National Education Policy – 2020

Common Minimum Syllabus for State Universities and Colleges of Uttarakhand

Four Year Undergraduate Programme- FYUP/HonoursProgramme/ 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

BACHELOR OF ZOOLOGY WITH HONOURS					
FOURTH YEAR	VII	(DSC)- **ZOO/DSC/VII/T**	Biology of Non- Chordata	Theory	3
		(DSC)- **ZOO/DSC/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE1)- **ZOO/DSE1/VII/T**	Evolutionary Biology/Elementary Ichthyology	Theory	3
		(DSE1)- **ZOO/DSE1/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE2)- **ZOO/DSE2/VII/T**	Animal Ecology/ Elementary Entomology	Theory	3
		(DSE2)- **ZOO/DSE2/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE3)- **ZOO/DSE3/VII/T**	Elementary Bio-technology/ Elementary Immunology	Theory	3
		(DSE3)- **ZOO/DSE3/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(GE1) - **ZOO/GE1/VII**	Bioinstrumentation	Theory	3
		(GE2) - **ZOO/GE2/VII**	Histology	Theory	4
		DISSERTATION	Dissertation on Major OR Dissertation on Minor OR Academic Project/Entrepreneurship OR Excursion/Field study	Theory/ Practical	6

	VIII	(DSC) - **ZOO/DSC/VIII/T**	Biology of Chordata	Theory	3
		(DSC) - **ZOO/DSC/VIII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE1) - **ZOO/DSE1/VIII/T**	Ethology/Research Methodology	Theory	3
		(DSE1) - **ZOO/DSE1/VIII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE2) - **ZOO/DSE2/VIII/T**	Cytology/Biotechniques	Theory	3
		(DSE2) - **ZOO/DSE2/VIII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE3) - **ZOO/DSE3/VIII/T**	Advance Genetics/Biomedical Technologies	Theory	3
		(DSE3) - **ZOO/DSE3/VIII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(GE1) - **ZOO/GE1/VIII**	General Biotechnology	Theory	4
		(GE2) - **ZOO/GE2/VIII**	Parasitology	Theory	4
		DISSERTATION	Dissertation on Major OR Dissertation on Minor OR Academic Project/Entrepreneurship OR Excursion/Field study	Theory/ Practical	6

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- VII

BACHELOR OF ZOOLOGY WITH HONOURS

DISCIPLINE SPECIFIC COURSE (DSC) – Biology of Non- Chordata

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITYAND 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: Biology of Non-Chordata	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology WithHonours	**Year: IV**	**Semester: VII** **Paper: DSC**
Subject: Zoology		

Course: DSC	Course Title: Biology of 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**
Unit I	General classification, characters, habits and habitats of Non-chordates Protozoa: Nutrition, Locomotion (Amoeboid, Flagellar and Ciliary movements) and reproduction in protozoa; Life-cycle of *Trypanosoma, Entameoba histolytica, Giardia* and *Leishmania*. Porifera: Canal system and phylogeny. Reproduction in Porifera.	**15**

Unit II	Coelenterata: Polymorphism in Coelenterata. Structure and affinities of Ctenophora, Coral and coral reefs. Helminthes: Life cycle of *Taenia solium, Fasciola hepatica, Wuchereria* and *Schistosoma.* Parasitic adaptations in helminths. Minor phyla: Rotifera and Brachiopoda: Organization and affinities.	**15**
Unit III	Annelida: Segmental organs in Annelida and Adaptive radiations in Polychaeta. Arthropoda: Larval forms in Crustacea. Mouth parts in insects. Social life in honeybees and termites. Onychophora: Organization and affinities. Mollusca: Torsion in Mollusca. Pearl formation and its commercial importance, respiratory and reproduction in Mollusca. Echinodermata: Water vascular system and larval forms Mechanism of Osmoregulation in invertebrate.	**15**
Practical		
	1. Study of living animals: *Amoeba, paramecium, Euglena, Hydra*, and rectal ciliates 2. Study of Nervous-system/General anatomy with the help of charts/models and simulation of Earthworm, Prawn, *Pila, Unio*.	**30**

	3. Study of permanent slides/museum specimens/models belonging to following phyla Protozoa, Porifera, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca andEchiodermata. 4. Study of Parasites: Protozoa: *Plasmodium, Moncystis, Trypanosoma, Leishmania, Entamoeba, Giardia*. Helminthes: *Fasciola, Taenia, Ascaris, Schistosoma* and filarial including larval stages. Annelida: Leeches Arthropoda: Sacculina, lice, flea, bedbug, tick and mites. Life Cycle of the following:-*Entamoeba, T. solium, A. lumbricoides, F. hepatica, Schistosoma*	

Recommended Readings

Textbooks

- Modern textbook of Zoology- R. L. Kotpal,
- Invertebrate Zoology- Anderson, Donald Thomas
- Textbook of Zoology Invertebrates – Parker and Haswell
- CNH Series, Kotpal Series, Hyman Series
- Invertebrates- Brown, A. Frank
- Invertebrate Zoology- E. L. Jordan and P. S. Verma
- Invertebrate Zoology- E. E. Ruppert and R. D. Barnes

Reference Book

- The Invertebrates. 6th ed. Barnes RD. Philadelphia: Saunders College Publishing; 1982.
- Principles of Invertebrate Paleontology. 2nd ed. Shrock RR, Twenhofel WH. New Delhi: CBS Publishers.
- Textbook of Invertebrate Zoology. 1st ed. Kapoor V. Meerut: Rastogi Publications; 2013.
- Invertebrate Structure and Function. 1st ed. Barrington EJW. London: Thomas Nelson and Sons.
- The Lower Metazoa: Comparative Biology and Phylogeny. 1st ed. Dougherty EC. Berkeley, CA: University of California Press.

