

National Education Policy – 2020

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

Four Year Undergraduate Programme- FYUP/Honours Programme/ Master's in Science

PROPOSED STRUCTURE FOR FYUP/ MASTER'S IN ZOOLOGY SYLLABUS

DEPARTMENT OF ZOOLOGY

Syllabus Expert Committee

S.No.	Name	Designation	Department	Affiliation
1.	Prof. H.C.S. Bisht	Head and Convener	Department of Zoology	Kumaun University, Nainital
2.	Prof. D.M.Tripathi	Head and Convener	Department of Zoology	S.D.S. University, Rishikesh
3.	Prof. Ila Bisht	Head and Convener	Department of Zoology	S.S.J. University, Almora
4.	Dr. Neeti Pande	Assistant Professor (External Subject Expert)	Department of Zoology	University of Delhi
5.	Dr. Aravinda	Coordinator(External Subject Expert)	Biology	IISC Challakere
6.	Dr. N.G. Prasad	Professor(External Subject Expert)	Zoology	IISER Mohali

Syllabus Preparation Committee

S.No.	Name	Designation	Department	Affiliation
1.	Prof. H.C.S. Bisht	Head and Convener	Department of Zoology	Kumaun University, Nainital
2.	Dr. Manoj K. Arya	Associate Professor	Department of Zoology	Kumaun University, Nainital
3.	Dr. Deepika Goswami	Associate Professor	Department of Zoology	Kumaun University, Nainital
4.	Dr. Sandeep Kumar	Associate Professor	Department of Zoology	S.S.J. University, Almora
5.	Dr. Mukesh Samant	Assistant Professor	Department of Zoology	S.S.J. University, Almora
6.	Dr. Himanshu P. Lohani	Assistant Professor	Department of Zoology	Kumaun University, Nainital
7.	Dr. Deepak K. Arya	Assistant Professor	Department of Zoology	Kumaun University, Nainital
8.	Dr. Divya Pangtey	Assistant Professor	Department of Zoology	Kumaun University, Nainital

		(Guest)		
9.	Dr. Netra Pal Sharma	Assistant Professor (Guest)	Department of Zoology	Kumaun University, Nainital
10.	Dr. Sandeep DuttMaindoli	Assistant Professor (Guest)	Department of Zoology	Kumaun University, Nainital
11.	Dr. Uzma Siddiqui	Assistant Professor (Guest)	Department of Zoology	Kumaun University, Nainital
12.	Dr. Seeta Dewali	Assistant Professor (Guest)	Department of Zoology	Kumaun University, Nainital
13.	Dr. Deepak Chandra Melkani	Tutor cum Demonstrator	Department of Zoology	Kumaun University, Nainital

List of Papers (DSC,DSE,GE) with Semester Wise Titles for Zoology					
Year	Semester	Course	Paper Title	Theory/ Practical	Credits
UNDERGRADUATE CERTIFICATE IN ZOOLOGY					
FIRST YEAR	I	(DSC)- ZOO/DSC/I/T	Non- Chordata	Theory	3
		(DSC)- ZOO/DSC/I/P	Laboratory Practical based on Theory Papers	Practical	1
		(GE)- ZOO/GE/I	Elementary Biostatistics	Theory	4
	II	(DSC)- ZOO/DSC/II/T	Cell Biology and Genetics	Theory	3
		(DSC)- ZOO/DSC/II/P	Laboratory Practical based on Theory Papers	Practical	1
		(GE)- ZOO/GE/II	Applied Zoology	Theory	4
UNDERGRADUATE DIPLOMA IN ZOOLOGY					
SECOND YEAR	III	(DSC)- ZOO/DSC/III/T	Chordata	Theory	3
		(DSC)- ZOO/DSC/III/P	Laboratory Practical based on Theory Papers	Practical	1
		(DSE)- ZOO/DSE/III/T	Taxonomy	Theory	3
		(DSE)- ZOO/DSE/III/P	Laboratory Practical based on Theory Papers	Practical	1

		(GE)- ZOO/GE/III	Environmental Biology	Theory	4
	IV	(DSC)- ZOO/DSC/IV/T	Animal Physiology and Biochemistry	Theory	3
		(DSC)- ZOO/DSC/IV/P	Laboratory Practical based on Theory Papers	Practical	1
		(DSE)- ZOO/DSE/IV/T	Elementary Ecology	Theory	3
		(DSE)- ZOO/DSE/IV/P	Laboratory Practical based on Theory Papers	Practical	1
		(GE)- ZOO/GE/IV	Bioinstrumentation	Theory	4
BACHELOR OF ZOOLOGY					
THIRD YEAR	V	(DSC)- ZOO/DSC/V/T	Evolution	Theory	3
		(DSC)- ZOO/DSC/V/P	Laboratory Practical based on Theory Papers	Practical	1
		(DSE)- ZOO/DSE/V/T	Animal Behavior	Theory	3
		(DSE)- ZOO/DSE/V/P	Laboratory Practical based on Theory Papers	Practical	1
		(GE)- ZOO/GE/V	Himalayan Biodiversity	Theory	4
	VI	(DSC)- ZOO/DSC/VI/T	Elementary Molecular Biology and Bio-technology	Theory	3

		(DSC)- ZOO/DSC/VI/P	Laboratory Practical based on Theory Papers	Practical	1
		(DSE)- ZOO/DSE/VI/T	Microbiology and Immunology	Theory	3
		(DSE)- ZOO/DSE/VI/P	Laboratory Practical based on Theory Papers	Practical	1
		(GE)- ZOO/GE/VI	Toxicology	Theory	4

Course Objectives (COs):

- The programme in Zoology aims to provide students with a strong foundation Core course in organismal and molecular biology, covering Non-chordata, Chordata, Cell Biology, Genetics and Physiology.
- It equips students with applied knowledge in Aquaculture, Reproductive Health, Animal Behavior, Immunology, Environmental Biology, Limnology, Microbiology and Biotechnology.
- The curriculum is designed to enable students to specialize in key disciplines such as Taxonomy, Ichthyology, Entomology, Conservation Biology and Toxicology through elective courses.
- The programme fosters interdisciplinary learning by offering generic electives in Computational Biology, Medical Laboratory Technology, Hydro Ecology and Research Methodology, attracting students from allied sciences.
- Practical-based skill development is emphasized through laboratory training in bioinstrumentation, histology, hematological techniques and immunodiagnostics.
- The course also integrates contemporary research trends such as Molecular Biology, Biomedical Technologies and Biofloc

Fish Culture to develop industry-relevant expertise.

