NATIONAL EDUCATION POLICY-2020

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

Four Year Undergraduate Programme- FYUP/Honours Programme/ Master in Zoology

PROPOSED AND APPROVED STRUCTURE
OF
ZOOLOGY SYLLABUS

By
Board of Study
University Department of Zoology
Pt. Lalit Mohan Sharma Campus, Rishikesh
Sri Dev Suman Uttarakhand University, Badshahithaul
Tehri-Garhwal, Uttarakhand, India
(2025-2026)

Name	Designation & Address	Sign.
Prof. G.K. Dhingra	Dean, Faculty of Science	

S. No.	Name	Designation	Sign.
1.	Prof. D. M. Tripathi	Professor & Head **(Convener)**	
2.	Prof. Surman Arya	Professor - **(Member)**	
3.	Prof. Ahmad Pervez	Professor - **(Member)**	
4.	Prof. Smita Badola	Professor - **(Member)**	
5.	Prof. Naresh Agarwal	Professor & Head (Dean) H. N. B. Garhwal University (Central University) S. R. T. Campus, Badshahithaul Tehri-Garhwal **(Subject Expert)**	
6.	Prof. M. S. Rawat, Campus Director	**(Subject Expert)**	

Theory and Practical Examination Pattern

Theory (External): Each theory paper of maximum 75 marks will consist of two sections - A and B. Examination duration shall be of 03 hours.

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

Total: 5× 6= 30

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

Total: 3×15 = 45

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

Practical: The laboratory work of the students has to be evaluated periodically.

The internal assessment (in the form of lab test, lab record, internal evaluation, assignment/ home assignment and attendance) of total 25 marks in each semester shall be conducted. All kinds of exercises have to be conducted during a semester. Maximum 5 marks of attendance can be given to the students. In each semester practical examination of 75 marks has to be conducted by two examiners (external and internal) having duration of 4 hours. The total number of the students to be examined per batch should not be more than sixty. Marks obtained in the practical examination have to be submitted to head of the concerned department/ the Principal of the college. The Head of the department/ the Principal of the college will make necessary arrangement for uploading the marks on to the University examination portal. The hard copy of the award list from portal has to be submitted to the Controller of Examination, Sri Dev Suman Uttarakhand University, Badshahithaul, Tehri-Garhwal.

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

Practical exam:

1. Spotting	10X 2=	20 Marks
2. Exercises based on theory papers	15X2=	30 Marks
3. Lab Record, Chart, Model, Collection etc.		15 Marks
4. Viva voce:		10 Marks
Sessional (Internal):		25 Marks
Total (Each semester) :		100 Marks

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**	Diversity of 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**	Diversity of 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					
		(DSC)- **ZOO/DSC/V/T**	Evolutionary Biology	Theory	3

THIRD YEAR	V	(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
BACHELOR OF ZOOLOGY WITH HONOURS					
	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**	Elementary Ichthyology	Theory	3

		(DSE1)- **ZOO/DSE1/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE2)- **ZOO/DSE2/VII/T**	Elementary Entomology	Theory	3
		(DSE2)- **ZOO/DSE2/VII/P**	Laboratory Practical based on Theory Papers	Practical	1
FOURTH YEAR		(DSE3)- **ZOO/DSE3/VII/T**	Elementary Immunotechnology	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
		(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**	Research Methodology	Theory	3
		(DSE1) - **ZOO/DSE1/VIII/P**	Laboratory Practical based on Theory Papers	Practical	1

	VIII	(DSE2) - **ZOO/DSE2/VIII/T**	Molecular Biology of Cell/ 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	Practical	1

			Theory Papers		
		(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
MASTER'S IN ZOOLOGY					
FIFTH YEAR	IX	(DSC) - **ZOO/DSC/IX/T**	Ichthyology-IA (General Ichthyology)	Theory	3
			Entomology-IB (Systematics and Applied Entomology)		
			Animal Biotechnology-IC (General Animal Biotechnology)		
			Immunology-ID(Fundamentals of Immunology)		
		(DSC) - **ZOO/DSC/IX/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE1) - **ZOO/DSE1/IX/T**	Mammalian Endocrinology/Reproductive Health	Theory	3
		(DSE1) - **ZOO/DSE1/IX/P**	Laboratory Practical based on Theory Papers	Practical	1

		(DSE2) - **ZOO/DSE2/IX/T**	Developmental Biology/Avian Diversityand Behavior	Theory	3
		(DSE2) - **ZOO/DSE2/IX/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE3) - **ZOO/DSE3/IX/T**	Limnology/Aquatic Animal Diversity	Theory	3
		(DSE3) - **ZOO/DSE3/IX/P**	Laboratory Practical based on Theory Papers	Practical	1
		(GE1) - **ZOO/GE1/IX**	Computational Biology	Theory	4
		(GE2) - **ZOO/GE2/IX**	Medical Laboratory Technology	Theory	4
		DISSERTATION	Dissertation on Major OR Dissertation on Minor OR Academic Project/Entrepreneurship OR Excursion/Field study	Theory/ Practical	6
		(DSC) - **ZOO/DSC/X/T**	Ichthyology-II A (Applied Ichthyology)	Theory	3
			Entomology-II B (Biology of Insects)		
			Animal Biotechnology-II C (Applied Animal Biotechnology)/		
			Immunology-II D (Applied Immunology)		
		(DSC) - **ZOO/DSC/X/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE1) - **ZOO/DSE1/X/T**	Human Physiology	Theory	3

	X	(DSE1) - **ZOO/DSE1/X/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE2) - **ZOO/DSE2/X/T**	Osteology	Theory	3
		(DSE2) - **ZOO/DSE2/X/P**	Laboratory Practical based on Theory Papers	Practical	1
		(DSE3) - **ZOO/DSE3/X/T**	Biochemistry	Theory	3
		(DSE3) - **ZOO/DSE3/X/P**	Laboratory Practical based on Theory Papers	Practical	1
		(GE1) – **ZOO/GE1/X**	Hydro Ecology	Theory	4
		(GE2) – **ZOO/GE2/X**	Conservation Biology	Theory	4
		DISSERTATION	Dissertation on Major OR Dissertation on Minor OR Academic Project/Entrepreneurship OR Excursion/Field study	Theory/ Practical	6

ABILITY ENHANCEMENT COURSE (AEC) PREPARED FOR THE POOL OF COURSES

Ability Enhancement Course (AEC)	Paper Title	Theory/Practical	Credits
ZOO/AEC/I/T	Aquarium Fish Keeping	Theory	1
ZOO/AEC/I/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/AEC/II/T	Wildlife Conservation and Management	Theory	1
ZOO/AEC/II/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/AEC/III/T	Fish Farming	Theory	1
ZOO/AEC/III/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/AEC/IV/T	Economic Zoology	Theory	1
ZOO/AEC/IV/P	Laboratory Practical based on Theory Papers	Practical	1

VALUE ADDITION COURSE (VAC) PREPARED FOR THE POOL OF COURSES

Value Addition Course (VAC)	Paper Title	Theory	Credits
ZOO/VAC/I	Food, Nutrition and Health	Theory	2
ZOO/VAC/II	Intellectual Property Rights	Theory	2
ZOO/VAC/III	Public Health and Hygiene	Theory	2
ZOO/VAC/IV	Research Publication Ethics	Theory	2
ZOO/VAC/V	Mind Body Medicine	Theory	2
ZOO/VAC/VI	Emotional Intelligence	Theory	2
ZOO/VAC/VII	Animal Husbandry (Goat & Sheep)	Theory	2

SKILL ENHANCEMENT COURSE (SEC) PREPARED FOR THE POOL OF COURSES

Skill Enhancement course (SEC)	PAPER TITLE	Theory	Credits
ZOO/SEC/I/T	Pearl Culture	Theory	1
ZOO/SEC/I/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/SEC/II/T	Vermiculture	Theory	1
ZOO/SEC/II/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/SEC/III/T	Sericulture	Theory	1
ZOO/SEC/III/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/SEC/IV/T	Biofloc Fish Culture	Theory	1
ZOO/SEC/IV/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/SEC/V/T	Immunodiagnostics	Theory	1
ZOO/SEC/V/P	Laboratory Practical based on Theory Papers	Practical	1
ZOO/SEC/VI/T	Hematological Techniques	Theory	1
ZOO/SEC/VI/P	Laboratory Practical based on Theory Papers	Practical	1

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: Diversity 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**
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: *Paramecium* with particular reference to locomotion, nutrition, osmoregulation and reproduction. Porifera: *Sycon* with reference to structure, reproduction and development. Canal system and affinities of Porifera.	**15**
II	Coelenterates*: Aurelia* 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 Helminthesandcontrol measures of *Fasiola.* Annelida*: Nereis*with reference to external features, excretory organs and reproduction. Metamerism in Annelida, its origin and	**15**

	significance. Trochophore larva and its significance. Parasitic adaptations in *Hirudinaria*.	
III	Arthropoda**:** *Palaemon* and *Peripatus*with reference toexternal features and reproduction. Its distribution and Zoological importance. Mollusca: *Pila*with reference toexternal features, Organs of Pallial complex and its reproductive system. A brief account of torsion in Gastropoda. Echinodermata: *Asterias*with reference toexternal 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) 1. Study of specimens: *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*and*Unio*. 3. Study of permanent slides/museum specimens/models belonging to following phyla Protozoa, Porifera, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca and Echiodermata.	**30**