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Evolutionary Biology

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		
DSE:Evolutionary Biology	4	4	0	0	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor Of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE**
Subject: Zoology		
Course: DSE	**Course Title: Evolutionary Biology**	
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 Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**

Unit	Topic	No. of Hours
Unit I	Origin of Life: Concept of Oparin and Haldane, Urey and Millers Experiment. Theories of Evolution: Lamarckism, Darwinism, Modern synthetic theory of Evolution Homologous and Analogous Organs.Concept of Variation, Adaptation,	**15**

	Struggle for existence, Natural Selection, Isolation.	
Unit II	Origin of Species: Categories of Species (Demes, Metapopulation, Geographical races, Ecological Races and Clines), Types of Species and Speciation. Basic pattern of Evolution (Micro, Macro and Mega Evolution).	**15**
Unit III	Population genetics: Micro and Macro evolution, allele frequency, gene frequency, Gene Pool, Hardy Weinberg's equilibrium and condition for its maintenance, forces of evolution: Mutation, selection and genetic drift. Direct evidences of Evolution: Types of fossils, living fossils, dating of fossils. Phylogeny of man, horse, camel and elephant. The evolutionary synthesis. Phylogenetic analysis among organisms using Computational biology tools.	**15**
Practical		
	1. Adaptive modification in beak and feet of birds (through charts/ slides). 2. Embryological evidences of evolution (through chart). 3. Analogy and Homology (wings of birds and insects, forelimbs of bats and rabbits. 4. Study of phylogenetic models: Man, Horse, Camel, Elephants etc. 5. Study of living fossils through specimens. 6. Phylogenetic tree preparation through computational tools.	**30**
Recommended Readings **Textbooks:**		

- Evolution And Taxonomy- JohnHenry Comstock
- Evolution - Strickberger
- Collecting Evolution: The Galapagos Expedition that Vindicated Darwin- Matthew J. James
- Evolution: an introduction- Stephen Stearns and Rolf Hoekstra
- Genetics and Evolution – P K Gupta
- Evolutionary Biology- Pierre Pontarotii
- Evolutinary Biology- Veer Bala Rastogi
- Evolutionary Biology-R. Paul Thompson
- Encyclopedia of Evolutionary Biology- Richard M. Kilman

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary Ichthyology

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		

DSE:Elementary Ichthyology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor Of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE**
Subject: Zoology		
Course: DSE	**Course Title: Elementary Ichthyology**	
Course Outcomes: After studying this course, the students will be able to: • Identify the major types of fish and their characteristics. • Understand the anatomy and physiology of fish. • Recognize the ecological roles and environmental significance of fish. • Classify fish into different families, orders, and classes. • Appreciate the importance of fish conservation.		
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 Ichthyology: Definition and scope, History and importance of Ichthyology Classification of fishes up to orders.	**15**
Unit II	Morphology of Fish: Body shape, Fins and types of fins, Scales and Types of scales Fish Physiology: Respiration, Digestion, Excretion, Reproduction and Sense organs system Adaptation in fish: Hill Stream and Deep-Sea Adaptation.	**15**
Unit III	Construction of aquarium and its maintenance Methods of fish collection and types of nets Fish processing and preservation techniques. Pisciculture: Carp farming, Integrated fish farming, Induced breeding: Induction agents and their applications.	**15**
Practical		
	1.To identify basis diagnostic (Morphological) features of fish 2. Age determination with the help of scale.	**30**

	3. Collection of blood and smear preparation. 4. Construction and Maintenance of fish aquarium.	

Recommended Readings
Textbooks

- A textbook of Fish Biology and Fisheries – S.S. Khanna and H. R. Singh
- Fish and fisheries of India – V.G. Jhingran
- The Book of Indian Fishes– Francis Day
- Freshwater Fishes of Peninsular India – K.C. Jayaram
- Freshwater Fish Diversity of India – Dahanukar, Raut, and Bhat
- Ichthyology - K.C. Pandey, Nirupama Agrawal

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Animal Ecology

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		
DSE:Anima	4	3	0	1	Passed Class XII with	Nil

l Ecology	Biology	

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VII** **Paper: DSE**
Subject: Zoology		
Course: DSE	**Course Title: Animal Ecology**	
Course Outcomes: After studying this course, the students will be able to: 1. Describe the history, introduction and nature of ecosystem. 2. Explain the biogeochemical cycles and laws. 3. Describe population and community ecology. 4. Describe wild life conservation and management. 5. Develop understanding of aquatic ecology.		
Credits:4		**Discipline Specific Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**

Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Concept of Ecology, its subdivisions and scope.Biotic and Abiotic Components. Concept of habitat and niche; fundamental and realized niche. Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).	**15**
Unit II	Laws of limiting factors and its impact on organisms. 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 structure pyramid. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	**15**
Unit III	Pollution:Point and non-point sources of pollution, types of pollution, indicators of pollution. Case study of various control measures taken for pollution in India. Eutrophication: Its causes, assessment, consequences and control.	**15**
Practical		
	1. Calculation of similarity index between different communities. 2. Calculation of concentration of dominance for different communities.	**30**

	3. Calculation of Shannon Weiner Index of diversity in different communities 4. Determination of salinity and chlorinity in water samples. 5. Determination of moisture content and total organic matter in soil sample. 6. Determination of dissolved oxygen. 7. Determination of free CO2 in water sample. 8. Study of Aquatic ecosystem i.e. Ponds, lakes, river etc.	

