NATIONAL EDUCATION POLICY-2020

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

PROPOSED STRUCTURE OF
UG & PG - ZOOLOGY
SYLLABUS

2021

Curriculum Design Committee, Uttarakhand

Sr.No.	Name & Designation	
1.	Prof. N.K. Joshi Vice-Chancellor , Kumaun University Nainital	Chairman
2.	Prof. O.P.S. Negi Vice-Chancellor , Uttarakhand Open University	Member
3.	Prof. P. P. Dhyani Vice-Chancellor , Sri Dev Suman Uttarakhand University	Member
4.	Prof. N.S. Bhandari Vice-Chancellor, Soban Singh Jeena University Almora	Member
5.	Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun	Member
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member
7.	Prof. K. D. Purohit Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	Member

Syllabus Expert Committee

S. N.	Name	Designation	Department	Affiliation
1.	Prof H.C. S Bisht	Head & Convener	Department of Zoology	D.S.B Campus, Kumaun University, Nainital
2.	Prof Ila Bisht	Head & Convener	Department of Zoology	S.S.J Campus, S.S.J University, Nainital
3.	Dr. Ahmad Pervez (Online)	Assistant Professor	Department of Zoology	S.S.D.U Rishikesh
4.	Dr. Manoj Kumar Arya	Assistant Professor	Department of Zoology	D.S.B Campus, Kumaun University, Nainital
5.	Dr. Divya Pangtiy	Assistant Professor (Guest)	Department of Zoology	D.S.B Campus, Kumaun University, Nainital

Syllabus Preparation Committee

S.N.	Name	Designation	Department	Affiliation
1.	Prof H.C. S Bisht	Head & Convener	Department of Zoology	D.S.B Campus, Kumaun University, Nainital
2.	Prof Ila Bisht	Head & Convener	Department of Zoology	S.S.J Campus, S.S.J University, Nainital
3.	Dr. Ahmad Pervez (Online)	Assistant Professor	Department of Zoology	S.S.D.U Rishikesh
4.	Dr. Manoj Kumar Arya	Assistant Professor	Department of Zoology	D.S.B Campus, Kumaun University, Nainital

YEAR	SEMESTER	PAPER CODE	PAPERTITLE	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	Non-Chordate	4+1
		ZOO503T	Chordate	4+1
		Industrial Training/Survey/ Research Project	It is based on Major Papers of Semester-V	04
	VI	ZOO601T	Developmental Biology of Vertebrates	4+1
		ZOO603T	Basic mammalian Endocrinology	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-VI	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	Basic Limnology	4+1
		PAPER- IV	Animal Ecology	4+1
		Industrial Training/Survey/ Research Project	With reference to Major Papers of Semester-VIII	04
	VII or 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	4+1
		PAPER- II	(Animal Cell Culture)+	4+1
		PAPER- III	Animal Biotechnology (Transgenics, Cloning And IPR)	4+1
		PAPER- IV	Medical Laboratory Techniques Wildlife Conservation	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 Anthropology, Environmental studies, Biomedical Sciences, etc.
- 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 programme 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 and Medical laboratory techniques related to concerned area.
PO 5	It will help to develop the knowledge on taxonomy of insects. Also, the conservation of wild animals to enhance the economy gained by the zoological content present in the environment.
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 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).
MASTER IN FACULTY (ZOOLOGY)	
YEAR 5	It will help students to improvise the Agro-Pest relationship, forensic Entomology & its implication it help 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.

Syllabus

First Year

Semester- I

Animal Physiology and Biochemistry (4+2 Credits) = 6 Credits

Animal Physiology

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

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

Excretion: Concept of ammonotelic, ureotelic and guanotelic animals, urine formation in mammals.

Blood vascular system: Haemopoiesis, composition and functions of blood, blood coagulation. A brief account of immunity. 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. Neurotransmitter

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 biological molecules: Proteins, Amino acids, Carbohydrates and Lipids- their structure, classification and significance. Metabolism of Carbohydrates. Enzymes and Vitamins.