- It encourages students to engage in research and academic projects through dissertations, fostering analytical and problem-solving skills.
- Students will be equipped to address societal challenges, including environmental sustainability, wildlife conservation, public health and bioremediation.
- The programme ensures career readiness by offering skill-enhancement courses in areas like Pearl Culture, Sericulture, Vermiculture and Applied Zoology.
- Specialization such as Ichthyology, Entomology, Animal Biotechnology and Immunology gives an immense platform to pursue higher carrier opportunities.
- Graduates and Post graduates will have ample opportunities in education, healthcare, environmental management and biological research, with the potential to pursue advanced studies and innovative entrepreneurship.

Programme Objectives (POs):

- To develop a comprehensive understanding of biological diversity, structure and function across various animal taxa.
- To provide in-depth knowledge of cellular and genetic mechanisms governing life processes, preparing students for advanced research and applications.
- To foster an appreciation for evolutionary biology and animal ecology, emphasizing biodiversity conservation and sustainable practices.
- To equip students with expertise in applied sciences, including medical laboratory techniques, immunology and

aquaculture.

- To enhance analytical and technical skills through practical training in molecular biology, cytology and bioinstrumentation.
- To instill research acumen through structured dissertations and academic projects in emerging areas of Zoology.
- To introduce students to interdisciplinary domains such as Environmental Biology, Toxicology and Computational Biology for holistic scientific learning.
- To promote entrepreneurial skills and job readiness through value-added courses in Intellectual Property Rights, Research Ethics and Emotional Intelligence.
- To enable students to critically assess biological challenges and contribute innovative solutions in health, agriculture and environmental sectors.
- To prepare students for diverse career opportunities, including academia, government organizations, conservation agencies and biotechnology industries.

Semester-I

UNDERGRADUATE CERTIFICATE IN ZOOLOGY

DISCIPLINE SPECIFIC COURSE (DSC) - Non- Chordata

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Non-Chordata	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN ZOOLOGY		
Programme: Undergraduate Certificate in Zoology	Year: I	Semester: I Paper: DSC
Subject: Zoology		
Course: DSC	Course Title: Non-Chordata	
Course Outcomes:		

After studying this course, the students will be able to:

1. Understand the biology and systematic features of non-chordates, including their body organization and adaptive features.
2. Understand the evolutionary relationships and identification of species.
3. Understand the diversity, organization, adaptation and taxonomic status of chordates.
4. Understand the basic concepts of biosystematics and taxonomy procedures.
5. Understand the types and origin of reproductive isolation, and taxonomic characters.

Credits:4

Discipline Specific Course

Max. Marks: As per Univ. rules

Min. Passing Marks: As per Univ. rules

THEORY

Unit	Topic	No. of Hours
I	Salient features and outline classification (up to orders) of various Non-chordates phyla and related type study and topics as covered under respective phyla: Protozoa: <i>Paramecium</i> with particular reference to locomotion, nutrition, osmoregulation and reproduction. Porifera: <i>Sycon</i> with reference to structure, reproduction and development. Canal system and affinities of Porifera.	15

II	Coelenterates: <i>Aurelia</i> with reference to structure, reproduction and development. Polymorphism in coelenterates. A brief account of Corals and Coral reefs. Helminthes: Taxonomy, morphology (including adaptations), life cycle, pathogenicity, parasitic adaptations in Helminthes and control measures of <i>Fasciola</i>. Annelida: <i>Nereis</i> with reference to external features, excretory organs and reproduction. Metamerism in Annelida, its origin and significance. Trochophore larva and its significance. Parasitic adaptations in <i>Hirudinaria</i>.	15
III	Arthropoda: <i>Palaemon</i> and <i>Peripatus</i> with reference to external features and reproduction. Its distribution and Zoological importance. Mollusca: <i>Pila</i> with reference to external features, Organs of Pallial complex and its reproductive system. A brief account of torsion in Gastropoda. Echinodermata: <i>Asterias</i> with reference to external features. Water vascular system. Mode of feeding and reproduction. Basic knowledge about different kinds of Microscopes.	15
PRACTICAL		

	1.Principles functioning and application of Compound Microscope (Hands on training) 2.Study of specimens: <i>Amoeba</i>, <i>Paramecium</i>, <i>Euglena</i>, <i>Hydra</i>, and rectal ciliates. 3.Study of Nervous-system/General anatomy with the help of charts/models and simulation of Earthworm, Prawn, <i>Pila</i> and <i>Unio</i>. 4. Study of permanent slides/museum specimens/models belonging to following phyla Protozoa, Porifera, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca and Echiodermata. 5.Study of Parasites: Protozoa: <i>Plasmodium</i>, <i>Monocystis</i>, <i>Trypanosoma</i>, <i>Leishmania</i>, <i>Entamoeba</i>, <i>Giardia</i>. Helminthes: <i>Fasciola</i>, <i>Taenia</i>, <i>Ascaris</i>, <i>Schistosoma</i> and filarial including larval stages. Annelida: Leeches Arthropoda: <i>Sacculina</i>, lice, flea, bedbug, tick and mites. Life Cycle of the following: -<i>Entamoeba</i>, <i>T. solium</i>, <i>A. lumbricoides</i>, <i>F. hepatica</i>, <i>Schistosoma</i>.	30
Recommended Readings Textbooks • Modern textbook of zoology- R. L. Kotpal		

- Invertebrate Zoology- E. L. Jordan and P. S. Verma
- CNH Series, Kotpal Series, Hyman Series
- Invertebrate Zoology- E. E. Ruppert and R. D. Barnes
- Invertebrate Zoology- Anderson, Donald Thomas
- Invertebrates- Brown, A. Frank

Reference books

- The Invertebrates-Hyman, L. H. (1940–1967). The Invertebrates (Vols. 1–6). New York: McGraw-Hill.
- Biology of the Invertebrates-Pechenik, J. A. (2005).
- Animals Without Backbones: An Introduction to the Invertebrates-Buchsbaum, R., Buchsbaum, M., Pearse, J., and Pearse, V. (1987).
- The Ancestor's Tale: A Pilgrimage to the Dawn of Life-Dawkins, R., and Wong, Y. (2016).