Recommended Readings

Textbook:

- Ecology and Environmental Science – H. R. Singh
- Animal Population Dynamics (Outline Studies in Ecology)- R. Moss, Adam Watson
- Animal Ecology and distribution of animals {PB}- Veer Bala Rastogi
- Perspectives in Animal Ecology and Reproduction- V. K. Gupta
- Animal Ecology- S. Charles (Samuel Charles) Kendeigh
- Animal Population Ecology: An Analytical Approach (Ecology, Biodiversity and Conservation)- T. Royama
- Animal Ecology- Charles Elton
- Limnology Lake and River Ecosystem – Robert G. Wetzel

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary Entomology

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		
DSE:Elementary Entomology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE**
Subject: Zoology		

Course: DSE	Course Title: Elementary Entomology	
Course Outcomes: After studying this course, the students will be able to: • Understand the Basics of Entomology • Identify and Classify Insects • Explain Insect Anatomy and Adaptations		
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 Entomology:Definition, History and Scope. Classification of insects up to orders; Brief knowledge of general characters of following insect orders- Thysanura, Collembola, Orthoptera, Odonata, Isoptera, Herteroptera, Coleoptera,Lepidoptera, Hymenoptera and Diptera.	**15**
Unit II	Methods of insect collection and preservation. Social life in insects: honey-bee and termites.	**15**

	A brief account on the life-cycle, pathogenecity and control measures. Insect Life Cycles and Metamorphosis (e.g., Butterflies and Grasshoppers)	
Unit III	Household insects: Cockroach and Silverfish. Insect injurious to man and Livestock: Mosquitoes, House fly and Bedbug. Economic importance of insect as food medicine. Insects in agriculture, Integrated pest management.	**15**
Practical		
	1.Collection, preservation and mounting different groups of insectsfauna. 2.Identification of insects using dichotomous keys. 3.Field visit to understand forest and agricultural habitats of insects. 4. Study of life cycles of some household and serious pest of crops and vegetables with the help of chart and models.	**30**

Recommended Readings

Textbooks

- Insects – M.S. Mani

- Modern Entomology – D. B. Tembhare
- Elements of Entomology – Rajendra Singh and G. C. Sachan
- Entomology Refresher – K. Phani Kuamar and C. P. Viji

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary 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		
DSE:Elementary Bio-technology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE**
Subject: Zoology		
Course: DSE	**Course Title: Elementary Bio-technology**	
Course Outcomes: After studying this course, the students will be able to: • Understand what biotechnology is and how it is used in various fields. • Explain the basic structure of cells and DNA. • Identify the role of microorganisms in food, medicine and the environment. • Describe how biotechnology is used in agriculture and food production. • Understand how vaccines, antibiotics and genetic engineering work. • Recognize the role of biotechnology in environmental protection. • Discuss future possibilities and ethical concerns in biotechnology. • Understand Genomics, Proteomics and Metagenomics.		
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 Biotechnology and its history. Restriction enzymes and cloning techniques used in recombinant DNA technology. Polymerase Chain Reaction (PCR) and its applications.	**15**
Unit II	DNA Fingerprinting. Blotting techniques (Northern, Western and Southern) Gene cloning techniques. Genomics, Proteomics and Metagenomics.	**15**
Unit III	Biotechnology in Food Production: Fermentation, genetically modified animals. Biotechnology in Medicine:vaccines, Antibiotics.	**15**
Practical		
	1. Culture and maintenance of bacteria. 2. To extract genomic DNA from bacterial cells. 3. To carry out the spectrophotometric analysis of genomic DNA. 4. Agarose gel electrophoresis. 5. Restriction enzyme digestion of the isolated DNA.	**30**

Recommended Readings

Textbooks

- Biotechnology – David P. Clark

- Genetic Engineering – Smita Rastogi and Neelam Pathak
- Elementary Biotechnology – R.C. Dubey
- Biotechnology for Beginners – Rajiv Aggarwal
- Textbook of Biotechnology – H.K. Das

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary Immunology

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		
DSE: Elementary Immunology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY

<table>
<tr><td colspan="2">Programme: Bachelor Of Zoology</td><td>Year: IV</td><td>Semester: VII

Paper: DSE</td></tr>
<tr><td colspan="4">Subject: Zoology</td></tr>
<tr><td>Course: DSE</td><td colspan="3">Course Title: Elementary Immunology</td></tr>
<tr><td colspan="4">Course Outcomes:

After studying this course, the students will be able to:
• Understand the basic concepts of immunology and its importance.
• Identify the major components of the immune system and their functions.
• Describe how vaccines work and their role in disease prevention.
• Recognize common immune-related diseases.
• Discuss the role of immunology in medical advancements.</td></tr>
<tr><td colspan="3">Credits:4</td><td>Discipline Specific Elective</td></tr>
<tr><td colspan="3">Max. Marks: As per Univ. rules</td><td>Min. Passing Marks: As per Univ. rules</td></tr>
<tr><td>Unit</td><td colspan="2">Topic</td><td>No. of Hours</td></tr>
<tr><td>Unit I</td><td colspan="2">Definition and principles of the immune system. Innate vs. adaptive immunity. Overview of immune cells (e.g., macrophages, T-cells and B-cells). Primary lymphoid organs (Bone marrow and Thymus).Secondary lymphoid organs (Lymph nodes and Spleen).</td><td>15</td></tr>
</table>

