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 TII+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

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.

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.