	5.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- 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: Elementary Biostatistics	4	4	0	0	Passed Class XII with Biology	Nil

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, Applications of Statistics in Research. Sampling (Random & Non-random sampling), Collection and Presentation of Data (Pie Chart, Bar Diagram, Histogram, Line diagram, Frequency Polygon).	**20**
Unit II	Measures of Central Tendency, Mean, Median, Mode, Measures of Dispersion, Variance, Coefficient of Variation, Standard Deviation, Standard Error.	**20**
Unit III	General idea of Hypothesis: Null Hypothesis, Parametric and non-parametric tests, definition, limitation of test of Hypothesis, Test of significance, Probability, Degree of Freedom	**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, 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: 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.	**15**

	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.	
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 bodyand different cell organelles etc. Study of permanent slides of different animal cells. 3. Genetics experiments: Study of various *Drosophila* mutants based on picture card Numerical based on Mendelian and Non-Mendelian Experiments Study of Giant Chromosomes (Lamp brush and Polytene Chromosome)	**30**

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., andWalter, 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: *Bombex mori*, types of silk worm and its rearing. Apiculture: Types of honey bees, typical honey and culture of *Apis melifera* and natural enemies. Lac culture Pearl culture Piggery Poultry Vermiculture		**20**

Unit II	Bionomics and control measures of the common pests of fruits (*Papilio demoleus*and *Quadraspidiotusperniciosus*), Vegetables (*Thrips tabaci* and *Aulacophorafoveicollis*) and stored grains (*Callosobruchus chinensis* and *Trogoderma granarium*). 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:Chor	4	3	0	1	Passed Class XII	Nil

data					with Biology	

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 *Balanoglossus.*	**15**

Unit II	Pisces: Scales and fins in fishes. Parental care in fishes. Amphibia: General Characters and affinities of *Gymnophiona*. 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 *Amphioxus* and *Balanoglossus* passing through different body regions, *Doliolum, Salpa, Oikopleura.* Museum specimens of *Herdmania, Cliona* and *Balanoglossus.* 2. Cyclostomata: Museum specimens of *Petromyzon* and *Myxine*. 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 *Scoliodon* Preparation of permanent slides of ampulla of *Lorenzini*, 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 *Sphyrna, Pristis, Torpedo, Trygon, Acipenser, Polypterus, Hippocampus, Exocoetus, Anguilla, Echeneis, Diodon, Protopterus, Synaptura* and *Chimaera.* 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 *Salamandra, Proteus, Amphiuma, Nectures, Siren,*	**30**

	Ambyostoma, Axolotl larva. *Rhacophorus, Alytes, Hyla, Pipa* and *Bufo*. Study of skeleton of frog and permanent histological slides of Amphibia. 5. Reptilia: Study of the skeleton of *Varanus*. Study of museum specimen of following: *Varanus, Heloderma, Hemidactylus, Phrynosoma, Chameleon, Draco, Calotes,* Cobra, Pitviper, Pitless –viper, Rattle snake, Krait, Dhaman, *Typhlops* 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 *Psittacula, Corvus, Pavo, Bubo,* and model of *Archaeopteryx*. 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 *Tachyglossus* and *Ornithorynchus*(models) *Pangolin, Funambulus, Pteropus*, Hedgehog and *Loris*.	

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) –

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 methodsof 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.	**30**

	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. 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 Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE:	4	4	0	0	Passed Class XII	Nil

Environmental Biology					with Biology	

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	**20**

	structure and the different ecosystems of India, such as 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. 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, 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: 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. (glycolyisis, Krebs cycle, gluconeogenesis, glyscogenesis, glyogenolysis)	**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: UndergraduateDiploma 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, Population dynamics, Birth, death and population size, age structure Ecosystem and Diversity of different ecosystems of India (forests, wetlands, grasslands, and aquatic systems).	**15**
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 andglobal 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.	**15**

	3. Study of Primary and secondary productivity. 4. Determination of physiochemical parameter of soil water and sewage.	

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 Exchange, Affinity Chromatography and Introduction to HPLC.	**20**
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, 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: 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: 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 Course
Max. Marks: As per Univ. rules		Min. Passing Marks: As per Univ. rules
Theory		
Unit	**Topic**	**No. of Hours**
Unit I	Origin of Life: Concept of Oparin and Haldane and Urey; Millers Experiment. Theories of Evolution: Lamarckism, Darwinism, Evidences of Evolution: Homologous and Analogous Organs. Concept of Variation, Mutation, Adaptation, Isolation, The synthetic theory of evolution Hardy Weinberg's equilibrium and condition for its maintenance, allele frequency, gene frequency and Gene Pool	**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), Types and dating of fossils	**15**
Unit III	Ecological generalist and specialist: evolutionary perspectives – species interaction: mutualism, parasitism, commensalism, amensalism, nutralism and symbiosis. Evolution of toxins and venoms in animals. Evolution of man and horse, forces of evolution: Mutation, selection and genetic drift	**15**
Practical		

	1. Study of evolution of man and horse through charts/ models 2. Adaptive modification in beak and feet of birds through charts/	**30**

	slides 3. Embryological evidences of evolution through chart 4. Analogy and Homology of wings of birds and insects, forelimbs of bats and rabbits 5. Study of living fossil specimens.	

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, Conditioned reflexes, Selective learning, Insight learning, Imprinting and Birds songs.	**15**
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-biologyand 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, *Euglena*, *Paramecium* 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.
- Biodiverstiy- M.N. William

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

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: 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	**15**

	of gene regulation in prokaryotes and eukaryotes. Operons and transcription factors. Epigenetics: DNA methylation, histone modification. Post-transcriptional regulation.	
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 (PCR). Gel electrophoresis and DNA sequencing. Gene cloning techniques. Introduction to gene editing. Applications of Biotechnology.	**15**
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 microscopes (Light and Electron)	**15**

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 andIgD). 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 spared plate methods). 4. Demonstration of the presence of micro flora in the environment (air and water). Common microbiological technique like staining (Gram and Endo-spore staining). To study the growth of bacterial culture(using spectrophotometers) and motility (using hanging loop method). 5. Identification of human blood grouping. 6. Separate serum from the blood sample(demonstration). 7. Perform Immunodiffusion by Ouchterlony method. 8. Perform ELISA.	**15**
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 Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
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, heavy metals 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

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 With Honours	**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	**15**

	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.	
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*. 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*	**30**

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.

BACHELOR OF ZOOLOGY		
Programme: Bachelor of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE-1**
Subject: Zoology		

DISCIPLINE SPECIFIC ELECTIVE (DSE-1) – 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: 1 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 – 1	**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	**30**

	2. Age determination with the help of scale. 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-2) – 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 - 2: 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-2**

Subject: Zoology		
Course: DSE-2	**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, Heteroptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera.	**15**
Unit II	Methods of insect collection and preservation. Social life in insects: honey-bee and termites. A brief account on the life-cycle, pathogenicity and control measures. Insect Life Cycles and Metamorphosis (*e.g.,* Butterflies and Grasshoppers)	**15**
Unit III	Household insects: Cockroach and Silverfish.	**15**

	Insect injurious to man and Livestock: Mosquitoes, House fly and Bedbug. Economic importance of insect as food medicine. Insects in agriculture, Integrated Pest Management.	
Practical		
	1.Collection, preservation and mounting different groups of insect fauna. 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

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Elementary Immunotechnology

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

BACHELOR OF ZOOLOGY		
Programme: Bachelor Of Zoology	**Year: IV**	**Semester: VII** **Paper: DSE-3**
Subject: Zoology		
Course: DSE -3	**Course Title: Elementary Immunotechnology**	

Course Outcomes:

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

- Understand the basic concepts of immunology and its importance in human health.
- Identify the major components of the immune system and their functions.
- Describe how vaccines work and their roles in disease prevention.
- Recognize common diseases caused by defects in the immune system.

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	Immunotechnology-introduction, scope and application for human health. Immunofacilitators /rejuvenators/revitalizers of natural and artificial types in health and diseases of human beings. Common Diseases and response of immune system	**15**
Unit II	Introduction to Immunodiagnostic techniques, comparative analysis of serodiagnosis and immunodiagnosis. Lymphocyte transfer therapy and immunotherapy, immunoprophylasxis. Indirect heamagglutination Assay. Immunodiffusion, Gel Electrophoresis, Western Blot.	**15**
Unit III	History of vaccine development, Different types of vaccines, Sera of Monoclonal and Polyclonal Nature. Lymphocyte Transformation Test (LTT). Epitope Maping. Phagocytosis, Graft vs Host Reactions. Hybridoma and Quadridoma Technology.	**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.	**30**

	4. Study of Ouchterlony double immunodiffusion method. 5. Antibody purification by-Affinity and column chromatography. 6. Indirect heamaglutination Assay. 7. Blood serotyping. 8. SDS-PAGE technique for separating the proteins of interest. 9. Scientific Study Tour Programme of Immunology concern.	

Recommended Readings

Textbooks and Reference books

1. Ivan M. Roitt , Essentials of Immunology.
2. Elgert, Immunology: understanding the immune system.
3. Kuby Essentials of Immunology 6th Ed. (2007) Freeman & Company, New York
4. Elgert , Immunology A. John Wiley, New York
5. Asuman & Barlas , Recent Advances in Immunology , Plenum Press, New York
6. Smith , Kendall A , The Quantal Theory of Immunity : The Molecular basis of Auto immunity, Leukemia& Vaccines. Cornell University , U.S.A.
7. Harlow and David, Antibodies: A laboratory manual.
8. Fundamentals of Immunology, William Paul , NIH, Bethesda, Mary Land, USA.