Unit II	Structure and function of antibodies (IgG, IgA, IgM, IgE andIgD). Antigenic determinants (epitopes). Antigen-antibody interactions. The Innate Immune Response. The Adaptive Immune Response. Immunological Disorders and Vaccination.	**15**
Unit III	Common Diseases and response of Immune System, Allergies, Autoimmune diseases and Immunodeficiency. Brief knowledge about Biofortifictaion.	**15**
Practical		
	1. Demonstration of lymphoid organs. 2. Histological study of spleen, thymus and lymph nodes through slides/ photographs 3. Preparation of stained blood film to study various types of blood cells. 4. Ouchterlony's double immuno-diffusion method. 5. ABO blood group determination. 6. Demonstration of ELISA	**30**

Recommended Readings

Textbooks

- Immunology – Kuby
- Immunology – Richard Coico and Geoffrey Sunshine
- A textbook of Immunology – P. Madhavee Latha
- Elements of Immunology – Dr. Fahim Halim Khan
- Basic Immunology – R.C. Dubey
- Textbook of Immunology – Arun Kumar and Sunil Kumar
- Immunology- Wiley Blackwell

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

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VII** **Paper: GE**
Subject: Zoology		
Course: GE1	**Course Title: Bioinstrumentation**	

Course Outcomes:

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

1. Understand the use of basic biomedical instrumentation, principles and techniques of Microscopy and preparative analytical centrifugation; include ultra centrifugation, sedimentation analysis and gradient centrifugation.
2. 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	Principles and techniques of Microscopy; Magnification and resolution parameters of light, fluorescent phase contrast scanning, transmission electron microscopy, tunneling microscopy and Invertedmicroscope, Micrometry, Colony counting, 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), X-ray Crystallography. Chromatographic techniques, Paper chromatography, partition chromatography, column chromatography, thin layer chromatography, Gas Chromatography, ion exchange, affinity chromatography.	**20**

Unit III	Introduction to HPLC, Electrophoresis: Capillary, Agarose, SDS and Native PAGE, pulse field, immuno-electrophoresis, paper electrophoresis, PCR and Thermal cyclers, Nucleic acid hybridization: Southern and Northern blotting, Western blotting, Autoradiography. ELISA, RIA.	**20**

Recommended Readings

Textbooks:

- Bioinstrumentation – M.H. Fulekar and Bhawna Pandey
- Textbook of Bioinstrumentation – Priyanka Pandey
- Bioinstrumentation – John G. Webster

Generic Elective (GE) –Histology

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: Histology	4	4	0	0	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY		
Programme: Bachelor Of Zoology	**Year: IV**	**Semester: VII** **Paper: GE**
Subject: Zoology		
Course: GE	**Course Title: Histology**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the basic concepts of histo technology. 2. Interpret the characteristic structural features of tissue group and main organs.		
Credits:4		**Generic Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**

Unit	Topic	No. of Hours
Unit I	Definition, scope, and significance of histology. Histological techniques: Fixation, sectioning, and staining. Basic Tissues and their types, structure and function (epithelial, connective, muscular and nervous tissue)	**20**

Unit II	Histology of Major Organ Systems: Digestive System: liver, pancreas. Respiratory System: Lungs. Excretory System: Kidney. Histology of Endocrine glands: Pituitary, thyroid, adrenal, Testis,Ovary.	**20**
Unit III	Study of different animal tissues of Protochordates, Cyclostomes, fishes, amphibians, birds and mammals with the help of permanent slides.	**20**

Recommended Readings

Textbooks:

- Junqueira's Basic Histology: Text and Atlas - Anthony L. Mescher
- A textbook of Animal Histology – A.K. Berry
- Histology: A Text and Atlas - Michael H. Ross and Wojciech Pawlina
- Functional Histology - William K. Ovalle
- Textbook of Histology- Dr. P. R. Joshi
- Basic Histology- Dr. A. K. Suri and Dr. B. D. Suri

SEMESTER- VIII

BACHELOR OF ZOOLOGY WITH HONOURS

DISCIPLINE SPECIFIC COURSE (DSC) – Biology of Chordata

No. of Hours – 75

CREDIT DISTRIBUTION, ELIGIBILITYAND 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: Biology of Chordata	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSC**
Subject: Zoology		

Course: DSC	Course Title: Biology of Chordata	
Course Outcomes: After studying this course, the students will be able to: 1. Describe general taxonomic rules on animal classification of chordates. 2. Classify Protochordata to Mammalian with taxonomic keys. 3. Understand Mammals with specific structural adaptations. 4. Understand the significance of dentition and evolutionary significance. 5. Understand the origin and evolutionary relationship of different phyla from Prochordata 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	Classification up to orders, characters, habits and habitats of chordates. Characteristic features and affinities of the following: Protochordata, Hemichordata, Urochordata, Cephalochordata, Cyclostomes, Dipnoi. Origin of the following: Amphibian, Reptiles, Birds, Mammals, Adaptive radiation in Chordates: Aquatic, Terrestrial, Aerial, Arboreal, Fossorial	**15**
Unit II	Parental care in Amphibians, Skull in Reptiles, Venom and anti-venom in Ophidians Flightless birds, Modification of beaks (Darwin finches), feet and	**15**

	palate in birds, Dentition in mammals, Stomach in ruminants. General organization, classification and affinities of Cyclostomata, Gymnophiona and its affinities, Parental care in Amphibian.	
Unit III	General organization, distribution and affinities of Rhynchocephalia. General organization, distribution and affinities of Crocodilian. Palate in Birds, Ratitae: Distribution and affinities, Dentition in mammals, General characters, distribution and affinities of Prototheria and Metatheria, Aquatic and flying adaptations in Mammals.	**15**
Practical		
	1. Microtomy of vertebrate tissues 2. Study of the skeleton of Frog, Varanus, Chelonia, Crocodile, Snake (vertebrae and skull of poisonous and non-poisonous snake), Gallus (various types of Palates) and Rabbit 3. Study of permanent slides of Protochordates and Chordates. 4. Study of the museum specimens of Protochordata and of the different classes of vertebrates.	**30**

Recommended Readings

Textbook

- Modern textbook of zoology, Vertebrates- R. L. Kotpal
- Chordate zoology - E. L. Jordan and P. S. Verma
- CNH Series, Kotpal Series, Hyman Series
- 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.

