and Microarriers).

Established Cell Line Cultures: Definition of Cell Lines, Maintenance and Management, Cell Adaptation.

Stem Cell Cultures, Embryonic Stem Cells and their Applications. Somatic Cell Genetics. Organ and Histotypic Cultures.

Cell Cloning, Cell Synchronization and Cell Manipulation. Various Methods of Separation of Cell Types, Advantages and Limitations, Flow Cytometry.

Production and Characterization of Monoclonal Antibodies and their Application.

Unit IV

Commercial Applications of Animal Cell Culture: Cell Culture Based Vaccines, Tissue Culture as a Screening System, Cytotoxicity, *in-vitro* Testing of Drugs and Diagnostic Tests.

Mass Production of Biologically Important Compounds (E.G. Vaccines and Pharmaceutical Proteins).

Production of Recombinant Hemoglobin, Blood Substituents, Artificial Blood. Harvesting of Products, Purification and Assays. Three Dimensional Cultures and Tissue Engineering (Artificial Skin and Artificial Cartilage).

Paper II Animal Biotechnology (Transgenics, Cloning and IPR)

(4+1Credits) = 5 Credits

Unit I

Gene Transfer Technology in Animals: Viral and Non-Viral Methods, Sperm Mediated Gene Transfer, Transfection of Animal Cell Lines and their Immortalization, Gene Knock Out Animal Models, Current Status of Production of Transgenic Animals.

Animal Cloning: Techniques, Relevance, Case Studies and Ethical Issues.

Unit II

in vitro Fertilization (IVF) and Embryo Transfer (ET) Technology in Humans, Superovulation, Micromanipulation, IVF And Embryo Culture in Farm Animals (E.G. Cow), Embryo Transfer in Cattle, Gene Transfer or Transfection (Using Eggs and Cultured Stem Cells): Targeted Gene Transfer, Transgenic Animals (Mice, Sheep, Pigs, Rabbits, Goats, Cows and Fish).

Unit III

Introduction to Biosafety Regulations, Primary Containment for Biohazards and Biosafety Levels, Biosafety Guidelines – Government of India. Definition of Genetically Modified Organisms (Gmos) & Living Modified Organisms (Lmos), Roles of Institutional Animal Ethical Committee, Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Approval Committee (GEAC).

Prevention of Cruelty on Animals Act Govt. of India, Concept of Bioethics, Public Concerns on Human Genome Research and Transgenics – Genetic Testing and Screening, Ethics in Clinical Trials and Good Clinical Practices (GCP), Ethical, Legal and Social Implications (ELSI) & Human Genome Project, Ethics in Human Cloning and Patenting Human Genes.

Unit IV

Intellectual Property Rights and Its Types-Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs, Basics of Patents (Types, Patent Application and Specifications), Concept of Prior Art and Patent Filling Procedures, Process Patent Vs Product Patent.

Introduction to General Agreement on Tariffs and Trade (GATT), World Trade Organization (WTO), World Intellectual Property Organization (WIPO) and Trade Related Intellectual Property Rights (TRIPS).

Paper III Evolutionary Biology and Taxonomy. (4+1Credits) = 5 Credits

Unit I

Introduction to Evolutionary Theories: Lamarckism, Darwinism, Neo-Darwinism. Direct Evidences of Evolution: Types of fossils, Incompleteness of fossil record, Dating of fossils, phylogeny of horse and man. Processes of Evolutionary Change: Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

The Mechanisms of Evolution: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;

Unit II

Species Concept: Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric). Evolution above species level: Macro-evolutionary Principles (example: Darwin's Finches) Extinction: Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution. Genetic polymorphism; Convergent evolution; Sexual selection; Co-evolution.

Unit III

Natural Selection: Role of Mutation in Evolution, (Gene mutation, Mutation Rates, Mutation and selection, Genetic Polymorphism). Speciation: Isolating mechanism, Modes of Speciation (Allopatric, Sympatric, Parapatric). Micro and Macroevolution. Animal Distribution: Zoogeographical division of the World (Characteristics and Fauna). Island Biogeography theory. Fossils and fossilization. Micro Evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches).

Unit IV

Taxonomy

Introduction to Systematics and Taxonomy: Significance and brief History of Taxonomy Modern: approaches in Taxonomy Concepts of Zoological classification: functions, systems of classification, Linean hierarchy, Taxonomic Aids (Museums, National Parks, and Keys) Species Concept: Typological, Nominalistic, Biological and Evolutionary Rules of Zoological Nomenclature: International Commission on Zoological Nomenclature (ICZN), Taxon, Rank and Categories Collection, Preservation and Identification of insects and other specimens using Keys

Practical

- Study of evolution of horse, elephant, and man(through charts/ models)
- Adaptive modification in feet of birds/mouthparts of Insects (through charts/ slides)
- Embryological evidences of evolution (through chart)
- Analogy and Homology (wings of birds and insects, forelimbs of bats and rabbits through charts)
- Identification of local fauna on the basis of their morphological characters (5 each)
- Construction of a dichotomous key
- Zoological names of some local fauna
- Taxonomy of Drosophila (Chaetotaxy)

Paper IV Research Methodology and Biostatistics (4+1Credits) = 5 Credits

Unit I

Introduction of Research Methodology: Meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India.

Research Problem: Definition, necessity and techniques of defining research problem, Formulation of research problem, Objectives of research problem.

Research Design: Meaning, need and features of good research design, Types of Research Designs, Basic Principles of Experimental Designs, Design of experiments, Synopsis design for research topic.

Sampling Designs: Census and Sample surveys, Different types of sample designs, Characteristics of good sample design, Techniques of selecting a random sample.

Unit II

Editing, Data Collection and Validation: Primary and secondary data, Methods of collecting primary and secondary data, Importance and methods of editing and data validation.

Hypothesis: Definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, Parametric and non-parametric tests for testing of hypothesis, Limitations of tests of hypothesis. 8. Paper/Thesis Writing and Report Generation: Basic concepts of paper their writing and report generation, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.

Unit III

Introduction to Biostatistics: Terminology and symbols, applications of statistics in biological research, collection and representation of data, measures of central tendency (Mean, Median, Mode), Coefficient of variation, Standard Deviation, Skewness and Kurtosis

Unit IV

Test of significance, Analysis of variation (ANOVA), measures of dispersion, distribution patterns (Binomial, Poisson & normal), tests of significance ('t' test, 'f' test & Chi-square test), probability, correlation and regression analysis, Introduction to statistical software and handling.

Skill Enhancement Course/Vocational Course

1. Public Health and Hygiene

Unit 1: Scope of Public health and Hygiene- nutrition and health- classification of foods- Nutritional deficiencies – Vitamin deficiencies.

Unit 2: Environment and Health hazard – Environment degradation – Pollution and associated health hazards.

Unit 3: Communicable diseases and their control measures such as Measles, Polio, Chikunguniya, Rabies, Plague, Leprosy and AIDS.

Unit 4: Non-Communicable diseases and their preventive measures such as Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.

2. Sericulture

Unit 1: Classification of commercial varieties of mulberry, Mulberry plantation establishments and cultivation practices.

Unit 2: Diseases of mulberry – fungal, bacterial, viral and Nematode diseases, Deficiency diseases and their remedial measures

Unit 3: Silkworm rearing operations – Chawki rearing and Late age rearing techniques.

Unit 4: Physical and commercial characters of Cocoons. Reeling operations, Importance of by –products if Sericulture.

Unit 5: Economics of Sericulture – Future and progress of Sericulture Industry in India. Prospects of Sericulture as Self-Employment venture.