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 palate in birds, Dentition in mammals, Stomach in ruminants. General organization, classification and affinities of Cyclostomata, Gymnophiona and its affinities, Parental care in Amphibian.	**15**
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.

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: 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 Interest. The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables. Levels of Measurement, Various Paradigms.	**15**

	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 - 2) – Molecular Biology of Cell

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: Cytology	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: Molecular Biology of Cell**	

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	**15**

	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 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 Lampbrush 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 – De Robertis and De Robertis
- 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

DISCIPLINE SPECIFIC ELECTIVE (DSE -3) – 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: DSE 3	**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 technology and its application in regenerative medicine; Drug delivery systems and nanomaterials in medicine.	**15**
	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: General 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	**20**

	gene therapy (*ex-vivo*and *in-vivo*), choosing targets for gene therapy, Vectors in gene therapy, Retroviruses, Adenoviruses, Adeno-associated viruses. Viral 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 *Plasmodium*)	**20**
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

SEMESTER- IX
MASTER'S IN ZOOLOGY

DISCIPLINE SPECIFIC COURSE (DSC) – General Ichthyology/ Systematic and Applied Entomology/General Animal Biotechnology / Fundamentals of 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		
DSC: Ichthyology-I A (General Ichthyology)	4	3	0	1	Passed Class XII with Biology	Nil
Entomology-I B (Systematic and Applied Entomology)						

Animal Biotechnology –I C (General Animal Biotechnology)						
Immunology – I D (Fundamentals of Immunology)						

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: IX** **Paper: DSC**
Subject: Zoology		
Course: DSC	**Course Title: Ichthyology-I A (General Ichthyology)**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the general form, function, and diversity of fish. 2. Understand the morphological and physiological adaptations of fish and their role in the aquatic environment. 3. Understand general concepts of biogeography and evolution of fish. 4. Applying principles of phylogeny to understand fish adaptations. 5. Becoming familiar with principles of ecology and behavior of fish. 6. Learning basic external and internal anatomy of fish.		
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 of fishes, Systematic position, habit and habitat, morphology, distribution, significance and affinities of Holocephali and Dipnoi. Fins, their origin and evolution; Locomotion in fishes. Histomorphology and elementary physiology (a) digestive system (with particular reference to food and feeding habits of freshwater fishes) (b) excretory system (with particular reference to acid base balance and osmoregulation).	**15**
Unit II	General survey of the marine, estuarine and inland capture fisheries of India with particular reference to fishery resources of Uttaranchal. Methods of fishing: Fishing gears and crafts. Cold water fishery Sewage-fed fishery, Shell–fish fishery. Nutrition and growth including age and growth relationship, chemical composition of fish flesh, length –weight relationship, Natural food and artificial feed and their role in fish culture. Plankton and benthos in relation to fish production.	**15**
Unit III	Electric organs in fishes. Accessory respiratory organs in fishes. Brief knowledge of sexual dimorphism, courtship and parental care. Migratory instincts, Hill stream adaptations Reproduction in a major carp- structure of gonad, spawning, early development and metamorphosis. Microscopic structure and hormonal functions of the following endocrine glands: Pituitary, Thyroid, Pancreas, Adrenal, Corpuscles of Stannins, Ultimobranchial glands, caudal neurosecretory system and Sex hormones. Current trends in induced breeding in fishes. Brief knowledge of sense organs: organs of smell, eyes, hearing, ampulla of Lorenzeni, Bioluminescence, sound production and lateral line system.	**15**

Practical		
	1. Fish collection, tools and types of net used in fish sampling. 2. Fish Identification, Classification and Taxonomic studies of fresh water fishes. 3. Study of preserved fish specimens. 4. Detailed study of the skeleton of a Cyprinoid and a Siluroid fish. 5. Permanent preparation of scales, sensory, Ampullae etc. 6. Aquarium fabrication, setting and its Maintenance. 7. Different types of modern fish farming techniques used in Uttarakhand. 8. Determination of age with the help of scales. 9. Calculation of Gonado- Somatic Index and Determination of fish fecundity. 10. Analysis of basic hematological parameters of fish blood and preparation of permanent slide of fish blood. 11. Project Work and Field Report, field visits will be integral part of the Practical.	**15**

Recommended Readings

Textbooks

- Textbook of Ichthyology- K. C. and Nirupama Agrawal Pandey
- A textbook of Fish biology and Fisheries – S. S. Khanna and H. R. Singh
- Fish Physiology- William Stewart Hoar and David J. Randall
- Fishes: A Guide to Their Diversity- Philip A. Hastings, H. G. Greene, and Conrad Limbaugh
- An Introduction to the Study of Fishes by James S. Nelson, Terry C. Grande, and Mark V. H. Wilson

Reference Book

- The Physiology of Fishes. 4th ed. Evans DH, Claiborne JB, Currie S. Boca Raton, FL: CRC Press; 2013.
- Fish Ecology. 1st ed. Pitcher TJ. New York.
- Ecology of Fishes. 1st ed. Wootton RJ. Dordrecht.
- Fish and Fisheries of India. 3rd ed. Jhingran VG. Delhi: Hindustan Publishing Corporation.
- Freshwater Fishes of the World. 1st ed. Axelrod HR, Burgess WE, Pronek N. New Jersey: TFH Publications.

OR

Course: DSC	**Course Title: Entomology-I B (Systematic and Applied Entomology)**

Course Outcomes:

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

1. Student will be able to classify insect up to their respective orders.
2. Understand the difference in the life cycles of insects.
3. Student will be able to describe various ecological importance of insects.
4. Understanding insect biology: Including general entomology, basic systematics, morphology, physiology and biodiversity.

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	Ancestry and evolution of insects, Classification of insects, Principles of construction and use of dichotomous keys in insect. Methods of collection, preservation, Mounting and culture of insects. Brief knowledge of habit, habitats and general characters of the following orders with special reference to the families mentioned: Thysanura, Collembola, Odonata, Orthoptera (Acrididae, Tettigoniidae, Gryllidae), Phase theory in locusts, Phthiraptera (Anoplura, Mallophaga), Isoptera, Thysanoptera, Heteroptera (Pentatomidae, Belostomatidae), Homoptera (Aphidae, Coccidae), Coleoptera (Coccinellidae, Curculionidae, Scarabaeidae), Lepidoptera (Pireidae,Nymphalidae, Papillionidae, Noctuidae, Sphingidae), Hymenoptera (Apidae, Ichneumonidae, Formicidae); Diptera (Muscidae, Culicidae, Syrphidae).	**15**
Unit II	Principles and Practices of Pest Control: Pests defined: Categories of crop pests (key pests, occasional pests, potential pests and migratory pests) Pest control procedures: Natural control, applied control (Cultural, Biological and Insecticidal) Modes of action of insecticides, factors affecting toxicity of insecticides Non-insecticidal methods: Anti-feedents, Attractants and Repellents, Feeding deterrents, Chemosterilants, Pheromones and Insect Growth Regulators (IGR's).	**15**
Unit III	Integrated Pest Management (IPM) Insecticide Application Equipments: Sprayers, Dusters, Granule Applicators Distribution, habit and habitats, life- cycle, nature of damage and control of pests of: Stored grains (*Sitophilus oryzae, Triboliumcastaneum, Callosobruchus chinensis*); Sugarcane (*Pyrillaperpusilla, Chio infuscatellus*); Paddy (*Leptocorisa acuta, Hieroglyphus banian/nigrorepletus*), Cotton (*Dysdercuskoengii, Pectinophoragossypiella*); Cereals (*Heliocoverpaarmigera, Agrotisipsilon*) Vegetables (*Raphidopalpa (=Aulacophora) foveicollis, Pieris brassicae*); Fruits (*Bactrocera (=Dacus)*	**15**

	cucurbitae, Papilio demoleus); Forests (Defoliator: Tasar silkworm, *Antheraea paphia*; Sapsucker of Khamer or Gamhar, *Tingisbeesoni*; Teak borer, *Aeolesthesholosericea*); and Polypha Pests (Locusts, Termites)	
	Practical	
	1. Hands on training of Equipments and accessories used in collection of insects. 2. Hands on training of Equipments and accessories used in mounting and preservation of insects. 3. Survey of representative insect order in the forest, orchards, crop lands etc. 4. Prepare a chart or model of classification of insects up to family level. 5. Identification of insects using dichotomous keys up to family level. 6. Life-cycle of different kinds of insect pests i.e. cereals (Sugarcane, Wheat, Rice), vegetables, fruits, cotton and stored grains. 7. Life-cycle of defoliator insects. 8. Taxonomic status, Life-cycle of Honey bee. 9. Taxonomic status, Life-cycle of Silk moth. 10. Taxonomic status, Life-cycle of Lac insect. 11. Life-cycle of House fly and Mosquito. 12. Comment on general characteristics, classification and habit, habitat of preserved museum insects. 13. Calculation of secondary productivity of herbivorous insects. 14. Sampling techniques for estimation of insect population. 15. Ecological adaptation of aquatic insects. 16. Project Work and Field Report, field visits will be integral part of the Practical.	**15**

Recommended Readings

Recommended text

- A textbook of Entomology – Dr. Mathur and Dr. Upadhyay
- Modern Entomology – D. B. Tembhare
- Agricultural Pests of South Asia and their management – A. S. Atwal and G. S. Dhaliwal
- The Insects Structure and Function – R.F. Chapman
- Principles of Insect Morphology- R. E. Snodgrass
- Introduction to Insect Pest Mangaement – Robert L. Metcalf and William H. Luckmann
- Introduction to General and Applied Entomology- V. B. Awasthi
- Entomology: An Introduction- George C. McGavin
- The Insects: An Outline of Entomology- P. J. Gullan and P.S. Cranston
- Insect Ecology: Behavior, Populations, and Communities- Peter W. Price

Reference Book

- Agricultural Entomology. 1st ed. Pedigo LP, Rice ME. Boston: Academic Press; 2009.
- Insect Pest Management. 2nd ed. Dent D. Wallingford: CABI Publishing; 2000.
- Systematic Entomology. 1st ed. Gullan PJ, Cranston PS. Chichester: Wiley-Blackwell; 2014.
- Medical and Veterinary Entomology. 2nd ed. Mullen GR, Durden LA. Amsterdam: Academic Press; 2009.
- Applied Entomology: An Introductory Textbook. 1st ed. Dhaliwal GS, Arora R. New Delhi: Kalyani Publishers; 2004.