Generic Elective (GE) – Elementary Biostatistics

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE:	4	4	0	0	Passed Class XII	Nil

Elementary Biostatistics					with Biology	
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UNDERGRADUATE DIPLOMA IN ZOOLOGY	
Programme: Undergraduate Certificate in Zoology	Year: I
	Semester: I
	Paper: GE
Subject: Zoology	
Course: GE	Course Title: Elementary Biostatistics
Course Outcomes: After studying this course, the students will be able to: 1. Understand statistical methods applications to analyze and interpret biological data. 2. Understand the representation of data from experiments and field studies using graphs and diagrams. 3. Understand the statistical concepts and use of statistical tests.	
Credits:4	Generic Elective
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules

Unit	Topic	No. of Hours
Unit I	Introduction to Biostatistics, Terminology and Symbols, Research and Types of Research, Applications of Statistics in Biological Research. Collection and Representation of Data (Pie Chart, Bar Diagram, Histogram, Frequency Polygon and Gantt Chart).	20
Unit II	Measures of Central Tendency (Mean, Median, Mode), Variance, Coefficient of Variation, Standard Deviation, Standard Error of Mean, Measures of Dispersion, Distribution Patterns (Binomial, Poisson and Normal).	20
Unit III	Parametric and non-parametric test, Hypothesis: definition, limitation of test of Hypothesis, t-test, f-test, chi-test, Correlation and regression Analysis of variance(ANOVA).	20
Recommended Readings		
Textbooks		
• Biostatistics- Veer Bala Rastogi • Fundamentals of Biostatistics- Khan and Khanum • Introduction To Bio-statistics- Banerjee Pranab Kumar • Biostatistics: Basic Concepts and Methodology for the Health Sciences, 10thED, ISV- Wayne W.Daniel and L. Chad • Principles and Practice of Biostatistics- B. Antonisamy, Prasanna S. Premkumar		

- Essentials of Biostatistics and Research Methodology- Indranil Shah and Boddy Paul
- Basics Biostatistics- Biswanath Patra, Bharat Bhushan, Hitesh Purohit, Parth Gaur
- Biostatistics An Introduction- P. Mariappan
- Biostatistical Analysis- Jerrold H. Zar

DISCIPLINE SPECIFIC COURSE (DSC) – Cell Biology and Genetics

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Cell Biology and Genetics	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE CERTIFICATE IN ZOOLOGY

Programme: Undergraduate Certificate in Zoology	Year: I	Semester: II
		Paper: DSC
Subject: Zoology		

Course: DSC	Course Title: Cell Biology and Genetics	
Course Outcomes:		
After studying this course, the students will be able to:		
1. Understand the relationship between cellular structure and function.		
2. Understand the relationship between molecule/cell level phenomena and organism-level patterns of heredity.		
3. Apply genetic technologies in industries like pharmaceuticals, biotechnology and diagnostic clinics.		
4. Understand the mathematical, statistical and computational basis of genetic analysis.		
5. Raise awareness of human genetic disorders and their inheritance patterns.		
Credits:4	Discipline Specific Course	
Max. Marks: As per Univ. rules	Min. Passing Marks: As per Univ. rules	
Theory		
Unit	Topic	No. of Hours
Unit I	Prokaryotic and Eukaryotic cells; Ultra structure of eukaryotic cell; Plasma membrane (Ultra structure, chemical composition, models of plasma membrane; Specializations of plasma membrane, functions of plasma membrane. Structure and functions of following cell organelles: Mitochondria, Ribosomes, Lysosomes, Centrioles, Golgi Complex and Endoplasmic reticulum. Structure and functions of Nucleus and nucleolus.	15

Unit II	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) An idea of cell transformation, Apoptosis and cancer.	15
Unit III	Mendel's laws, Pre- Mendelian experiments, symbols and terminologies, Linkage: Morgan's view of linkage, kinds of linkage, chromosome theory of linkage. Crossing over: Types of Crossing over, mechanism and its significance. Determination of sex: chromosome mechanism, genetic balance theory and effects of external environment on sex determination. Sex linked inheritance: Inheritance of X-linked gene, Sex linkage in Drosophila. Mutation: Historical background, chromosomal aberrations and gene mutations.	15
Practical		
	1. A complete record of laboratory work will be maintained by every student. The practical work will consist of the following: 2. Cytology experiments: Study of mitosis and meiosis using available material Study of permanent slides showing stages of cell division, Mitochondria, Golgi body and different cell organelles etc.	30

	Study of permanent slides of different animal cells. 3. Genetics experiments: Study of various <i>Drosophila</i> mutants based on picture card Numerical based on Mendelian and Non-Mendelian Experiments Study of Giant Chromosomes (Lamp brush and Polytene Chromosome)	
Recommended Readings Textbooks • A Text Book of Cell Biology And Genetics- Veer Bala Rastogi • The Cell: A Molecular Approach- Geoffrey M. Cooper and Robert E. Hausman • Molecular Biology of the Cell-Alberts, B., Heald, R., Lewis, J., Morgan, D., Raff, M., Roberts, K., and Walter, P. (2022) • Cell Biology Genetics Molecular Biology- Halder Kar • Cell Biology, Genetics, Evolution and Ecology (multicolor Edition): Evolution and Ecology- P.S. Verma and V.K. Agarwal • Principles of genetics- E. J. Gardner Reference books • The Gene: An Intimate History-Mukherjee, S. (2016).		

- Molecular Cell Biology-Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M. P. (2021).
- Essential Cell Biology-Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2019).
- The Cell: A Molecular Approach-Cooper, G. M., and Hausman, R. E. (2018).

Generic Elective (GE) – Applied Zoology

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Applied Zoology	4	4	0	0	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Certificate in Zoology

Year: I

Semester: II

Paper: GE

Subject: Zoology		
Course: GE	Course Title: Applied Zoology	
Course Outcomes: After studying this course, the students will be able to: • Understand the biology of silk worms, Honey bees, Earth worm and Pearl oyster. • Understand the methods used for culturing various useful organisms for commercial purposes. • Understand the technical aspects of different animal cultures. • Understand the prospects of Sericulture, Vermiculture, Apiculture and Pearl culture.		
Credits:4		Generic Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction to: Pisciculture: Cultivable fishes. Sericulture: <i>Bombex mori</i> , types of silk worm and its rearing. Apiculture: Types of honey bees, typical honey and culture of <i>Apis mellifera</i> and natural enemies.	20

	Lac culture Pearl culture Piggery Poultry Vermiculture	
Unit II	Bionomics and control measures of the common pests of fruits (<i>Papilio demoleus</i> and <i>Quadraspidiotus perniciosus</i>), Vegetables (<i>Thrips tabaci</i> and <i>Aulacophora foveicollis</i>) and stored grains (<i>Callosobruchus chinensis</i> and <i>Trogoderma granarium</i>). Polyphagous pests (Locust and Termites).	20
Unit III	Pest management, including insect pest control and integrated pest management.	20
Recommended Readings Textbooks • Applied Zoology- N. Arumugam, T. Murugan • Applied and Economic Zoology- Shukla and Upadhyay • A Textbook of Applied Zoology- Meerut • Applied and Economic Zoology- Tripurari Mishra • Applied and Economic Zoology- Ashok Kumar		