(glycolyisis, Krebs cycle, gluconeogenesis , glyscogenesis glyogenolysis)

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

Practical

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

Mendel's life, Pre-Mendelian experiments, symbols and terminologies, Laws of dominance, segregation and independent assortment.

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

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

Eukaryotic chromosomes- Structure, chemical composition, classification and uninemic and multinemic concept of chromosome structure.

Structure and functions of polytene and lampbrush chromosomes.

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

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

Prokaryotic and Eukaryotic cells; Ultrastructure of eukaryotic cell; Plasma membrane (Ultrastructure, chemical composition , models of plasma membrane; Specialisations of plasma membrane , functions of plasma membrane).

Structure and functions of following cell organelles: (a) Mitochondria (b) Ribosomes (c) Lysosomes (d) Centrioles (e) Golgi Complex (f) Endoplasmic reticulum. Structure and functions of Nucleus and nucleolus.

Cell division – (a) Cell cycle (b) Mitosis (Process of mitosis, mitotic poisons and significance of mitosis), (c) Meiosis (Process of meiosis, structure and functions of synaptonemal complex, significance of meiosis). An idea of cell transformation and cancer.

Practical

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.

2. Ecosystems: definition, structure and function of ecosystem, energy flow in an ecosystem, food chain, food web and ecological, case studies of the following ecosystem: forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem.

3. Natural resources: Renewable and Non-renewable resources: land resources and land use change, land degradation soil erosion and desertification. Deforestation: causes and impacts due to mining, dam building on environment, of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and non-renewable energy sources, growing energy needs case studies.

4. Biodiversity and conservation: Level of biodiversity- genetic, species and ecosystem diversity, Bio geographic zones of India, biodiversity patterns and global biodiversity hot-sports. India as a mega-biodiversity nation, endangered and endemic species of India. Threats to biodiversity - Habitat loss, poaching of wildlife, man-wildlife conflict, biological invasions, conservation of biodiversity-in-situ ex-situ conservation of biodiversity.

5. 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.

6. 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, International agreements-Montreal and Kyoto protocols and Conservation of Biological Diversity (CBD).

Basic Concepts of Ecology

Definition of ecology and its relation to humanity.

The environment: Abiotic factors, biotic factors, edaphic factors.

Concept of ecosystem with reference to pond, Grassland, Forest & River ecosystem. Energy flow in ecosystem. Pyramids of number, biomass and energy. Food chain- grazing and detritus, Food web and trophic levels. Biosphere: Hydrosphere, Lithosphere and Atmosphere. Biogeochemical cycles: Carbon and Nitrogen cycles.

Population: Definition and characteristics: density, natality, mortality, migration, emigration and immigration, growth and growth-curves. Dispersion and aggregation. Negative and positive interactions including commensalism, mutualism, predation, competition and parasitism.

Practical

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 (DNA & RNA): DNA chemistry, nucleosides, nucleotides, polynucleotide chain, Watson and Crick DNA double helix model, identification of genetic material (DNA-as genetic material). RNA-chemistry, genetic and non-genetic RNAs. Clare leaf model of RNA Elementary knowledge of genetic code. Expression of gene-protein synthesis.

Lac operon concept. Mechanism of DNA damage & repair

Toxicology

Introduction and brief history of toxicology: General principles of toxicology, Brief history, Environmental toxicology (kinds and sources of toxic agents- animal toxins, plant toxins, pesticides, metals and food additives).

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

Histology

Histology: Structure of epithelium, connective tissue, cartilage, bone, smooth,, striped and cardiac muscles, and nervous tissue as studied under light microscope.

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

Practical

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: kinds of microbes, Typical structure of a bacterium, Gram positive and Gram negative bacteria and virus. With reference to (COVID)

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

A brief knowledge of AIDS.