OR

Course: DSC	**Course Title: Animal Biotechnology –I C (General Animal Biotechnology)**

Course Outcomes:

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

1. Successfully maintain cultures of animal cells and established cell lines with good viability, minimal contamination and appropriate documentation.
2. Perform supportive or episodic tasks relevant to cell culture, including preparation and evaluation of media, cryopreservation and recovery, and assessment of cell growth/health.
3. Recognize and troubleshoot problems common to routine cell culture.

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	Animal Cell Culture: Equipment and materials for animal cell culture technology. Design and layout of culture room, Sterilization and aseptic techniques. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, serum and supplements in animal cell culture. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication. Mechanical and enzymatic disaggregation of tissue and setting up of primary cultures, Candling of eggs, preparation of chick fibroblast, culture of lymphocytes for chromosomal studies. Roller and Suspension culture techniques.	**15**

Unit II	Large-scale production of cells using bioreactors, micro- carries and perfusion techniques. Measurement of viability and cytotoxicity. Biological characterization of the cultured cells, karyotyping, cryopreservation and revival. Detection of contaminants in cell cultures. Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fiber reactors, Air-lift fermentors, chemostats and microarriers). Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics. Organ and histotypic cultures. Cell cloning, cell synchronization and cell manipulation.	**15**
Unit III	Various methods of separation of cell types, advantages and limitations; flow cytometry. Production and characterization of monoclonal antibodies and their application. Commercial applications of animal cell culture: cell culture-based vaccines, Tissue culture as a screening system; cytotoxicity, in vitro testing of drugs and diagnostic tests. Mass production of biologically important compounds (e.g. Vaccines and Pharmaceutical proteins). Production of recombinant hemoglobin, blood substituents, artificial blood. Harvesting of products, purification, and assays. Three dimensional cultures and tissue engineering (artificial skin and artificial cartilage).	**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	**15**

	7. To study - DNA Sequencing, Sanger's Method, DNA fingerprinting 8. Good Laboratory Practices (GLP); ELISA (Demo online). 9. Project Work and Field Report, field visits will be integral part of the Practical.	

Recommended Readings

Textbook

- Animal Cell Culture and Technology- Veer Bala Rastogi and Nirvika Rastogi
- Animal Cell Culture and Technology (The Basics (Garland Science)- Michael Butler
- Animal Cell Culture and Technology. 2nd ed. Butler M. Boca Raton, FL: CRC Press; 2003.
- Basic Cell Culture Protocols. 4th ed. Helgason CD, Miller CL. New York: Humana Press; 2012.
- Animal Cell Culture: Concepts and Applications. 1st ed. Shivaji S, Prasad AK, Kumar S. Hyderabad: Universities Press; 2010.

Reference book

- Cell Culture Bioprocess Engineering. 1st ed. Xing J, Kenty BM, Li ZJ, Lee SS. Cham: Springer; 2020.
- Mammalian Cell Biotechnology in Protein Production. 1st ed. Spier RE. Cambridge: Cambridge University Press; 2008.
- Principles and Practice of Animal Tissue Culture. 1st ed. Bhattacharya S. Hyderabad: Universities Press; 2012.
- Stem Cells and Cloning. 2nd ed. Lanza RP, Gearhart J, Hogan B, Melton D, Pedersen R, Thomas ED, et al. Amsterdam: Academic Press; 2009.
- Biotechnology of Animal Cells in Vitro. 1st ed. Davis JM. Weinheim: Wiley-VCH; 2011.

OR

Course: DSC	Course Title: Immunology – I D(Fundamentals of Immunology)	
Course Outcomes: After studying this course, the students will be able to: 1. Understand Immunology and the way it is applied in diagnostic and therapeutic techniques and research. 2. Learn the essentiality of molecules, cells, tissues and organs involved in the defense mechanism. 3. Learn the techniques involved in understanding the immunological aspects of physiology and biological samples.		
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	An overview of historical developments and landmark contributions in immunology including the contributions of Sir Edward Jenner, Louis Pasteur, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Emil von Behring, Karl Landsteiner, Cesar Milstein and George Kohler. Introduction to neuroimmunoendocrinology, psycho-immunoaxis, branches, scope and significance of immunology, Immune orchestra, Comparative immunobiology of fish and human beings, Patterns and types of various immune responses.	**15**

Unit II	Cells of the immune system- B-lymphocytes, T-lymphocytes, NK Cells, Granulocytic cells, dendritic cells, antigen processing and presenting cell, Hematopoiesis and formation and regulation of B-lymphocytes and T-lymphocytes. Anatomy and functional roles of Primary and Secondary lymphoid organs focussing on Bone marrow, Thymus, Lymph nodes, Spleen, Gut Associated Lymphoid Tissue (GALT), Mucous Associated Lymphoid Tissues (MALT), Mucosal Associated Lymphoid Tissue (MALT), Cutaneous Associated Lymphoid Tissue (CALT). Anatomical, Physiological and Inflammatory barriers Secretions of various immunocytes and their roles in human healthcare and management.	**15**
Unit III	Antigen, Immunogen, Haptens and Adjuvants, antigen recognition by T and B lymphocytes, Processing and presentation of antigens, Antigenicity vs. lmmunogenicity, complement and adjuvants. Cellular and molecular mechanisms involved in the development and regulation of humoral antibody mediated and cell mediated immune responses, role of CD molecules, introduction to Immunoprophylaxis, Ig E and allergic reactions, immunological tolerance, immunological memory, clonal selection and clonal deletion. Basic structure, types and functions of immunoglobulin Immunogenetics, antibody diversity, immunoglobulin genes, Ig/TCR rearrangements, Structure of MHC genes, MHC-I and MHC-II molecules, super antigens.	**15**
Practical		

	1. ELISA (Enzyme-Linked Immunosorbent Assay) for detecting the presence of specific antibodies or antigens in a sample. 2. Flow Cytometry to analyze the expression of specific cell surface markers on immune cells. 3. Western blotting to analyze the expression of a particular protein in immune cells or tissues.	**30**

	4. Immuno fluorescence microscopy to visualize the distribution of antigens or antibodies in immune cells or tissues. 5. Mixed Lymphocyte Reaction to measure the proliferation of T cells in response to stimulation by alloantigens from another individual. 6. Project Work and Field Report, field visits will be integral part of the Practical.	

Recommended Readings

Textbooks

•Kuby Immunology- Judy Owen, Jenni Punt, Sharon Stranford, and Patricia Jones

•Basic Immunology: Functions and Disorders of the Immune System- Abul Abbas, Andrew H. Lichtman, and Shiv Pillai

•The Immune System- Peter Parham

Reference Books

•Cellular and Molecular Immunology. 10th ed. Abbas AK, Lichtman AH, Pillai S. Philadelphia: Elsevier; 2022.

•Essential Immunology for Surgeons. 1st ed. Wood PJ, Slapak M, Tamimi RM. Cambridge: Cambridge University Press; 2004.

•Clinical Immunology: Principles and Practice. 5th ed. Rich RR, Fleisher TA, Shearer WT, Schroeder HW Jr, Frew AJ, Weyand CM. Philadelphia: Elsevier; 2018.

•The Immune System. 5th ed. Parham P. New York: Garland Science; 2021.

•Ivan M. Roitt, Essentials of Immunology.