Reference Book

- The Vertebrate Body. 6th ed. Romer AS, Parsons TS. Philadelphia: Saunders College Publishing; 1986.
- Chordate Structure and Function. 1st ed. Waterman AJ. New York: Macmillan Publishing Co.; 1971.
- Vertebrate Life. 10th ed. Pough FH, Janis CM, Heiser JB. New York: Oxford University Press; 2018.
- The Origin of Vertebrates. 1st ed. Gee H. Oxford: Oxford University Press; 1996.
- Functional Anatomy of the Vertebrates: An Evolutionary Perspective. 3rd ed. Liem KF, Bemis WE, Walker WF, Grande L. Belmont, CA: Brooks/Cole; 2001.

DISCIPLINE SPECIFIC ELECTIVE (DSE1) – Ethology

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		
DSE1:	4	3	0	1	Passed Class XII with	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**
Subject: Zoology		
Course: DSE1	**Course Title: Ethology**	

Course Outcomes:

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

- Learn about the role of hormones, an animal's genotype and its environment in the development of behavior.
- Learn to exhibit critical and integrative thinking skills.
- Learn about the systems that affect animal behavior, such as the central neural system, hormones and pheromones.
- Learn about physiological mechanisms that cause or modulate animal behavior, animal sensory systems and evolutionarybehavioral biology.
- Learn 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**
Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Brief history, Introduction, Significance of Study of Animal Behaviour. Behaviour Patterns: Fixed Action Pattern (FAP) or Instinctive Behaviour: Characteristics, modes Kinesis, Taxes, Reflexes, Instincts), Releasers, Innate Releasing Mechanism (IRM). Learned Behaviour or Acquired Behaviour: Non-associative learning (Habituation, Sensitization), Associative learning (Classical conditioning, Trial and Error learning), Latent learning, Insight learning (Reasoning, Intelligence, Cognitive thinking), Phase-specific learning (Imprinting, Avian Song Learning, Language learning) Memory: Nature of Memory, Positive and Negative Memory (Reasoning, Remembering, Forgetting and Retention), Types of Memory (Short-term Memory (STM), Intermediate term Memory (ITM), and Long-term Memory).	**15**
Unit II	Individual Behaviour: Conflicts (Situations, Types of conflicts, Behaviour display as an evidence of Conflict), Aggression (Forms and causes of aggression), Territoriality (Individual territories, Pair territories, Group territories, Use of scent, urine and faeces and special glands such as anal and salivary glands in marking territories by Mammals) Feeding Strategies: Non-	**15**

	selective and Selective feeding, Food begging, Courtship feeding, Predatory and Anti-predatory feeding mechanisms, Food sharing in insect societies, Parental feeding, Coprophagy Social Behaviour: Costs and benefits of group living, Types of Social Acts, Social Organizations in Termites and Primates, Parental Care in Insects, Fishes, Amphibians, Birds and Mammals.	
Unit III	Communication: Visual and Auditory communication, Infrasound communication in Elephants and Whales, Tactile communication (Dance language of honey bees), Electric communication, Chemical communication (Pheromones: Types and their functions in Insects and Mammals), Echolocation in Bats, Postures and Gestures in Mammals Migratory Behaviour: Bird Migration: Types of Migration, Causes of Migration, Advantages of Migration, Methods of Studying of Migration, Orientation and Navigation, Fish Migration: Homing, Causes of Migration, Factors influencing Migration, Fish Migration ways or Fish Ladders, Migration of Salmon, Eel and Hilsa. Biological Rhythms: Circa-annual Clocks, Circatidal Clocks, Circa-lunar or Circa-syndic Clocks, Semi-lunar Clocks, Circadian Clocks.	**15**
Practical		
	1. Study of different kinds of behavior with the help of models/photographs. 2. To study different types of taxis in organisms (honey bee, ants, earthworms etc.) 3. Study of motivation behavior through models. 4. Study of social groups and socio-biology of animals. 5. To study nesting behavior of wasps.	**30**

	6. Direct and indirect sighting of birds behavior. 7. Study of behavior of Drosophila and fish with the help of direct and indirect sighting.	

Recommended Readings

Textbooks

- Textbook of Animal Behaviour- Mandal Fatik Baran
- 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

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Research Methodology

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

		Lecture	Tutorial	Practical/Practice		**Course (if any)**
DSE1: Research Methodology	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**
Subject: Zoology		
Course: DSE1	**Course Title: Research Methodology**	

Course Outcomes:

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

- Understand the basic concepts of Research and methodology.
- Develop advance critical thinking skill.
- Define and apply appropriate parameter and research problems.