- Fundamentals of Applied Zoology- Dr. Shaheen Khurshid
- Agricultural Insect Pests and their control- V. B. Awasthi

DISCIPLINE SPECIFIC COURSE (DSC) – Chordata

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC:Chordata	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY		
Programme: Undergraduate Diploma in Zoology		Year: II
		Semester: III
		Paper: DSC
Subject: Zoology		
Course: DSC	Course Title: Chordata	

Course Outcomes:		
After studying this course, the students will be able to:		
• Describe general taxonomic rules on animal classification of chordates. • Understand Mammals with specific structural adaptations. • Understand the significance of dentition and evolutionary significance. • Understand the origin and evolutionary relationship of different phyla from Proto-chordata to mammalian.		
Credits:4		Discipline Specific Course
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Theory		
Unit	Topic	No. of Hours
Unit I	Salient Features and outline Classification (up to order) of Various Chordate Groups. Proto-chordata: Salient features of body organization and systematic position of <i>Balanoglossus</i> .	15
Unit II	Pisces: Scales and fins in fishes. Parental care in fishes. Amphibia: General Characters and affinities of <i>Gymnophiona</i>. Parental care in amphibians. Reptilia: Poisonous and non-poisonous snakes and Poison apparatus of Snakes. Adaptive radiation in reptiles.	15

Unit III	Aves: Flightless birds and their distribution Flight adaptation in birds. Mammalia: General organization, distribution and affinities of Prototheria and its Economic importance. Adaptive Radiation with particular reference to Aquatic mammals.	15
Practical		
	1. Protochordata: Study of permanent slides of <i>Amphioxus</i> and <i>Balanoglossus</i> passing through different body regions, <i>Doliolum</i>, <i>Salpa</i>, <i>Oikopleura</i>. Museum specimens of <i>Herdmania</i>, <i>Cliona</i> and <i>Balanoglossus</i>. 2. Cyclostomata: Museum specimens of <i>Petromyzon</i> and <i>Myxine</i>. 3. Fishes: Dissections only with the help of Simulations, charts/models of general anatomy, afferent and efferent branchial arteries, cranial nerves and internal ear of <i>Scoliodon</i> Preparation of permanent slides of ampulla of <i>Lorenzini</i>, placoid, Cycloid and ctenoid scales. Study of permanent slides of shark T.S. passing through different body regions and different kinds of scales of fish. Museum specimens of <i>Sphyrna</i>, <i>Pristis</i>, <i>Torpedo</i>, <i>Trygon</i>, <i>Acipenser</i>, <i>Polypterus</i>, <i>Hippocampus</i>, <i>Exocoetus</i>, <i>Anguilla</i>, <i>Echeneis</i>, <i>Diodon</i>, <i>Protopterus</i>, <i>Synaptura</i> and <i>Chimaera</i>. 4. Amphibia: Dissections only with the help of Simulations, charts/models of cranial nerves, hyoid apparatus, brain and columella of frog. Study of museum specimen of <i>Salamandra</i>, <i>Proteus</i>, <i>Amphiuma</i>, <i>Nectures</i>, <i>Siren</i>,	30

	<i>Ambyostoma</i>, Axolotl larva. <i>Rhacophorus</i>, <i>Alytes</i>, <i>Hyla</i>, <i>Pipa</i> and <i>Bufo</i>. Study of skeleton of frog and permanent histological slides of Amphibia. 5. Reptilia: Study of the skeleton of <i>Varanus</i>. Study of museum specimen of following: <i>Varanus</i>, <i>Heloderma</i>, <i>Hemidactylus</i>, <i>Phrynosoma</i>, <i>Chameleon</i>, <i>Draco</i>, <i>Calotes</i>, Cobra, Pitviper, Pitless –viper, Rattle snake, Krait, Dhaman, <i>Typhlops</i> and marine snake; Alligator, Crocodile, Gavialis, Turtle and tortoise. 6. Aves: Permanent preparation of filoplume and down feather. Study of the skeleton of fowl. Study of museum specimens of <i>Psittacula</i>, <i>Corvus</i>, <i>Pavo</i>, <i>Bubo</i>, and model of <i>Archaeopteryx</i>. 7. Mammalia: Dissection only with the help of Simulations, charts/models of the general anatomy and blood vascular system of a mammal. Study of permanent slides of mammals. Study of the skeleton of rabbit. Study of the museum specimens of <i>Tachyglossus</i> and <i>Ornithorynchus</i>(models) <i>Pangolin</i>, <i>Funambulus</i>, <i>Pteropus</i>, Hedgehog and <i>Loris</i>.	
Recommended Readings Textbooks • Modern textbook of zoology, Vertebrates- R. L. Kotpal • Chordate zoology - E. L. Jordan and P. S. Verma		

- Chordate zoology- H. C. Nigam
- CNH Series, Kotpal Series, Hyman Series
- Textbook of zoology Vertebrates- Parker and Haswell
- Chordate zoology- P. S. Dhami and J. K. Dhami.
- Textbook of Chordate Zoology - G. S. Sandhu and H. Bhaskar
- Textbook of zoology, Vertebrates- A. J. Marshall.
- Advance Practical Zoology- P.S. Verma
- A manual of Practical Zoology Vertebrates- P.S. Verma

Reference books

- Vertebrate Life-Pough, F. H., Janis, C. M., and Heiser, J. B. (2012).
- Vertebrates: Comparative Anatomy, Function, Evolution-Kardong, K. V. (2014).
- Muscles of Chordates: Development, Homologies, and Evolution-Diogo, R., Ziermann, J. M., Molnar, J., Siomava, N., and Abdala, V. (2018).

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Taxonomy

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Taxonomy	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Diploma in Zoology

Year: II

Semester: III

Paper: DSE

Subject: Zoology

Course: DSE

Course Title: Taxonomy

Course Outcomes:

After studying this course, the students will be able to:

1. Categorize organisms based on shared characteristics, creating a hierarchical classification system.
2. Gain insights into the diversity of life on Earth and the processes that have shaped it.
3. Understand these concepts aids in fields such as ecology, conservation and biotechnology.