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

Industrial microbiology- Food production, dairy products, fermented food, alcoholic beverages, microbial spoilage, food preservation. A brief knowledge of Antibiotics.

Animal Behaviour

Patterns of behaviour: Stereotype innate behaviour: Kinases, 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: Chemical, 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

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, Bio Informatics 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

Non-Chordate– (4+2 Credits) = 6 Credits

Salient features and outline classification (up to orders) of various Non-chordate Phyla and related type study and topics as covered under respective Phyla.
Protozoa*: Paramecium* with particular reference to locomotion, nutrition, osmoregulation and reproduction.

Porifera: *Sycon* with reference to structure, reproduction and development. Canal system, and affinities of Porifera.

Coelenterata*: Aurelia* with reference to structure, reproduction and development. Polymorphism in Coelenterata. A brief account of Corals and Coral reefs.

Helminthes: Taxonomy, morphology (including adaptations), life cycle, pathogenicity and control measures of *Fasiola.* Parasitic adaptations in Helminthes.

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*- Its distribution and Zoological importance.

Mollusca: *Pila*- External features, Organs of Pallial complex. Reproduction. A brief account of torsion in Gastropoda.

Echinodermata: *Asterias*- External features. Water vascular system. Mode of feeding and reproduction.

Chordate– (4+2 Credits) = 6 Credits

Salient features and outline classification (up to order) of various chordate groups as covered under respective taxonomic groups.

Protochordata: Salient features of body organisation and systematic position of *Balanoglossus* and *Amphioxus* as a type 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 A brief knowledge of extinct reptiles. Poisonous and non- poisonous snakes. Poison apparatus of snake. Snake venom and anti-venom. Adaptive radiation in reptiles. Adaptations of reptiles to desert life.

Aves: Flightless birds and their distribution. Flight adaptations in birds.

Mammalia: General organisation, distribution and affinities of Prototheria. Economic importance. Adaptive radiation with particular reference to aquatic mammals.

Practical

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

Semester- VI

Developmental Biology of Vertebrates (4+2 Credits) = 6 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.

Retrogressive metamorphosis: As exhibited by an 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

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.

General Endocrinology (4+2Credits) = 6 Credits

Endocrine system: A brief knowledge of the structure and hormonal functions of the glands namely, Pituitary, Thyroid, Pancreas, Adrenal, Testis and Ovary. Elementary knowledge of the Dwarfism, gigantism, acromegaly, diabetes insipidus , Goitre, Cretinism, Myxoedema, Diabetes mellitus and Addison's disease.

Fourth Year

Semester- VII

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

Unit - I

Introduction and Historical Background: Cells and Organs of Immune System

- Definition, Overview of Immune System- Anatomical, Physiological and Inflammatory Barriers. Major Contribution of Following Scientists- 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 of B-Lymphocytes and T-Lymphocytes and Its Regulation. Cells of The Immune System- NK Cells, B-Lymphocytes, T-Lymphocytes, Granulocytic Cells, Dendritic Cells Primary Lymphoid Organs and their Functional Role- Bone Marrow and Thymus. Secondary Lymphoid Organs and Its Functional Role- Lymph Nodes, Spleen, Mucosal-Associated Lymphoid Tissue [MALT], Intraepithelial Lymphocytes [IEL], Cutaneous-Associated Lymphoid Tissue [CALT]

Unit - II

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

Antigen- Definition and Its Properties. Immunogen-Definition and Its Properties. Antigenecity Vs. Immunogenicity and Factors Affecting It. Haptens and Adjuvants. Basic Structure of Immunoglobulin. Classes of Immunoglobulin and Its Biological Activities. Major Histocompatibility Complex [MHC] - Structure, Types and Function. Regulation of

MHC Expression. Production of Monoclonal Antibodies, Its Mechanism [De Novo and Salvage Pathway] and Application in Research and Health.