Credits:4		**Discipline Specific Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Research – types, selection and formulation of research Problem – research Design. Analytical study of Statistical Method, Historical Research. Statistics as a tool of research, Methods and demerits of statistics. Surveys, types of research methods, Case Study, Sampling types and Methods. Historical Method and Scientific Method. Characteristic Features of Scientific Method; Empirical Verifiable, Cumulative, Self - Correcting, Deterministic. Ethical and Ideological neutrality (Value Free), Statistical Generalizability.	**15**
Unit II	Collection, Objectives and Classification of Data, Types of data presentation. Data Interpretation, Primary, Secondary and Tertiary Data. Data organization in SPSS and Excel, Computer and Content Analysis. Discussion and Interpretation of results. Testing of Hypothesis: Logical and Statistical Techniques.	**15**
Unit III	Locating Information on a Topic of Interest, Acquiring Copies of Articles of	**15**

	Interest. The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables. Levels of Measurement, Various Paradigms. The Basic Format for a Research Report, Identification of the Parts of a Research Report. Citation and Referencing Styles. Essentials of Report Writing, Aids for Writing Good Research Report.	
Practical		
	1. Usage of search engine tools for retrieving research/review papers. 2. To generate a hypothesis and design an experiment. 3. Collection of data, interpretation and writing an article (research/review papers). 4. Graphical representation and interpretation of the data provided. 5. Title and abstract writing for a given research paper. 6. Preparation of bibliography/references in different formats as per journal requirements. 7. Usage of software tools for checking plagiarism. 8. Drug designing tools and their usage.	**30**

Recommended Readings

Textbooks:

- Research Methodology Methods and Techniques – C R Kothari
- Research Methodology: Techniques and Applications - K. Hanumantha Rao
- Research Methodology in Social Sciences: A Practical Guide - Bagchi, Kanak Kanti
- Research Methods in Librarianship- B.A.V. Busha, C. H and Harter, S.
- Business Research Methods - Cooper, R. Donald and Pamela S. Schindler.
- Making Social Science Matter: Why Social Inquiry Fails and How it can Succeed - Flyvbjerg

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Cytology

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		
DSE:	4	3	0	1	Passed Class XII with	Nil

Cytology	Biology	

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**
Subject: Zoology		
Course: DSE2	**Course Title: Cytology**	
Course Outcomes: After studying this course, the students will be able to: • Understand the relationship between cell structure and function. • Correlate the relationship between cellular structure and function in the context of cell growth and death. • Understand DNA regulation and replication: Students can understand DNA regulation and replication, as well as types of DNA damage and DNA repair pathways.		
Credits:4		**Discipline Specific Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**

Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Diversity of cell size, type and shape, Cell theory. Structure of Prokaryotic and Eukaryotic cells. Cellular organelles: Plasma membrane, cell wall and their structural organization; Mitochondria, Nucleus ER, Golgi complex and micro-bodies, Nuclear Pore complex. Organization of cytoskeleton; cell microtubules, micro filament and intermediate filaments. Molecular aspects of cell division; Cell cycle - molecular events and model system, cell cycle regulation.	**15**
Unit II	Structure and Organisation of membranes, Glycoconjugates and Proteins in membrane system, Protein Localization, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis Transport of nutrients, ions and macromolecules across membranes, Passive and active transport, Na+ /K+ pump. Cellular communication: general principles of cell communication, cell adhesion molecules and roles of different adhesion molecules, gap junctions, plasmodesmata, extracellular matrix, selectins, Cadherins, integrins, neurotransmission and its regulation.	**15**
Unit III	Cellular responses to environmental signals in bacteria and animals - mechanisms of signal transduction; Endocrine, Exocrine and Synaptic signaling, Surface and intracellular receptors, G Proteins and generation of second messengers, mode of action of cAMP and Ca ++ Calmodulin, signal transduction pathways, regulation of signaling pathways. GPCR Signaling, Wnt Signaling, Notch Signaling, Hedgehog Signaling, NO Signaling, RAS-MAP	**15**

	Signaling. Biology of cancer: Oncogenes and Tumor Suppressor Genes, Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, function and mechanism of pRB and p53 tumor suppressor proteins. Apoptosis and necrosis.	
Practical		
	1. Cytology: Study of different stages of mitosis with the help of onion root tip/animal cell. 2. Study of Giant Chromosomes (Polytene and Lambrush Chromosome) 3. Preparation of DNA / RNA structure Nucleosides Nucleotides through chart/model. 4. Laboratory preparation of following models using beads and wire. • Adenosine triphosphate (ATP). • DNA and RNA bases Nucleosides Nucleotides.	**30**

Recommended Readings

Textbooks:

- Cell and Molecular Biology – DeRobertis and DeRobertis
- Molecular Biology of the Cell – Alberts
- Cell Biology – P.S. Verma
- The Cell: A Molecular Approach- Geoffrey M. Cooper and Robert E. Hausman
- A Text Book of Cell Biology And Genetics- Veer Bala Rastogi
- Cell Biology Genetics Molecular Biology- Halder Kar
- Cell Biology and Genetic- V. R. Dnyansaga

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Biotechniques

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		
DSE: Biotechniques	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**

Subject: Zoology		
Course: DSE2	**Course Title: Biotechniques**	
Course Outcomes: After studying this course, the students will be able to: • Understand the use of basic biomedical instrumentation, principles and techniques of 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		**Discipline Specific Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Theory		
Unit	**Topic**	**No. of Hours**
Unit I	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.	**15**

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 Exchange, Affinity Chromatography and Introduction to HPLC.	**15**
Unit III	Electrophoresis: Capillary, Agarose, SDS and Native PAGE, Pulse Field, Immuno- Electrophoresis and Paper Electrophoresis. PCR and Therma lCyclers, Nucleic Acid Hybridization: Southern and Northern Blotting, Western Blotting, Autoradiography. ELISA and RIA.	**15**
Practical		
	1. Media preparation and sterilization for animal cell culture 2. Primary cell culture of fish organ 3. Restriction digestion of plasmid DNA/genomic DNA 4. PCR for cloning a DNA segment 5. Construction of circular and linear restriction map from the data provided 6. To study - Southern Blotting, Northern Blotting and Western Blotting 7. To study - DNA Sequencing, Sanger's Method, DNA fingerprinting 8. Good Laboratory Practices (GLP); ELISA (Demo online).	**30**