Credits:4

Discipline Specific Course

Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction to taxonomy and systematic; their relationship and significance. Rules of nomenclature- Binomial, Trinomial (ICZN), Homonyms, Synonyms and Tautonomy.	15
Unit II	Components of classification – Linnean hierarchy. Species concept: typological nominalistic and biological species conceptspecies as a category, kinds of species. Taxonomic methodology and tools.	15
Unit III	Morphological, molecular and anatomical methods of identification. Importance of museums, dichotomous key in taxonomy. Importance of endemic species in India. Threatened species and conservation efforts in India.	15
Practical		
	1. General characteristics habit, habitat, conservation and Classification of local fauna including mammals, birds, fish and insects. 2. Classification of mammals including tribe. 3. Classification of fishes including super class. 4. Classification of insect up to super family and super order. 5. Collection and preservation technique of Museum specimens. 6. Study of different type of keys used in animal taxonomy. 7. Use of taxonomic aids with the help of library visits and herbaria.	30

	8. A Local visit of zoo and botanical garden. 9. Hands on training on using dichotomous keys for the classification of invertebrates and vertebrates.	
Recommended Readings Textbooks: • Evolution And Taxonomy (1893)- JohnHenry Comstock • "Biodiversity of India" by R. S. Bawa and K. S. Bawa • "Ecology and Biodiversity Conservation in India" by P. V. S. S. Prasad • "Biodiversity of India: The Challenges" by P. S. Ramakrishnan • Animal Taxonomy and Biodiversity- V.C. Kapoor • Principle of Animal Taxonomy- Ashok Verma • Principles of systematic zoology-Ernst Mayr		

Generic Elective (GE) –Environmental Biology

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course	Eligibility criteria	Pre-requisite of the
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		Lecture	Tutorial	Practical/Practice		Course (if any)
GE: Environmental Biology	4	4	0	0	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Certificate in Zoology

Year: II

Semester: III

Paper: GE

Subject: Zoology

Course: GE

Course Title: Environmental Biology

Course Outcomes:

After studying this course, the students will be able to:

- Explore the complex interactions between living organisms and their environments, with a particular focus on India's diverse ecosystems.
- Study the principles of ecology, the dynamics of environmental change and the importance of sustainable practices for biodiversity conservation.
- Emphasizes human impact on the environment, pollution, climate change and conservation strategies relevant to India.

Credits:4		Generic Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction to ecology, energy flow, biogeochemical cycles and ecological succession. India's rich biodiversity, understanding the role of plants and animals in maintaining ecological balance. Population dynamics, community structure and the different ecosystems of India, such as forests, wetlands, grasslands and aquatic systems.	20
Unit II	Environmental issues faced globally, such as deforestation, water scarcity, land degradation and loss of biodiversity. Human impact on the environment, focusing on urbanization, industrialization and agricultural practices. Contemporary challenges like climate change, pollution and global warming.	20
Unit III	Conservation strategies specific to India, such as national parks, wildlife sanctuaries and protected areas. Environmental policies and laws in India and the role of governmental and non-governmental organizations in environmental protection. Assessment of Faunal diversity with special emphasis on local fauna diversity in the academic institutions, protected forest i.e. Zoo, Botanical Garden etc.	20

Recommended Readings

Textbooks:

- Ecology and Environment – P.D. Sharma
- Essentials of Ecology and Environment Science – S.V.S. Rana
- Fundamentals of Ecology – E. P. Odum and G.W. Barrett
- "Environmental Biology" - P. K. Ghosh
- "Environmental Science" - R. Rajagopalan
- "Ecology and Environmental Studies" - M. P. Purohit
- "Indian Environmental Laws" - B. S. Bhatia
- "Conservation Biology: The Indian Perspective" - M. S. Swaminathan
- “Environmental Biology” - K.B. Patel

DISCIPLINE SPECIFIC COURSE (DSC) – Animal Physiology and Biochemistry

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Animal Physiology and Biochemistry	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor Of Zoology	Year: II	Semester: IV Paper: DSC
Subject: Zoology		
Course: DSC	Course Title: Animal Physiology and Biochemistry	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the mechanisms involved in digestion, respiration, blood, renal and heart. 2. Understand the metabolism of carbohydrates, protein, lipids and protein. 3. Understand the importance of macro- and micronutrients, and their deficiencies and effect on health. 4. Understand the nature of biochemistry. 5. Understand the physical and chemical properties of molecules as a linkage of biochemistry.		

Credits:4		Discipline Specific Course
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Theory		
Unit	Topic	No. of Hours
Unit I	Nutrition: Stimulation, secretion and action of digestive fluids (including enzymes and hormones). Digestion, absorption and assimilation of various food stuffs. Human Digestive system - Digestion, absorption, energy balance. Respiration: Pulmonary ventilation, respiratory pigments, gaseous transport and control of respiration	15
Unit II	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.	15
Unit III	Neurotransmitter Muscular system: Types of Muscles molecular and chemical basic of Muscle contraction and its Mechanism. A brief idea of tetanus and fatigue. Introduction to biological molecules: Proteins, Amino acids, Carbohydrates and Lipids- their structure, classification and significance. Metabolism of Carbohydrates. Enzymes and Vitamins. (glycolysis, Krebs cycle, gluconeogenesis, glycogenesis, glycolysis)	15

	Mechanism of Enzyme Action, Kinetics, Inhibition and Regulation. Vitamins, Types and source, deficiencies.	
Practical		
	1. Preparation of haemin crystals from human blood 2. Determination of bleeding and clotting time 3. Counting of RBCs and WBCs in human blood 4. Estimation of ESR in human blood 5. Determination of haemoglobin percentage in human blood 6. Qualitative identification of carbohydrate, protein and lipid.	30
Recommended Readings Textbooks • Principles of anatomy and physiology – Tortora • Essentials of Animal Physiology- S. C. Rastogi • Animal Physiology and Biochemistry- R. A. Agarwal, Anil. K. Srivastava, • Principles of Animal Physiology - Moyes/Schulte • Animal Physiology and Biochemistry- H. R. Singh and Neeraj Kumar • Biochemistry –Satyanarayana • Fundamentals of Biochemistry – J. L. Jain Reference book • Animal Physiology: Adaptation and Environment-Schmidt-Nielsen, K. (1997). • Principles of Animal Nutrition-McDonald, P., Edwards, R. A., Greenhalgh, J. F. D., Morgan, C. A., Sinclair, L. A., and Wilkinson, R. G. (2010). • Medical Physiology – Guyton and Hall		

- Animal Physiology-Hill, R. W., Wyse, G. A., and Anderson, M. (2012).
- Principles of Animal Physiology-Moyes, C. D., and Schulte, P. M. (2008).