Unit - III

Primary And Secondary Line Of Defence [Innate And Acquired Immunity], Antigen-Antibody Interactions:

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

Structure of Antibody, Treatment of Antibody with Pepsin, Papain, B-Mercaptoethanol and DMSO. Interaction of Antigen-Antibody- Antibody Affinity, Antibody Avidity, Cross Reactivity, Precipitation Reactions and Agglutination Reactions.

Unit - IV

Immune Effector Mechanism, Allergy And Hypersensitivity:

Cytokines- Properties and Its Receptors. Cytokine Secretion by Th1, Th2 And Th17 Subsets And Its Function. The Complement System: Its Components, Functions, Activation and Regulation. Complement Deficiencies.

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:

Mechanism of Immune Response During: Viral Infections [Influenza, HIV], Bacterial Infections [*Corynebacteria* and *Mycobacterium*] Protozoan Infection [*Plasmodium, Trypanosoma* and *Leishmania*], Helminthes Infections [*Ascaris* and *Schistosoma*].

Unit - II

Disease of Immune System And Vaccines:

Mechanism of Autoimmune Diseases- Systematic Lupus Erythromatous [SLE], Myasthenia Gravis, Rheumatoid Arthritis, Celiac Disease. Cancer of Blood Cells- Lymphoma and Leukemia [Hodgkin and Non-Hodgkin]. Vaccines- Historical Background, Routine Vaccines, DNA Vaccines, Snake-Antidotes. Production of Monoclonal Antibodies and Its Mechanism.

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 Studies for Specific Transplantation I.E Skin Graft, Kidney, Liver and Heart With Reference to Hyperacute, Acute and Chronic Rejection and Its Mechanism. Immunosuppression- Definition, Drugs Used for Immunosuppression and Its Mechanism of Action. Xenotransplantation- Definition and Its Application. HLA Phenotyping, Lymphoproliferation Assay, Its Working Principle and Applications. Blood Groups- MN, ABO Blood Group and Blood Transfusion.

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

Unit-I

- Ecology: Its Relevance to Human Welfare, Subdivisions and Scope. The Environment: Physical Environment; Biotic Environment; Biotic and Abiotic Interactions.
- Habitat and Niche: Concept of Habitat and Niche; Niche Width and Overlap; Fundamental and Realized Niche; Resource Partitioning; Character Displacement.

- Ecosystem's Structure and Function: Forest and Lake's Biotic and Abiotic Components, 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. Structure and Function of Some Indian Ecosystems: Terrestrial (Forest, Grassland) and Aquatic (Fresh Water, Marine and Eustarine).
- Population Ecology: Characteristics of a Population; Population Growth Curves; Population Regulation; 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, Various Types of 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

- Stressed Water Ecosystems: Point and Non-Point Sources of Pollution, Assessment of Freshwater Pollution Using Various Parameters. Water Quality Monitoring Using Abiotic Factors (E.G. Ph, Oxygen, Nitrate, Ammonia, Phosphate, BOD), Bio-Monitoring (Phytoplankton, Zooplankton and Zoo Benthos), Environmental Impact Assessment (EIA)-Impact Of Environmental Stress on Biotic And Abiotic Factors.
- Eutrophication: Its Causes, Assessment, Consequences and Control. Indicators of Pollution and Eutrophication.
- Species Interactions: Types of Interactions, Interspecific Competition, Herbivory, Carnivory, Pollination and Symbiosis.

Unit-IV

- Ecological Succession: Types; Mechanisms; Changes Involved In Succession; Concept Of Climax.
- Biogeography: Major Terrestrial Biomes; Theory of Island Biogeography; Bio-Geographical Zones of India.

- Applied Ecology: Environmental Pollution; Global Environmental Change; Biodiversity: Status, Monitoring and Documentation; Major Drivers Of Biodiversity Change; Biodiversity Management Approaches. Global Conventions on Environmental Pollution (Kyoto Protocol, Montreal Protocol, Earth Summit 2002 and Copenhagen Accord).
- Conservation Biology: Principles of Conservation, Major Approaches to Management, Indian Case Studies on Conservation /Management Strategy (Project Tiger, Biosphere Reserves and Lakes).