Recommended Readings

Textbooks

- Basic Biotechniques – P. Cheena Chawla
- Biotechniques – M.V. Radakrishnan

- Basic Biotechniques – P. Ruban
- Biotechniques – P. Ponmurugan
- Bioinstrumentation (ynthesis Lectures on Biomedical Engineering)- John Enderle
- Bioinstrumentation- L. Veerakumari

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Advance 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		
DSE: Advance	4	3	0	1	Passed Class XII with	Nil

Genetics	Biology	

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**
Subject: Zoology		
Course: DSE3	**Course Title: Advance Genetics**	
Course Outcomes: After studying this course, the students will be able to: • Understand Mendelian genetics principles to understand gene interactions, multiple alleles, and sex-linked inheritance. • Understand principles of chromosome structure and gene frequencies to understand inherited disorders and population genetics.		
Credits:4		**Discipline Specific Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**

Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Chromosomal analysis, Banding techniques, Sex-chromatin techniques, Autoradiography, Chromosomes: Structure, chemical composition, classification, folded fibre model and nucleosome model, karyotype, euchromatin and heterochromatin, Giant chromosomes, B-chromosomes. Concept of gene: Allele, multiple alleles, isoallele, pseudoallele. Chromosome mapping: Chromosome mapping in Drosophila (single and double crossing over), human chromosomes (Somatic cell genetics) Mutation: Type and mechanism and effects.	**15**
Unit II	Mendelian genetics: Dominance, segregation, independent assortment, Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, linkage and crossing over. Gene mapping, Point crosses, Qualitative trait loci (QTL), Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes.	**15**
Unit III	Microbial genetics: Methods of genetic transfers – conjugation, transformation, transduction (generalized and specialized transduction) and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Plasmids, IS Elements, Transposons and Retro-Elements: Plasmids, inversion sequences of IS-elements, Transposons and controlling elements in prokaryotes and eukaryotes.	**15**
	Practical	

	1. Study of various Drosophila mutants 2. Mendelian and Non- mendelian based Experiments 3. Karyotyping technique for chromosomal analysis. 4. Study of Giant chromosomes (Lampbrush and Polytene Chromosome)	**30**

Recommended Readings

Textbooks

- Cell Biology, Genetics, Evolution and Ecology (multicolor edition): Evolution And Ecology- P. S. Verma and V. K. Agarwal
- Principles of Genetics – E. J. Gardner
- Concepts of Genetics – Williams
- Introduction to Genetic Analysis – Anthony J. F. Griffiths
- A Text Book of Cell Biology and Genetics- Veer Bala Rastogi
- Cell Biology Genetics Molecular Biology- Halder Kar
- Cell Biology and Genetic-V. R. Dnyansaga

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Biomedical Technologies

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		
DSE: Biomedical Technologies	4	3	0	1	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: DSE**
Subject: Zoology		
Course: DSE3	**Course Title: Biomedical Technologies**	

Course Outcomes:

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

- After studying this course, the students will be able to the fundamental concepts of biomedical instrumentation, focusing on the principles, operation, and application of medical devices, sensors used in healthcare, medical imaging techniques used in the diagnosis and treatment of diseases and medical implants, prosthetics, and

tissue engineering.

- Understand the fundamental concepts, basic principles and function of biological systems.
- Learn techniques relevant for medical diagnostics.
- Learn about the emphasis of new technologies for medical advancement.

Credits:4	**Discipline Specific Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: As per Univ. rules**

Theory

Unit	Topic	No. of Hours
Unit I	Biomedical Instrumentation and Sensors: Introduction to medical instrumentation and biomedical signal processing; Sensors and transducers for biomedical applications; Biopotential measurements (ECG, EEG, EMG); Patient monitoring systems; Bioelectric signals and noise reduction techniques.	**15**
Unit II	Medical Imaging Techniques: X-ray, CT, and MRI imaging principles; Ultrasound and Doppler imaging; Positron Emission Tomography (PET) and Single Photon Emission CT (SPECT); Medical image processing and analysis; 3D imaging and virtual surgery technologies	**15**
Unit III	Biomaterials and Tissue Engineering: Types of biomaterials: metals, polymers, ceramics, and composites; Biocompatibility, biodegradability, and material testing; Tissue engineering principles and scaffold design; Stem cell	**15**

	technology and its application in regenerative medicine; Drug delivery systems and nanomaterials in medicine.	
	Practical	
	1. Practical training in a range of techniques that are fundamental in biomedical research including assessment organ-bath assessment of ligand-receptor interactions, radioligand binding assays, diagnostic applications of enzyme kinetics, history and design of structure of clinical trials, systematic review approaches and meta-analysis. 2. Understanding of receptor pharmacokinetics, pre-clinical methods used in drug screening and development, enzyme-linked diagnostics, clinical trial structure and the systematic, statistical evaluation of clinical trial data.	**30**

Recommended Readings

Textbooks

- Biomedical Technology and Devices, 2nd Edition, Moore, James E and Duncan J Maitland
- Handbook of Biomedical Instrumentation [May 01, 2003] by R.S. Khandpur.
- Introduction to Biomedical Equipment Technology (4th Edition) by Joseph J. Carr
- Biomedical Instrumentation and Measurements- Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer (Pearson Education)
- Introduction to Medical Imaging: Physics and Technology- Nadine Barrie Smith and Andrew Webb