•Elgert, Immunology: understanding the immune system, John Wiley, New York

•Fundamentals of Immunology, William Paul, NIH, Bethesda, Mary Land, USA

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Mammalian Endocrinology

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:Mammalian Endocrinology	4	3	0	1	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: IX** **Paper: DSE**
Subject: Zoology		
Course: DSE1	**Course Title: Mammalian Endocrinology**	

Course Outcomes:

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

- Understand the role of hormonesin regulating various physiological processes in mammals, including metabolism, growth, reproduction and stress response.
- Learn about the anatomy and function of major endocrine glands such as the pituitary, thyroid, adrenal, pancreas and gonads, as well as the hormones they produce and their mechanisms of action.
- To analyze and interpret feedback mechanisms involved in endocrine regulation, including negative and

positive feedback loops, and understand how disruptions in these mechanisms can lead to endocrine disorders. • Apply their knowledge of mammalian endocrinology to real-world scenarios, such as diagnosing and treating endocrine disorders, understanding the hormonal basis of diseases, and designing hormone-based therapies.		
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 and scope of endocrinology. Chemical nature, classification and mode of secretion of hormones, hormonal feedback in homeostasis. Mechanisms of hormone action: Complete knowledge of the generalized mechanisms of action (at molecular level) of protein (Plasma membrane mediated actions as well as intracellular CAMP mediated actions) and steroid hormones (nuclear activity mediated actions).	**15**
Unit II	Hypothalamo-hypophysial System: General organization, Neuro-hypohysial octapeptides, Adeno-hypophysial hormones. Detailed structure of mammalian Pituitary gland and synthesis, storage, control of release, transport, denaturation, physiological actions, morphological and chemical consequences of excess and deficiency of various pituitary hormones. Endocrine Pancreas: Detailed structure, Biosynthesis and physiological actions of insulin and glucagon. Thyroid Gland: Detailed structure, biosynthesis of thyroid hormones, control of secretion, transport, denaturation, physiological roles,	**15**

	morphological and chemical consequences of excess and deficiency of various thyroid hormones.	
Unit III	Parathyroid Gland: Synthesis of parathyroid hormones, Role of parathormone: Calcitonin and vitamin-D in calcium homeostasis. Adrenal gland: Adrenal Cortex: Detailed structure, Organization, physiological roles and control of mineralocorticoides and glucocorticoids secretion. Adrenal Medulla: Detailed structure, Catecholamine, biosynthesis, release and its physiological roles. Pineal gland: Detailed structure, physiological actions of pineal hormones. Reproductive endocrinology: Molecular structure, origin, release and transport of sex hormones and their role in reproductive physiology (Hormonal regulation of Oestrus and Menstrual cycle and that of lactation). Environmental endocrinology: A brief knowledge of environmental endocrinology.	**15**
Practical		
	1. Study of the Mammalian Pituitary, Thyroid Gland, Parathyroid Gland, Adrenal gland, Pineal Glands, Pancreas etc. 2. Disorders related to Endocrine Glands with the help of chart / photographs/ models. 3. To perform the technique of home test kit for pregnancy.	**30**

Recommended Readings

Textbooks

- Endocrinology – Mac E. Hadley
- Mammalian Endocrinology – B. N. Yadav
- Concepts of Endocrinology – F.Y. Peyami
- Mammalian Endocrinology and Male Reproductive Biology- Shio Kumar Sing
- Mammalian Endocrinology- Ashoke Kumar Boral

- Mammalian Endocrinology- Manju Yadav
- Mammalian Physiology: A Course of Practical Exercises- Charles Scott Sherrington
- Mammalian Endocrinology- Raghvendra Puri

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Reproductive Health

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: Reproductive Health	4	3	0	1	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: IX** **Paper: DSE**
Subject: Zoology		
Course: DSE1	**Course Title: Reproductive Health**	

Course Outcomes:

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

- Understand the Concept of Reproductive Health
- Explain Human Reproductive Systems
- Describe Reproductive Health Issues and Solutions
- Understand Family Planning and Contraception

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	Reproductive Health- historical aspects and significance. Right to healthy and respectful relationships, health services. Safe and appropriate access to accurate information. Effective and affordable methods of contraception Access to timely support and services. Sexually transmitted diseases (HIV, reproductive tract) and their containment.	**15**
Unit II	Sex education, contraception and health care in pregnancy. Historical trends in maternal and neonatal outcomes. The ante- natal, perinatal, postpartum and new born care. Providing high-quality services for family planning, including infertility services.	**15**

	Abortions and their health implications	
Unit III	Birth control, meaning and role in population regulation. Significant facts about birth control. Genetic Abnormalities. Human Immunodeficiency Syndrome (HIV/AIDS) and human reproductive health. Pregnancy and Diet. Family Size, sexual healthy life and significance. Care and its importance for mother and the growing baby. Public Aspects of Human Sexuality and Family Planning. Legal measures and the reproductive health.	**15**
Practical		
	1. Study of animal house: set up and maintenance of animal house 2. breeding techniques, care of normal and experimental animals 3. Examination of vaginal smear rats from live animals 4. Surgical techniques: principles of surgery in endocrinology 5. Ovarectomy, hysterectorny, castration and vasectomy in rats 6. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems 7. Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina 8. Human vaginal exfoliate cytology	**30**

	9. Sperm count and sperm motility in rat; Study of modern contraceptive devices.	

Recommended Readings

Textbooks:

- Human Reproductive Biology, 2006 by Kristin H. Lopez and Richard E Jones, Academic Press.
- Essentials of Gynecology by Snehamay Chaudhary.

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

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: DSE**

Subject: Zoology		
Course: DSE2	**Course Title: Developmental Biology**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the basic concepts of developmental biology. 2. Understandthe concept of hormonal regulation of reproduction. 3. Describe the morphological processes that transform a fertilized egg into a multicellular organism. 4. Explain the molecular, biochemical, and cellular events that regulate the development of specialized cells, tissues, and organs during embryonic development.		
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	Fertilization: Mechanism of fertilization, early and late changes in egg organization caused by fertilization, molecular events during fertilization. Mechanism of fertilization in Sea Urchin. Cleavage and Blastulation: Patterns of cleavage, determinate and indeterminate cleavage with examples, influence of yolk on cleavage, metabolic changes during cleavage, morulation and blastulation in frog, chick and rabbit, types of blastulae. Gastrulation: Fate maps, morphogenetic movements in frog, chick and rabbit, significance of Gastrulation, exogastrulation. Development and functions of the foetal membranes in chick and mammals.	**15**

Unit II	Organogenesis: Development of brain, eye and heart in chick Anterior and posterior regions development in *Drosophila melanogaster*. Role of polarity genes (hunchback, bicoid and nanos) in anterior and posterior regions. Organizer Concept: Embryonic induction, primary organiser and its morphological differentiation, origin of primary organizer, inductive interactions, nature of inductive signal (Possible mechanism of neural induction) competence. Basic introduction to β-catenin pathway, ingression, epiboly, delamination, involution and invegination. Regeneration and Metaplasia: Distribution of regenerative ability, polarity in regeneration, mechanism of regeneration of amphibian limb and lens, metaplasia, super-regeneration and heteromorphosis.	**15**
Unit III	Metamorphosis: Kinds of metamorphosis, metamorphosis in Amphibians, Physiological and biochemical changes during metamorphosis, hormonal control of metamorphosis. Teratogenesis: Genetic and environmental Teratogenesis, phenocopies, developmental mechanisms of teratogenesis. Ageing: Theories of Ageing (Quantative Changes in Nucleic Acids, Changes in Information Content, Changes in Protection Regulatory Mechanisms, Free Radical Theory of Ageing), Ageing and Immunological Surveillance (Somatic Mutation Hypothesis, Function of Thymus, Immune Surveillance); Ageing of Connective Tissue; Mental Aspects of Ageing.	**15**
Practical		
	1. Study of the permanent slides of the chick embryos (whole mounts) and those showing the embryology of frog. 2. Study of eggs from collected / preserved material 3. Study of development of frog, chick through models/charts	**30**

	4. Study of chick embryos from 16-18 hrs, 24-28 hrs 33-36 hrs, 42-72 hrs of development (Whole mount models, charts)	

Recommended Readings

Textbooks

- Vertebrate Development: Maternal to Zygotic Control: 953 (Advances in Experimental Medicine and Biology)- Francisco Pelegri, MichaelDanilchik
- An Introduction to Embryology – B. I. Balinsky
- Comparative Anatomy and Developmental Biology (Z-72)- Prof. R. L. Kotpal (Rastogi Publications)
- Developmental Biology- Scott F. Gilbert and Michael J. F. Barresi
- Developmental Biology- Scott F. Gilbert and Susan R. Singer
- Essential Developmental Biology - Jonathan M. W. Slack and Leslie Dale

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Avian Diversity and Behavior

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: Avian Diversity and Behavior	4	3	0	1	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY

Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: DSE**
Subject: Zoology		
Course: DSE2	**Course Title: Avian Diversity and Behavior**	

Course Outcomes:

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

- Understand Birds Diversity of India
- Understand Birds Diversity of Uttarakhand
- Understand Threatened, Endemic and Migratory Birds
- Understand Different behavioral and ecological aspects
- Know about the status and distribution of avian fauna of various habitats
- Gain knowledge to identify the different species of Birds
- Photography knowledge
- Bird watching ethics

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	Introduction to Ornithology; Avian Diversity and Classification, Introduction to Birds: morphology, anatomy, food and feeding habits; Life History, Foraging Behaviour; Mating and Breeding Behaviour, Social Behaviour; Vocal Behaviour: Mechanisms; Ecology and Evolution; Vocal Behaviour: Case Study, Migration; Bird Populations, Concepts of Bird Communities, Mixed species flocks; Avian Disease. Body plan in birds: topography, feathers, avian flight, flight adaptation in birds.	**15**
Unit II	Importance of birds, Breeding Biology, Territoriality, Nesting, Eggs, Incubation and case for the young, Brood parasitism. Birds Behaviour, Flying, Walking, Eating, Perching on trees or wires, Drinking water, Singing, Nesting, Preening, Moulting, Bathing, Dust bath, Flocking, Roosting etc, Understanding Camera basics and lenses and light conditions, Equipment for Bird Watching, Famous ornithologists of the World.	**15**
Unit III	Diversity and distribution of birds in India, notes on speciation in Indian birds. Endemism in Indian avifauna- endemic bird areas of India. Endangered and endemic birds of India and Uttarakhand. Status and distribution of birds in Uttarakhand. Major sites for migrant birds in India and Uttarakhand. Threats to migratory birds population sites in India and Uttarakhand. Flightless birds: status and distribution	**15**
Practical		
	1. Study of Bird Populations and Communities: Techniques 2. Case Study, Avian Conservation: Concepts; Case Studies 1 (House Sparrow Conservation Project); Avian Conservation Case Studies 2 (Asian Vultures Conservation Project).	**30**

	3. Study of Photographing- water bird, Small perching birds, Birds in Dark Forest, Waders, Birds in urban setting etc. 4. Project Work and Field Report, field visits will be integral part of the Practical. Field trips for bird study, the trip will be day trips, three days camp for study of bird and their habitats, Visits to nearby Zoo, Museum, Forest, Nursery, Aquaria or any other relevant site must be arranged. The report of these visits will be submitted as part of the Practical work. Preparing of PPT, followed by student presentation. 5. Field visits to major sites for migrant birds – both wetlands and forests; field exercise in censusing and monitoring of migrant birds; analysis of eBird data on migration phenology of common migratory birds of India. 6. Group discussion/seminar on specific issues of bird conservation with case-studies from India and other Himalayan states.	