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary Ecology

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Elementary Ecology	4	3	0	1	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Diploma in Zoology	Year: II	Semester: IV
		Paper: DSE

Subject: Zoology		
Course: DSE	Course Title: Elementary Ecology	
Course Outcomes: After studying this course, the students will be able to: • Understand ecological principles and the interactions between organisms and their environments. • Understand the fundamental concepts of ecology, such as ecosystems, energy flow, population dynamics and biodiversity. • Explore the ecological challenges faced by India and the world, emphasizing sustainable practices for environmental conservation.		
Credits:4		Discipline Specific Course
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction to environmental sciences. Principles and its Scope. Structure and Functions of Ecosystems- Abiotic and Biotic components. Energy flow and bio-geo chemical cycle,	15

	Population dynamics, Birth, death and population size, age structure Ecosystem and Diversity of different ecosystems of India (forests, wetlands, grasslands, and aquatic systems).	
Unit II	Environmental issues faced globally, such as deforestation, water scarcity, land degradation, and loss of biodiversity. Human impact on the environment, focusing on urbanization, industrialization, and agricultural practices. Alterations of ecosystem function: different types of pollution, acid rain, ozone depletion and global warming.	15
Unit III	Conservation strategies specific to India, national parks, wildlife sanctuaries, and protected areas. UNESCO biosphere reserves; IUCN conservation categories-endangered, threatened, vulnerable, Red Data Books. Environmental policies and laws in India, and the role of governmental and non-governmental organizations in environmental protection.	15
Practical		
	1. Study of pond/lake, grassland and forest ecosystem. 2. Field visits regarding food chain and food web. 3. Study of Primary and secondary productivity. 4. Determination of physiochemical parameter of soil water and sewage.	15
Recommended Readings Textbooks: Fundamentals of Ecology-V. K. Bhatia		

- Fundamentals of Ecology-H. T. Odum
- Ecology – Peter Stilling
- Ecology – E. P. Odum
- Ecology: Principles and Applications- S. K. Jain
- Basic Ecology- B. N. Pandey
- Ecology and Conservation- K. M. S. Reddy
- Textbook Of Ecology- P.N. Tyagi
- Ecology- Kailash Choudhary, Ram Prakash Saran

Generic Elective (GE) –Bioinstrumentation

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Bioinstrumentation	4	4	0	0	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Certificate in Zoology

Year: II

Semester: IV

Paper: GE

Subject: Zoology

Course: GE

Course Title: Bioinstrumentation

Course Outcomes:

After studying this course, the students will be able to:

- Understand the use of basic biomedical instrumentation, principles and techniques of microscopy, preparative analytical centrifugation; include ultra centrifugation, sedimentation analysis and gradient centrifugation.
- Understand the theory and application of Chromatography techniques, Gel filtration, ion exchange, affinity, HPLC and electrophoresis.

Credits:4		Generic Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Light and Electron Microscopy, 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.	20
Unit II	Principle and 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	20

	Exchange, Affinity Chromatography and Introduction to HPLC.	
Unit III	Electrophoresis: Capillary, Agarose, SDS and Native PAGE, Pulse Field, Immuno- Electrophoresis and Paper Electrophoresis. PCR and ThermalCyclers, Nucleic Acid Hybridization: Southern and Northern Blotting, Western Blotting, Autoradiography. ELISA and RIA. Hands on training of different kinds of Instruments used in Biological Sciences.	20
Recommended Readings Textbook: • Bioinstrumentation (Synthesis Lectures on Biomedical Engineering)- John Enderle • Bioinstrumentation- L. Veerakumari • Bioinstrumentation- Priyanka Pandey • Bioinstrumentation- S.C. Bhatia • Bioinstrumentation- John G Webster		

DISCIPLINE SPECIFIC COURSE (DSC) – Evolution

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Evolution	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY			
Programme: Bachelor Of Zoology		Year: III	Semester: V
			Paper: DSC
Subject: Zoology			
Course: DSC	Course Title: Evolution		
Course Outcomes:			
After studying this course, the students will be able to:			
1. Explain important processes, principles and concepts and evaluate theories and research.			
2. Apply evolutionary theory and concepts to address questions in evolutionary biology.			
3. Independently investigate evolutionary questions using literature and data analyses.			
4. Provide information about the geological time scale.			
Credits:4			Discipline Specific Course
Max. Marks: As per Univ. rules			Min. Passing Marks: As per

		Univ. rules
Theory		
Unit	Topic	No. of Hours
Unit I	Theories of Evolution, Origin of Life: Concept of Oparin and Haldane and Urey; Millers Experiment. Evolution: Lamarckism, Darwinism, Evidences of Evolution Homologous and Analogous Organs. Concept of Variation, Mutation, Adaptation, Struggle for existence, Natural Selection, Isolation. The evolutionary synthesis.	15
Unit II	Species Concept and Extinction, Biological species concept, advantage and limitation, mode of speciation (Allopatric and Sympatric), mass extinction (Causes, names of five major extinction) Origin of Species: Categories of Species. Basic pattern of Evolution (Micro, Macro and Mega Evolution). Evolutionary time scale (Geological time scale).	15
Unit III	Ecological generalist and specialist: evolutionary perspectives – species interaction: mutualism, parasitism, commensalism, amensalism, neutralism and symbiosis. Evolution of toxins and venoms in animals. Evolution of man.	15
Practical		
	1. Study of evolution of man, horse, camel and elephants(through	30

	charts/ models.) 2. Adaptive modification in beak and feet of birds (through charts/slides). 3. Embryological evidences of evolution (through chart). 4. Analogy and Homology (wings of birds and insects, forelimbs of bats and rabbits). 5. Study of living fossil specimens.	
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Recommended Readings

Textbooks

- Evolution And Taxonomy- JohnHenry Comstock
- Evolution – Strickberger
- Evolutionary biology- Dr. Kishore R. Pawar
- Cytology Genetics and Evolution- P.S. Verma
- Cytology Genetics and Evolution- P.K.Gupta
- Collecting Evolution: The Galapagos Expedition that Vindicated Darwin- Matthew J. James
- Evolution: an introduction- Stephen Stearns and Rolf Hoekstra
- Evolutinary Biology- Veer Bala Rastogi

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Animal Behavior

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE:Animal Behavior	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY

Programme: Bachelor Of Zoology

Year: III

Semester: V

		Paper: DSE
Subject: Zoology		
Course: DSE	Course Title: Animal Behavior	
Course Outcomes:		
After studying this course, the students will be able to: 1. Understand the role of hormones, an animal's genotype and its environment in the development of behavior. 2. Develop critical and integrative thinking skills. 3. Learn about animal behavior systems that affect animal behavior, such as the central neural system, hormones, and pheromones. 4. Understand domestic animal behavior that cause or modulate animal behavior, animal sensory systems and evolutionary behavioral biology. 5. Understand about animal welfare issues and how animal behavior can help address these issues.		
Credits:4		Discipline Specific Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction to Animal behavior (Branches of Ethology and history). Patterns of behaviour: Stereotype innate behaviour: Kinases, Taxes and Reflexes. Concepts of (i) Fixed action patterns (FAPs) (ii) Sign stimulus or releasers and (iii) Innate releasing mechanism. Instinctive behaviour. Learned behaviour: Habituation,	15

	Conditioned reflexes, Selective learning, Insight learning, Imprinting and Birds songs.	
Unit II	Communication: Chemical, Visual, Auditory, Electric and tactile, Dance language of honey bees.	15
Unit III	Biological clocks and rhythms and types Bird migration and Navigation, Fish Migration. Introduction to Socio-biology and Social behavior in Honey Bees	15
Practical		
	1. Study of animal behavior with the help of models/photographs and chart. 2. To study different types of taxis in organisms (Honey bee, <i>Euglena</i> , <i>Paramecium</i> etc.) 3. Study of social behavior in Termites, Honey bee and Ants. 4. Study of song learning in birds.	15
Recommended Readings Textbook: • Textbook Of Animal Behaviour- Mandal Fatik Baran • Primitive groups (Part 1 and 2) – William Albert Manning • Animal Behaviour (Ethology) - V. K. Agarwal • Animal Behaviour 6th Edition- Reena Mathur • A Textbook of Animal Behaviour- H. S. Gundevia and Hare Govind Singh • Animal behavior – J.Alcock • Animal Behavior- Barrett Adkin		

Generic Elective (GE) –Himalayan Biodiversity

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Himalayan Biodiversity	4	4	0	0	Passed Class XII with Biology	Nil

UNDERGRADUATE DIPLOMA IN ZOOLOGY

Programme: Undergraduate Certificate in Zoology

Year: III

Semester: VI

Paper: GE

Subject: Zoology

Course: GE

Course Title: Himalayan Biodiversity

Course Outcomes:

After studying this course, the students will be able to:

• Get a deep knowledge on biodiversity richness and biogeography of Himalayas. • Assess the value of biodiversity wealth. • Analyze various threats to our biodiversity and able to suggest measures for conservation Strategies. • Trained effectively and scientifically to convey the message of sustainable use of resources and conservation of biodiversity to the public and young generation.		
Credits:4		Generic Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	An overview of the spatial distribution, altitudinal and latitudinal gradients, topographical features of different habitats in Himalaya and their effects on faunal distribution. Birds in Himalaya- distribution and behavioural adaptations of birds across the span of Himalaya, Trans-Himalayan Bird Migration.	20
Unit II	Monkeys in the Mountains, Living in the hills, various species of monkeys, their relationship with the forest and humans. Human monkey conflicts, fatalities and mitigation strategies. Reptiles and Amphibians, their adaptations. Significance of these animals for the ecosystem. Ecology of these predators and relationship with the Himalayan ecosystem and the threats they face from humans.	20

Unit III	Himalayan wildlife- the illegal trade and related threats. Human- Wildlife conflict in Himalaya. Environmental Activism in the Himalayas. Conservation History of Himalaya: the past, present and future. The challenges of climate change and the Anthropocene Era, Future of Himalayan ecosystems. Asian Elephants and their conservation. The outer fringes of Himalaya as the best Asian elephant habitat in the world, Elephant- the mega-herbivores are crucial for the health of these forests and grasslands.	20
Recommended Readings Textbook: • An Advanced Textbook on Biodiversity: Principles and Practice by K V Krishnamurthy. Biodiversity of the • Himalaya: Jammu and Kashmir State (Hardback) Released: 27 Feb 2020 • Biodiversity Threats and Conservation - R. C. Sobti • Biodiversity of the Himalaya: Jammu and Kashmir State by Ghulam Hassan Dar (Edited), Publisher: Springer • Biodiversity Conservation in The Himalayas by Bansi Lal Kaul (Author) By Daya Publishing House. • Biodiversity - M.N. William		

DISCIPLINE SPECIFIC COURSE (DSC) – Elementary Molecular Biology and Bio-technology

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSC: Elementary Molecular Biology and Bio-technology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY			
Programme: Bachelor Of Zoology		Year: III	Semester: VI
			Paper: DSC
Subject: Zoology			
Course: DSC		Course Title: Elementary Molecular Biology and Bio-technology	
Course Outcomes:			
After studying this course, the students will be able to:			
• Understand the core concepts of molecular biology, including DNA structure and function. • Explain the process of DNA replication and how it ensures genetic accuracy. • Describe the mechanisms of gene expression and regulation at both the transcriptional and translational			

levels. • Apply knowledge of biotechnology techniques to real-world scenarios, including gene editing and PCR. • Recognize the ethical, environmental and medical applications of biotechnology.		
Credits:4		Discipline Specific Course
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Theory		
Unit	Topic	No. of Hours
Unit I	Introduction to Molecular Biology. Central dogma of molecular biology. The double-helix structure of DNA. The process of DNA replication in prokaryotes and eukaryotes. The concept of semi-conservative replication and its significance Enzymes involved in DNA replication (e.g., DNA polymerase, helicase and ligase).	15
Unit II	The process of transcription: from DNA to mRNA. Translation: from mRNA to protein. Ribosomes, tRNA, and the genetic code. Mechanisms of gene regulation in prokaryotes and eukaryotes. Operons and transcription factors. Epigenetics: DNA methylation, histone modification. Post-transcriptional regulation.	15
Unit III	Introduction to Biotechnology and its history. Applications of biotechnology in medicine, agriculture and industry. The role of molecular biology in biotechnological advancements. Polymerase Chain Reaction	15