Paper IV Medical Laboratory Techniques

(4+1Credits) = 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 of Common Laboratory Equipment's: Hot Air Oven, Incubator, Autoclave, Water Bath and Centrifuges
- Microscope - Fundamentals of Microscopy, Resolution and Magnification, Light Microscopy, Electron Microscopy, PCR Machine (Thermal Cycler), Electrophoresis Unit and UV Trans Illuminator Etc.

Unit III

- Specimen Collection, Processing and Analytical Techniques Collection and Preservation of Blood, Urine, Stool, Sputum, Pus, Body Fluids and Swab.
- Preparation of Blood Smears. Sources of Biological Variations and Pre-Analytical Variables.

Unit IV

- Preparation of Reagents: Buffers and pH, Normal, Percent and Molar Solution, Normal Saline -Methods of Measuring Liquids.
- Clinical Laboratory Records - Modern Laboratory Set Up - Quality Control: Accuracy, Precision, and Reference Values.
- Disposal of Biomedical Waste
- Laboratory Safety Protocols and Guidelines

Semester- VIII

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

Unit I

- Classification of Fishes, Systematic Position, Habit and Habitat, Morphology, Distribution, Significance and Affinities of Holocephali and Dipnoi.
- Fins, Their Origin and Evolution; Locomotion in Fishes.
- Histomorphology and Elementary Physiology (A) Digestive System (With Particular Reference to Food And Feeding Habits of Freshwater Fishes) (B) Excretory System (With Particular Reference to Acid Base Balance and Osmoregulation.) (C) 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 Uttaranchal. Methods of Fishing: Fishing Gears and Crafts. Cold Water Fishery Sewage-Fed Fishery and Shell –Fish Fishery.
- Nutrition and Growth Including Age and Growth Relationship, Chemical Composition of Fish Flesh, Length –Weight Relationship, Natural Food and Artificial Feed and Their Role in Fish Culture. Plankton and Benthos in Relation to Fish Production

Unit III

- Electric Organs in Fishes.
- Brief Knowledge of Sexual Dimorphism, Courtship And Parental Care. Migratory Instincts, Hill Stream Adaptations
- Reproduction in a Major Carps- Structure Of Gonad, Spawning, Early Development And Metamorphosis. Microscopic Structure And Hormonal Functions Of The Following Endocrine Glands: Pituitary, Thyroid, Pancreas, Adrenal, Corpuscles Of Stannins, Ultimobranchial Glands, Caudal Neurosecretory System And Sex Hormones. Current Trends In Induced Breeding In Fishes.

Unit IV

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

Paper IIApplied Ichthyology (4+1Credits) = 5 Credits

Unit I

- Important Cultivable Fishes
- Important Cultivable 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 Responsive 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.

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.
- Planktonic Organisms: Classifications of Organisms in Water Distribution of Plankton Food For Plankton Organisms

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.

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

Unit-I

- Ecology: Its Relevance to Human Welfare, Subdivisions and Scope. The Environment: Physical Environment; Biotic Environment; Biotic and Abiotic Interactions.

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Unit-III

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- Eutrophication: Its Causes, Assessment, Consequences and Control. Indicators of Pollution and Eutrophication.

- Species Interactions: Types of Interactions, Interspecific Competition, Herbivory, Carnivory, Pollination and Symbiosis.

Unit-IV

- Ecological Succession: Types; Mechanisms; Changes Involved in Succession; Concept of Climax.
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- Applied Ecology: Environmental Pollution; Global Environmental Change; Biodiversity: Status, Monitoring and Documentation; Major Drivers of Biodiversity Change; Biodiversity Management Approaches. Global Conventions on Environmental Pollution (Kyoto Protocol, Montreal Protocol, Earth Summit 2002 and Copenhagen Accord).