Recommended Readings

Textbooks

- Lovette I.J. and Fitzpatrick J.W. (2016). The Cornell Lab of Ornithology Handbook of Bird Biology (third edition). John Wiley and Sons, West Sussex, UK.
- Lovette, I.J and Fitzpatrick, J.W. 2016. Handbook of Bird Biology, 3rd ed. Wiley.
- .Gill, F.B, and Prum, R.O. 2019. Ornithology, 4th ed. Macmillan.
- Birkhead, T. 2013. Bird Sense: What it's like to be a bird? Bloomsbury, NY.
- Birkhead, T., Wimpenny, J., and Montgomerie, B. 2014. Ten Thousand Birds: Ornithology since Darwin. Princeton University Press, Princeton, NJ.
- Bhatt, Dinesh (Acoustic Communication in Birds).
- Ali, S. (2003). The Book of Indian Birds. Oxford Publishers. ISBN: 978-0195665239.

- Ali, S., Ripley, D. (1988). Handbook of the Birds of India and Pakistan: Together with Those of Bangladesh, Nepal, Bhutan and Sri Lanka. Oxford University Press, Bombay. 884pp. ISBN: 978-0195620634.
- Bibby, C.J., Burgess, N.D., Hill, D.A., Mustoe, S.H. (2000). Birds Census Techniques. 2nd ed. Academic Press, London. 180pp. ISBN: 978-0-12-095831-3.
- Bisht, A., Negi, B. (2022). Birds of Uttarakhand. Leafbird Foundation. 248pp. ISBN: 9788195630707.
- Grimmett, R., Inskipp, C., Inskipp, T. (2016). Birds of the Indian Sub-continent. 1st ed.. Bloomsbury Publishers, India. 448 pp. ISBN: 978-8193315095.
- Singh, A.P. (2000). Birds of lower Garhwal Himalayas: Dehra Dun valley and neighbouring hills. Forktail: 101-124.
- Tong, W., Sheldon, B.C. (2020). Understanding Bird Behavior: An Illustrated Guide to What Birds Do and Why. Princeton University Press. 224pp. ISBN: 9780691206004.
- Ali, S. and Ripley, S. D. (1987). A Compact Handbook of the Birds of India and Pakistan, Second Edition. Oxford University Press, Delhi.
- Choudhury, A. U. (2000). The Birds of Assam. Guwahati Gibbon Books and World Wide Funds for Nature.
- Grimmett R, Inskipp C, Inskipp T. (2011). Birds of the Indian Subcontinent (2nd ED). Oxford University Press: United Kingdom.

DISCIPLINE SPECIFIC ELECTIVE (DSE) –Limnology

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:Basic	4	3	0	1	Passed Class XII with	Nil

Limnology					Biology	

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: DSE**
Subject: Zoology		
Course: DSE3	**Course Title: Limnology**	
Course Outcomes: After studying this course, the students will be able to: 1. Get knowledge of relevance in limnology to analyze and evaluate abiotic and biotic conditions in aquatic systems. 2. Understand about the Inland Water bodies. 3. Understand the distribution and dynamics of plankton and benthos of freshwater bodies. 4. Knowledge of morphometry, physico-chemical and biological characteristics of fresh water bodies. 5. Understand the significance of aquatic flora, fauna, insects, birds and macrophytes inwater bodies.		
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	Introduction and Development of Limnology in India. Inland, Waters Distribution of Inland Waters: Ponds, Lakes, Streams, River. Lakes: Thermal Classification of Lakes, Famous Lakes of India and World, Nature of Inland Water Environment. Physical Characteristics: Pressure, Compressibility, Density Mobility, Buoyancy, Movement of Water Thermal Stratification Light, Color and Turbidity.	**15**
Unit II	Chemical Characteristics: Dissolved Gases – Oxygen, Carbon Dioxide and Other Dissolved Gases Dissolved Solids and Dissolved Organic Matter Influence of Physical and Chemical Conditions on Living Organisms in Inland Water Bodies. Planktonic Organisms: Classifications of Organisms in Water Distribution of Plankton Food for Plankton Organisms.	**15**
Unit III	Biological Productivity, Circulation of Food Material, Classification of Lakes Based on Productivity, Laws of Minimum, Biotic Potential and Environmental Resistance, Quantitative Relations in a Standing Crop Water Pollution, Eutrophication, Algal Blooms, Water Borne Diseases and Drinking Water Parameters Bioremediation of Polluted Water Bodies.	**15**
Practical		
	1. Determination ofbasic physico-chemical parameters of given water samples 2. Estimation of free CO_2 3. Determination of DO 4. Determination of pH 5. Determination of turbidity 6. Estimation and observation of microbial diversity of tap water, polluted water and sewage	**30**

	7. Measurement of primary productivity 8. Qualitative and quantitative analysis of Phytoplankton 9. Qualitative and quantitative analysis of Zooplankton 10. Qualitative and quantitative analysis of benthos 11. Determination of total alkalinity 12. Determination of hardness	

Recommended Readings

Textbooks

- Limnology- Alexander Horne and Charles Goldman
- Advances in Limnology – H. R. Singh
- Fresh Water Biology – W. T. Edmondosn
- An introduction to Limnology- Bhukya Sai kumar, Dharavath Ram Kumar
- Textbook of Limnology (PB 2015)- G. A. Cole
- Limnology Essentials: Ecosystems, Ecology and Evolution- Nishant Kumar Singh and amp; Murlidhar Rao
- Understanding Limnology- S. Srivastava

OR

DISCIPLINE SPECIFIC ELECTIVE (DSE) – Aquatic Diversity

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	Nil

Aquatic Animal Diversity					with Biology	

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: DSE**
Subject: Zoology		
Course: DSE3	**Course Title: Aquatic Animal Diversity**	
Course Outcomes: After studying this course, the students will be able to: • Understand the different type of aquatic environment, importance of interaction of abiotic and biotic factors • Study the aquatic ecology and ecological modelling		
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	History and Development of Limnology in India.	**15**

	Inland,Water Distribution of Inland waters Lentic and lotic water bodies Lakes: Thermal Classification of lakes, famous lakes of World, India and Uttarakhand. Physical characteristics: Radiant energy and optics, Density and thermal properties, Buoyancy, Compressibility, Thermal Stratification, Movement and suspended solids. Chemical Characteristics Dissolved gases- Oxygen, Carbon dioxide, pH and the hydrogen ion, Nitrogen, Phosphorus, Dissolved solids and dissolved organic matter. Influence of physical and chemical conditions on living organisms in inland water bodies.	
Unit II	Aquatic Ecosystem's structure and function: littoral Zone, limnetic zone,profundal zone, abiotic and biotic component, food chain, food web, trophic levels, ecological pyramids,primary and secondary productivity, movement of energy and materials, ecological efficiencies, thermal stratification circulation and lake typology. Limiting factors, Laws of limiting factor, Impact of temperature, moisture and pH on organisms. Structure and function of some Indian ecosystems Aquatic Freshwater marine andEstuarine) Planktonic organisms: Classification of organisms in water, distribution of plankton, food for planktonic organisms. Macrozoobenthos organisms: Classification of organisms in water, Distribution of zoobenthos, food for macroinvertebrates, water quality indicator organisms.	**15**
Unit III	Stressed water ecosystems: Point and non-point sources of pollution, assessment of freshwater pollution, assessment of freshwater using various parameters; water quality monitoring using abiotic factors (e.g. pH, Oxygen, Carbon dioxide, pH and the hydrogen ion concentration,Nitrogen, Phosphorus,BOD),	**15**

	Biomonitoring (phytoplankton, zooplankton andzoobenthos). Environmental Impact Assessment (EIA). Impact of environmental stress on biotic and abiotic factors. Water pollution, Eutrophication, algal blooms, water borne diseases, drinking water parameters,Bioremediation of polluted water bodies. National Lakes conservation program, Namami Gange Yojana,Sparsh Ganga Abhiyan.	
Practical		
	1. Estimation of D.O. content of water sample by Winkler method. 2. Estimation of the amount of free carbon dioxide in water sample. 3. Determination of salinity and chlorinity in water sample. 4. Determination of moisture content and total organic matter in soil sample. 5. Estimation of the alkalinity of water sample. 6. Quantitative study (total count and differential count) of planktons. 7. Calculation of similarity index between different communities. 8. Calculation of concentration of dominance for different communities. 9. Calculation of Shannon Weiner Index of diversity in different communities. 10. Study and observation of aquatic biodiversity of local water bodies.	**30**

Recommended Readings

Textbooks

- Freshwater Biology - W.T Edmondson
- Methods for physical and chemical analysis offreshwater. - H.L Golterman,.,R.SClyno,. and M.A.M.Ohnstad,
- A Treatise on limnology. Vol. I and II John Wiley and sons-G.E. Hutchinson.
- Fish and Fisheries of India. - V.G. Jhingaran.