	(PCR). Gel electrophoresis and DNA sequencing. Gene cloning techniques. Introduction to gene editing. Applications of Biotechnology.	
Practical		
	1. Introduction to lab safety protocols. 2. Overview of lab equipment (micropipettes, centrifuges, vortex mixers etc.). 3. Preparing solutions and buffers. 4. Practice using micropipettes to measure and transfer liquids accurately. 5. Packing and sterilization of glass and plastic wares for cell culture 6. Grow transformed bacteria on selective agar plates and observe colony growth. 7. DNA/ RNA isolation and estimation 8. Protein isolation and SDS PAGE 9. Tools of Bioinformatics.	30
Recommended Readings Textbooks • Molecular Biology of the Cell- Alberts et al. • Biotechnology: Expanding Horizons- B.D. Singh. • Textbook of Biotechnology- R.C. Dubey. • Molecular Biology and Biotechnology: A Guide for Students- G. R. K. Naidu • Modern Biotechnology - S.N. Jogdand		

ReferenceBook

- Introduction to Biotechnology. 4th ed. Thieman WJ, Palladino MA. New York: Pearson; 2018.
- Molecular Biology of the Cell. 6th ed. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. New York: Garland Science; 2014.
- Biotechnology: An Introduction. 3rd ed. Barnum SR. Belmont, CA: Cengage Learning; 2010.
- Recombinant DNA: Genes and Genomes – A Short Course. 3rd ed. Watson JD, Myers RM, Caudy A, Witkowski JA. New York: W.H. Freeman; 2007.
- Biotechnology: Academic Cell Update Edition. 2nd ed. Smith JE. Amsterdam: Academic Press; 2009.

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Microbiology and Immunology**No. of Hours – 60****CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
DSE: Microbiology and Immunology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY			
Programme: Bachelor Of Zoology		Year: III	Semester: VI
			Paper: DSE
Subject: Zoology			
Course: DSE		Course Title: Microbiology and Immunology	
Course Outcomes:			
After studying this course, the students will be able to:			
• Understand microbial identification, microbial habitat, growth characteristics, physiology etc. • Understand foundation of immunological processes and how the interaction between pathogen and immune system takes place.			
Credits:4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules
Unit	Topic		No. of Hours
Unit I	History and Development of Microbiology. Discovery of microorganisms. Pioneers in microbiology (e.g., Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch). Role of microbiology in medicine, agriculture, and industry. Classification of microorganisms. Characteristics and general morphology of microbes. Types of		15

	microscopes (Light and Electron)	
Unit II	Prokaryotic vs. eukaryotic cells. Metabolic pathways (Aerobic and anaerobic fermentation). Factors affecting microbial growth (temperature, pH and oxygen). Growth curve (Lag, Log, Stationary and Death phases).	15
Unit III	Definition and principles of the immune system. Innate vs. adaptive immunity. Overview of immune cells (e.g., macrophages, T-cells, B-cells). Primary lymphoid organs (Bone marrow, Thymus). Secondary lymphoid organs (Lymph nodes, Spleen). Structure and function of antibodies (IgG, IgA, IgM, IgE and IgD). Antigenic determinants (epitopes). Antigen-antibody interactions. Innate Immune Response. The Adaptive Immune Response. Immunological Disorders and Vaccination.	15
Practical		
	1. Microbiology good laboratory practices and Bio-safety. 2. To study the principle and application of important instruments (biological safety cabinet, autoclave, BOD, incubator and shakers, hot air oven, light microscope, pH meter, water bath) use in the microbiology laboratory. 3. Sterilization and Preparation of culture media (solid and liquid), culture techniques (streaking, pour plate and spread plate methods). 4. Demonstration of the presence of micro flora in the environment (air and water). Common microbiological technique like staining (Gram and Endospore staining). To study the growth of bacterial culture (using spectrophotometers) and motility (using hanging loop method). 5. Identification of human blood grouping.	15

	6. Separate serum from the blood sample(demonstration). 7. Perform Immunodiffusion by Ouchterlony method. 8. Perform ELISA.	
Recommended Readings Textbooks: • Medical Microbiology- Patrick R. Murray • Microbiology – Michel J. Pelczar • A textbook of Microbiology – R. C. Dubey and DK Maheshwari • Immunology: A Short Course- Richard Coico and Geoffrey Sunshine • Microbiology: A Systems Approach- Marjorie Kelly Cowan • Janeway's Immunobiology- Kenneth Murphy and Casey Weaver • Microbiology and Immunology- Subhash Chandra Parija		

Generic Elective (GE) – Toxicology

No. of Hours – 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credits	Credit distribution of the Course	Eligibility criteria	Pre-requisite of the
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Title		Lecture	Tutorial	Practical/Practice		Course (if any)
GE: Toxicology	4	4	0	0	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	Year: III	Semester: VI
		Paper: GE
Subject: Zoology		
Course: GE	Course Title: Toxicology	
Course Outcomes: After studying this course, the students will be able to: • Understand the core concepts of the science of toxicology, including hazard identification, exposure assessment, dose-response assessment and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. • Understand the role for the science of toxicology in society, including the importance of risk analysis, management and communication. • Identify and discuss contemporary issues in toxicology. • Learn technical aspects and experimental approaches in toxicological research, testing and risk assessment. • Understand scientific analysis and communication, including the ability to analyze relationships, draws appropriate conclusions supported by data and articulates in writing and orally a critical perspective using evidence as support.		

Credits:4		Generic Elective
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Unit	Topic	No. of Hours
Unit I	Introduction and brief history of toxicology: General principles of toxicology, Brief history Environmental toxicology: kinds and sources to toxic agents animal toxins, plant toxins, pesticides, heavymetals and food additives, Metabolism of toxic substances.	20
Unit II	Dose response relationship: Frequency and cumulative responses, determination ofED ₅₀ , LD ₅₀ , EC ₅₀ , LC ₅₀ , TLM values, margin of safety, threshold limits. Drugs as Toxic Substances in Genetic aspects(Carcinogenicity, Teratogenicity and Mutagenicity)	20
Unit III	Analytical toxicology: Toxic response of blood, organ function tests. Organ toxicity: Hepatotoxicity, Nephrotoxicity, Cardiotoxicity, Respiratory Toxicity, Neurotoxicity, Toxicity effect in Male and Female Reproductive System and Carcinogenic tests (Ames Test). Hands on training or laboratory experiments based on toxins (How a toxin works)	20
Recommended Readings		
Textbooks:		

- Toxicological Testing Handbook- David Jacobson, Kram and Kit A. Keller
- Concepts of Toxicology – Dr. Omkar
- Small Animal Toxicology- Michael E. Peterson and Patricia A. Talcott
- Forensic Medicine and Toxicology- K S Narayan Reddy, O P Murty
- A Textbook of Medical Jurisprudence and Toxicology (26th Edition) - Modi and K. Kannan-Modi and K. Kannan
- Modern Medical Toxicology- V. V. Pillay