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

Practical

Suggested books:

1. Srivastava CBL: Fish Biology, Narendra Publishing House.
2. Singh HR: Advance in Fish Biology, Hindustan Publishing Corp.

3. Munshi & Munsi: Fundamental of Freshwater Biology. Narendra Publishing House.
4. Kyle: The biology of Fishes.
5. Khanna & Singh: Fish and Fisheries.

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.

Studying 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 circdian 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-transdustion. Human Health and diseases-chronopharmacology, chronomedicine, chronotherapy.

or

Applied Zoology (4+1Credits) = 5 Credits

Parasitic protozoa and Helmeinthes: *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 Pest 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 sciences.

Fifth Year

Semester- IX

Paper ISystematics 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, Chio Infuscatellus*); **Paddy***(Leptocorisa Acuta*, *Hieroglyphus Banian/Nigrorepletus*), C**otton (***Dysdercus Koengii, Pectinophora Gossypiella*); **Cereals** *(Heliocoverpa Armigera, Agrotis Ypsilon)* **Vegetables***((Raphidopalpa (=Aulacophora) Foveicollis, Pieris Brassicae*); **Fruits**(*Bactrocera* (*= Dacus) Cucurbitae, 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).

Life-Cycle and Control of Insects of Medical Importance of Man and Animals: House Flies, Mosquitoes, *Phelbotomus* (Sandfly) and *Tabanus* (Horse Fly)

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
- Bioluminescence: Light Producing Organs, Mechanism and Significance of Light Production in Insect
- Structure of Pheromone Producing Glands, Different 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; Different Types of Larvae and Pupae, Polyembryony and Parthenogenesis in Insects

PAPER III Economic Zoology and Vermicology

(4+1Credits) = 5 Credits

Unit I

- The General Study 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. *Leishmenia* Spp. Etc.) *Giardia* and Vector Biology.

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

Unit II

- Pests and Parasites, Apiculture, Sericulture, Lac Culture, Pisciculture, Dairy and Farming's Products.
- Pesticides (Organchlorines, Arganophosphates, Carbanates, Pyrethroids, Triazmes, Bardeux Nixture), Mode of Action of Pesticides, Advantages and Disadvantages of Pesticides Hazards of Pesticides,
- Biological Methods of Pest Control.

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 Compostion of Vermicompost

Vermicomposting at Home and Agricultural Farm; The Business of Worms; Interaction of Vermicompost Earthworms.

Unit IV

- Earthworm Bio-Technology: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, IUCN Categories
- Protected Area Network: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant 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, Ecosystem and Biome Diversity.

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 (Zoos, Natural History Museums and Collections, Zoological Survey of India and Its Regional Centres.
- 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 for Animal Cell Culture Technology. 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 for the Growth of Animal Cells and their Products (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) Etc.

- 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 Medical Laboratory Techniques (4+1Credits) = 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 of Common Laboratory Equipment's: Hot Air Oven, Incubator, Autoclave, Water Bath, Centrifuges
- Microscope - Fundamentals of Microscopy, Resolution and Magnification, Light Microscopy, Electron Microscopy, PCR Machine (Thermal Cycler), Electrophoresis Unit and UV Trans Illuminator Etc.

Unit III

- Specimen Collection, Processing and Analytical Techniques Collection and Preservation of Blood, Urine, Stool, Sputum, Pus, Body Fluids and Swab.
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- Preparation of Reagents: Buffers and pH, Normal, Percent and Molar Solution, Normal Saline - Methods of Measuring Liquids.
- Clinical Laboratory Records - Modern Laboratory Set Up - Quality Control: Accuracy, Precision, and Reference Values.
- Disposal of Biomedical Waste
- Laboratory Safety Protocols and Guidelines

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

Unit I

- Indian Wildlife: Introduction, Distribution of Wildlife in Ecological Subdivision of India, IUCN Categories
- Protected Area Network: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant and Tiger).

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