- Fundamentals of Ecology. - M Barrick, E. P Odum, G. W Barrett.
- Freshwater Ecology: Concepts and Environmental Applications of Limnology - W.K. Dodds and M.R. Whiles

Generic Elective (GE) – Computational 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 Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Computational Biology	4	4	0	0	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: GE**
Subject: Zoology		
Course: GE1	**Course Title: Computational Biology**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the fundamentals of computer.		

2. Use bioinformatics tools and databases to analyze DNA and protein sequences.

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 computers, Computer fundamentals (Hardware and Software), Input, Output devices and Storage devices, Web Browsers, Search Engines, Flow charts, Methods and types of networks, Intra and Internet, Introduction to MS-office.	**20**
Unit II	Introduction to Bioinformatics, Scope and application of Bioinformatics, NCBI Data model, DNA and Protein Sequence database, Motif analysis, structural database, Structural Viewers (RasMol, RasTop, Cn3D, CSHF Chimera, Swiss PDB Viewer, PyMOL),	**20**
Unit III	Sequence submission to database, Literature database (PubMed, Biomed Central, Medline), Internet and biologist. Online study E.coli, D. melanogaster, Human genome, Mice genome. DNA Chips and their replications. Practical knowledge about Hardware and Software, application of MS Office. Basic knowledge about applications and functioning of different AI Tools.	**20**

Recommended Readings

Textbooks

- Bioinformatics Methods- Shili Lin, Denise Scholtens
- Computational Biology- Er. H. Rocky Singh and Mohd. Azharul Haque
- Introduction to Computational Biology: An Evolutionary Approach - Haubold

Generic Elective (GE) – Medical Laboratory Technology

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:Medical Laboratory Technology	4	4	0	0	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: IX** **Paper: GE**
Subject: Zoology		
Course: GE2	**Course Title: Medical Laboratory Technology**	
Course Outcomes: After studying this course, the students will be able to: 1. Work under different specialties of Laboratory Medicine (Biochemistry, Microbiology, Pathology and Blood bank departments respectively).		

2. Work and contribute in National Accreditation Board for Testing and Calibration Laboratories (NABL) program.		
Credits:4		**Generic Elective**
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Unit	**Topic**	**No. of Hours**
Unit I	Basic laboratory principles - Code of conduct of medical laboratory personnel. Organization and functioning of clinical laboratory. Safety measures - safety equipment's, safety symbols. Hazards in the laboratory (chemical hazards, clinical hazards, electrical hazards, biological hazards. Waste disposal.	**20**
Unit II	Introduction of Common Laboratory Equipment's: Hot Air Oven, Incubator, Autoclave, Water Bath, Centrifuges. Microscope - Fundamentals of Microscopy, Resolution and Magnification, Light Microscopy, Electron Microscopy, PCR, Electrophoresis, UV trans illuminator etc. Specimen Collection, Processing and Analytical Techniques Collection and preservation of blood, urine, stool, sputum, pus, body fluids, swab. Preparation of blood smears. Sources of biological variations, pre-analytical variables.	**20**
Unit III	Preparation of reagents: Buffers and pH, Normal, percent and molar solution, normal saline –Methods of measuring liquids. Clinical Laboratory records - Modern Laboratory set up - Quality control: Accuracy, Precision, and Reference values. Disposal of biomedical waste laboratory safety protocols and guidelines.	**20**
Recommended Readings **Textbooks**		

- Textbook of Medical Laboratory Technology Clinical Laboratory Science and Molecular DiagnosisDarshan P. Godkar, Praful B. Godka
- Textbook of Medical Laboratory Technology- Mrinalini Sant
- Textbook of Medical Laboratory Technology- M. Sant
- Textbook of Medical Laboratory Technology- Ramnik Sood
- Medical Laboratory Technology, 4/e, Volume 2 Procedure Manual for Routine Diagnostic Tests Including Molecular Pathology- Kanai L. Mukherjee

SEMESTER- X
MASTER'S IN ZOOLOGY

DISCIPLINE SPECIFIC COURSE (DSC) – Applied Ichthyology / Biology of Insects (Morphology, Physiology and Development) / Animal Biotechnology (Transgenics, Cloning and IPR) / Applied 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		

DSC: Ichthyology - II A (Applied Ichthyology)	4	3	0	1	Passed Class XII with Biology	Nil
Entomology – II B (Biology of Insects)						
Animal Biotechnology- II C (Applied Animal Biotechnology)						
Immunology – II D(Applied Immunology)						

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: X** **Paper: DSC**
Subject: Zoology		
Course: DSC	**Course Title: Ichthyology - II A (Applied Ichthyology)**	
Course Outcomes: After studying this course, the students will be able to: 1. Apply principles of phylogeny to understand fish adaptations. 2. Become familiar with principals of ecology and behavior of fishes. 3. Become familiar with fish anatomy.		

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	Important cultivable fishes' Important cultivable shellfishes Biology of cultivated fish and shellfish. Fish preservation, transport and marketing. Ecology and productivity of fish ponds. Pollution in relation to fisheries. Carp culture: Mono culture, Poly culture and Composite fish culture. Live fish culture. Management practices: weed, insect, and carnivorous fishes.	**15**
Unit II	Maturation and fecundity, spawning and seed collection, induced breeding, hatching techniques and hatcheries, nursery management, packing and transport of fish. Integrated Aquaculture: Fish-cum poultry, Fish-cum duckery, Fish-cum piggery, Paddy-cum fish culture and Dairy-cum fish culture.	**15**
Unit III	Induced spawning and hybridization. Factors responsive for induced breeding, hypophysation. Use of different synthetic and natural hormones. Larvivorus fishes and public health. Fish diseases and their management. Exotic fishes and their merits and demerits, Cryopreservation of gametes and embryos. Ornamental fish culture.	**15**
Practical		
	1. Determination of free CO_2 2. Determination of DO 3. Determination of turbidity 4. Qualitative and quantitative analysis of phytoplankton	**30**

	5. Qualitative and quantitative analysis of Zooplankton 6. Qualitative and quantitative analysis of benthos 7. Project Work and Field Report, field visits will be integral part of the Practical.	

Recommended Readings

Textbooks

- Textbook of Ichthyology- K. C. and Nirupama Agrawal Pandey
- Fish Physiology- William Stewart Hoar and David J. Randall
- Fishes: A Guide to Their Diversity- Philip A. Hastings, H. G. Greene, and Conrad Limbaugh
- An Introduction to the Study of Fishes- James S. Nelson, Terry C. Grande, and Mark V.H. Wilson
- General and Applied Ichthyology (Fish and Fisheries) – S. K. Gupta and P. C. Gupta
- Fish and Fisheries of India – V.G. Jhingran
- A textbook of Fish Biology and Fisheries – S.S. Khanna

Reference Book

- Applied Fishery Science. 1st ed. Jhingran VG, Pullin RSV. Delhi: Hindustan Publishing Corporation; 1985.
- Aquaculture and Fisheries Biotechnology: Genetic Approaches. 2nd ed. Dunham RA. Cambridge: CABI Publishing; 2011.
- Sustainable Aquaculture Techniques. 1st ed. Costa-Pierce BA. Boca Raton, FL: CRC Press; 2016.
- Advances in Fish Processing Technology. 1st ed. Hall GM. London: Springer; 1992.
- Post-Harvest Technology of Fish and Fish Products. 1st ed. Balachandran KK. New Delhi: Daya Publishing House; 2012.

OR

Course: DSC	Course Title: Entomology – II B (Biology of Insects)

Course Outcomes:

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

1. Attain a solid foundation in insect biology, including general entomology, basic systematics, morphology, physiology, and biodiversity.
2. Understand evolution and biodiversity generation through macro- and micro-evolutionary processes, including how these processes have formed and diversified insects.
3. Develop the ability to design and perform a scientific study on insects, and to analyze results.
4. Develop an understanding of the distributions and abundances of organisms including insects, and their interactions with each other and the environment.
5. Develop an understanding of the distributions and abundances of organisms including insects, and their interactions with each other and the environment.