(Cambridge University Press)

- "Biomaterials Science: An Introduction to Materials in Medicine" - Buddy D. Ratner, Allan S. Hoffman, and Robert L. Schoen (Academic Press)
- "Principles of Tissue Engineering" - Robert Lanza, Robert Langer, and Joseph P. Vacanti (Elsevier Science)

Generic Elective (GE) – General Biotechnology

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:General Biotechnology	4	4	0	0	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS		
Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: GE**

Subject: Zoology		
Course: GE1	**Course Title: Biotechnology**	
Course Outcomes: After studying this course, the students will be able to: 1. To understand principles of animal culture, media preparation. 2. To explain *in-vitro* fertilization and embryo transfer technology. 3. To get insight in applications or recombinant DNA technology inagriculture, production of therapeutic proteins. 4. To describe commercial production of fuels, microbial enzymes.		
Credits:4		**Generic Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Unit	**Topic**	**No. of Hours**
Unit I	Origin and definition of biotechnology, Scope and importance of biotechnology, Biotechnology in India. Basic introduction: Recombinant DNA Technology (Tools and techniques), Restriction and modification enzymes; Vectors: Plasmid, Bacteriophage and other viral vectors, Cosmids, Ti-plasmid, Yeast Artificial Chromosome; Polymerase chain reactions; DNA fingerprinting; Southern, Western and Northern blotting; In-situ hybridization and Molecular markers. Gene therapy and Gene Delivery methods – Background, Types of gene therapy (*ex-vivo*and *in-vivo*), choosing targets for gene therapy, Vectors in gene therapy, Retroviruses, Adenoviruses, Adeno-associated viruses. Viral	**20**

	delivery (Retroviral vectors and Adenoviral vectors), non-viral delivery. Vaccines – nucleic acid vaccines, Biopharming and edible vaccines, immuno-enhancing technology.	
Unit II	Transplantation biology – Terminology, Technology behind it, Organ donors, Social and ethical issues. Xenotransplantation and tissue engineering. Stem cell cultures, Human embryonic stem cell culture, cryopreservation of Umbilical cord stem cells and their potential use. Genetic engineering in animals: Transgenic animals and their applications. Transgenic gens and various transgenic animal models. Therapeutic products produced by genetic engineering-blood proteins, Human hormones, Immune modulators and vaccines, Embryo transfer technology and artificial insemination. Social issues of transgenics and IPR- public opinions against the molecular technologies. Legal issues – legal actions taken by countries for use of the molecular technologies.	**20**
Unit III	Ethical issues – Ethical issues against molecular technologies. Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National and International. Intellectual Property Rights – Why IPR is necessary, TRIPS and IPR, IPR – National and International scenario, IPR protection of life forms. Bioremediation – Petroleum prospecting and formation of oil spills, Wastewater treatment, Chemical degradation, heavy Metals. Introduction to Bioreactor: Types and operation of Bioreactors, Physico-chemical standards used in bioreactors, Limitations of bioreactors.	**20**
Recommended Readings		

Textbooks

- Practical Techniques in Molecular Biotechnology- Bal Ram Singh and Raj Kumar
- Biotechnology: A Problem Approach- Pranav Kumar and Usha Mina
- Textbook of Biotechnology- H. K. Das
- A Textbook of Biotechnology-R. C. Dubey
- Molecular Biotechnology - Bernard
- Biotechnology - A Textbook Of Industrial Microbiology- W. Crueger

Generic Elective (GE) – Parasitology

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: Parasitology	4	4	0	0	Passed Class XII with Biology	Nil

BACHELOR OF ZOOLOGY WITH HONOURS

Programme: Bachelor of Zoology with Honours	**Year: IV**	**Semester: VIII** **Paper: GE**
Subject: Zoology		
Course: GE2	**Course Title: Parasitology**	
Course Outcomes: After studying this course, the students will be able to: • Understand the interaction of various host parasites. • Understand the parasitic adaptation in various ecto and endo Parasites. • Understand the various vectors of disease-causing parasite.		
Credits:4		**Generic Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Unit	**Topic**	**No. of Hours**
Unit I	Parasitism and evolution of parasitism. Protozoan parasites: Biology, life cycle and diseases caused by selected pathogenic protozoans of Man theirPreventive and control measures (*Entamoeba histolytica*, *Trypanosoma, Leshmaniadonovani, Trichomonas vaginalis, Giardia intestinalis* and	**20**

	Plasmodium)	
Unit II	Parasitic adaptations in Platyhelminthes and Aschelminthes. Common trematode, cestodea and nematode parasites. Biology, life history and preventive measures of economically important helminth parasites of man and domesticated animals (*Ascaris, Schistosoma, Faciola, Wuchereria, Taenia)*.	**20**
Unit III	Introduction to arthropods and vectors of human diseases (mosquitoes, lice, flies and ticks). Parasites in Crutaceans.	**20**

Recommended Readings

Textbooks

- Textbook of Microbiology with Parasitology, 7/e – 2024- D. R. Arora and Brij Bala Arora
- Textbook of Medical Parasitology : Protozoology and Helminthology, 4th Edition- Subhash Chandra Parija
- Parasitology Protozoology and Helminthology 13Ed (Hb 2019): (Protozoology and Helminthology)- K. D. Chatterjee
- Textbook of Medical Parasitology- Sumeeta Khurana and Abhishek Mewar
- Textbook of Human Parasitology, Protozoology and Helminthology (PB 2020)- R. Sood