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	Integument: Structure, functions and modifications of insect cuticle, moulting and sclerotization Structure of an insect head, thorax and abdomen; Appendages of head (mouthparts and antennae) and thorax (legs and wings) Structure of a wing of an insect, types of wings, hypothetical wing venation, wing-coupling mechanisms, and flight mechanism Structure and modifications of male and female genitalia in	15

	insects. Structure and modifications of alimentary canal; food and feeding mechanism of a generalized insect with special reference to physiology of digestion in different insects.	
Unit II	Structure and functions of blood and mode of circulation in insects' Principal organs of excretion of insects found in different habitats, physiology of excretion with special reference to osmoregulation in insects. Structure and functioning of various types of respiratory organs, modes of respiration, physiology of respiration in terrestrial, aquatic and endoparasitic insects Generalized plan of nervous system in insects and its modifications Neuroendocrine system in insects and the role of neurosecretion in various metabolic activities, metamorphosis and development of insects.	**15**
Unit III	Structure and functions of different types of visual and sound producing organs in insects. Structure, function and physiology of mechanoreceptors and chemo receptors in insects Bioluminescence: Light producing organs, mechanism and significance of light production in insect Structure of pheromone producing glands, different types of pheromones and their chemical nature Structure and modification of male and female reproductive systems in insects. Development: Structure of egg, maturation, cleavage, blastokinesis, formation of germ layers and segmentation; different types of larvae and pupae, Polyembryony and parthenogenesis in insects.	**15**
Practical		
	1. Study the modifications of insect heads on the basis of their orientation (picture). 2. Identify different types of appendages of insect (slide). 3. To study mouth parts and their modification (slide).	**30**

	4. To study antennae and their modification(slide). 5. Study different types of legs (slide). 6. Study different types of wings (slide). 7. Study of wing venation and wing coupling mechanism in insects. 8. Study of alimentary canal/digestive system and nervous system of Cockroach and Grasshopper. 9. Determination of pH of the gut content of cockroach. 10. Study different type of larvae and pupae. 11. Study the stinging mechanism of honey bee. 12. To study the anatomical and physiological basis of sound and light producing organin insects. 13. Project Work and Field Report, field visits will be integral part of the Practical.	

Recommended Readings

Recommended Text

- Introductionto General and Applied Entomology- V. B. Awasthi
- Entomology: An Introduction- George C. McGavin
- The Insects: An Outline of Entomology- P.J. Gullan and P.S. Cranston
- Insect Ecology: Behavior, Populations, and Communities- Peter W. Price
- The Insects Structure and Function – R.F. Chapman
- Imms' General Textbook of Entomology Volume 1 and 2 – O.W. Richard and R.G. Davies
- Applied Entomology – P.G. Fenemore

Reference Books

- General Entomology – M.S. Mani
- Insect Physiology and Biochemistry. 1st ed. Kerkut GA, Gilbert LI. Oxford: Pergamon Press; 1985.
- Developmental Biology of Insects. 1st ed. Counce SJ, Waddington CH. Cambridge: Cambridge University Press; 1972.
- Hormones, Brain and Behavior in Insects. 1st ed. Simpson SJ, Casas J. Oxford: Elsevier; 2011.
- Insect Molecular Biology and Biochemistry. 1st ed. Gilbert LI. London: Academic Press; 2011.
- The Development of Insect Form. 1st ed. Truman JW. Cambridge: Cambridge University Press; 1996.

OR

Course: DSC	**Course Title: Animal Biotechnology-II C (Applied Animal Biotechnology)**

Course Outcomes:

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

1. Play leading role in industry, research, and the public services.
2. Understand and appreciate major public concerns and issues associated with Animal Biotechnology.
3. Have an understanding and grasp of international research environment where the frontiers of knowledge in Animal Biotechnology are under research.
4. Be able to adapt and respond positively and flexibly to changing circumstances.
5. Develop the professional skills and personal attributes to deal with complex issues, both systematically and creatively.

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	Animal Cell Culture: Equipment and materials for animal cell culture technology. Design and layout of culture room, Sterilization and aseptic techniques. Culture medium: natural media, synthetic media, sera. Introduction to balanced salt solutions and simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, role of carbon dioxide, serum and supplements in animal cell culture. Characteristics of cells in culture: Contact inhibition, anchorage dependence, cell-cell communication. Mechanical and enzymatic disaggregation of tissue and setting up of primary cultures, Candling of eggs, preparation of chick fibroblast, culture of lymphocytes for chromosomal studies. Roller and Suspension culture techniques.	**15**
Unit II	Large-scale production of cells using bioreactors, micro- carries and perfusion techniques. Measurement of viability and cytotoxicity. Biological characterization of the cultured cells, karyotyping, cryopreservation and revival. Detection of contaminants in cell cultures. Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fiber reactors, Air-lift fermentors, chemostats and microarriers). Established cell line cultures: Definition of cell lines, maintenance and management; cell adaptation. Stem cell cultures, embryonic stem cells and their applications. Somatic cell genetics. Organ and histotypic cultures. Cell cloning, cell synchronization and cell manipulation.	**15**
Unit III	Various methods of separation of cell types, advantages and limitations; flow cytometry. Production and characterization of monoclonal antibodies and their application. Commercial applications of animal cell culture: cell culture based	**15**

	vaccines, Tissue culture as a screening system; cytotoxicity, in vitro testing of drugs and diagnostic tests. Mass production of biologically important compounds (e.g. Vaccines and Pharmaceutical proteins). Production of recombinant hemoglobin, blood substituents, artificial blood. Harvesting of products, purification, and assays. Three dimensional cultures and tissue engineering (artificial skin and artificial cartilage).	
Practical		
	1. Preparation of tissue culture medium and membrane filtration; 2. Preparation of single cell suspension from spleen and thymus; 3. Preparation serum; Egg candling; Cell counting and cell viability; 4. Chick fibroblast culture; Trypsinization of monolayer and sub-culturing; 5. Transfection of cultured monolayer; Cryopreservation and thawing; Measurement of doubling time; 6. Role of serum in cell culture; Preparation of metaphase chromosomes from cultured cells; 7. Isolation of DNA and demonstration of apoptosis of DNA laddering; Cell fusion with PEG; 8. Permanent slide preparation setting up and maintenance of fish hepatocytes /murine macrophages. 9. Project Work and Field Report, field visits will be integral part of the Practical.	**30**

Recommended Readings

Textbook

- Animal Cell Culture and Technology- Veer Bala Rastogi and Nirvika Rastogi
- Animal Cell Culture and Technology (The Basics (Garland Science))- Michael Butler

- Animal Biotechnology: Science-Based Concerns. 1st ed. Committee on Defining Science-Based Concerns Associated with Products of Animal Biotechnology. Washington, DC: National Academies Press; 2002.
- Transgenic Animal Technology: A Laboratory Handbook. 2nd ed. Pinkert CA. San Diego: Academic Press; 2002.
- Animal Cloning: The Science of Nuclear Transfer. 1st ed. Westhusin M, Betthauser J, Bishop M. Boca Raton, FL: CRC Press; 2002.

Reference Book

- Transgenic Animals: Generation and Use. 1st ed. Houdebine LM. Amsterdam: Harwood Academic Publishers; 1997.
- Principles of Cloning. 2nd ed. Cibelli JB, Wilmut I, Jaenisch R, Gurdon J, Lanza RP, West MD, et al. Amsterdam: Academic Press; 2013.
- Intellectual Property Rights in Agricultural Biotechnology. 1st ed. Singh RP. New Delhi: Daya Publishing House; 2014.
- The Science of Cloning: Genetic Engineering and Its Applications. 1st ed. Harris J. London: Routledge; 2004.
- Patent Law and Biotechnology. 1st ed. Kankanala C. Oxford: Oxford University Press; 2011.

OR

Course: DSC	**Course Title: Immunology – II D(Applied Immunology)**

Course Outcomes:

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

1. Understand the immune system by exploring its components structurally and functionally and assess about the modulation of immune response by signal transduction pathways.
2. Evaluate how aberrations in immunoregulation can cause autoimmunity, immunodeficiency, allergies and cancer and also learn how to apply immunological principles to develop new drugs, vaccines and diagnostic techniques.

3.Learn how to communicate their views on the latest findings in written and oral formats. 4. Learn how to perform common laboratory experiments accurately, record and analyse data, and present their findings in the context of scientific literature. 5. Understand the critical interpretation of published data related to immunology research. 6. Become conversant with technical skills in Applied Immunology.

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 immunotechnology, serodiagnosis, immunodiagnosis, coprodiagnosis, Enzyme Linked Immunosorbent Assay (ELISA), Radio Immuno Assay(RIA), Immunodiffusion, Gel Electrophoresis, Indirect heamagglutination Assay, Western Blot, Separation of immune cells by flow cytometry [FACS]-principle and application, Functioning and application of microscopes: Immuno-fluorescence and confocal, Lymphocyte Transformation Test (LTT), Phagocytosis, Epitope Mapping. Graft vs Host Reactions, Hybridoma and Quadridoma Technology.	**15**

Unit II	History of vaccine development, Different types of vaccines, snake- antidotes, Monoclonal and Polyclonal sera, Immunofacilitators /rejuvenators/revitalizers of natural and artificial types in health and diseases of human beings, Lymphocyte transfer therapy and Immunotherapy. Autoimmune disorders- Systematic Lupus Erythromatous [SLE], Myasthia gravis, Rheumatoid arthritis, diagnosis and clinical treatment, role of herbal preparations. Lymphoma and Leukemia, HLA phenotyping,	**15**
Unit III	Transplantation immunology- graft vs. host rejection studies for skin graft and kidney with reference to hyperacute, acute and chronic rejection and its mechanism. Immunosuppression- definition, drugs used for Immunosuppression and its mechanism of action. Xenotransplantation- definition and its application. Graft vs. host reaction and diseases- definition, mechanism, treatment and prevention. Recent advancements in diagnosis and treatment of HIV/AIDS, Corona, Global developments in diagnosis and treatment of Cancer, Introduction to psychotherapeutic immunology and herbal immunology.	**15**
	Practical	
	1. Indirect Haemagglutination Assay. 2. Mixed Lymphocyte Reaction to measure the proliferation of T cells in response to stimulation by alloantigens from another individual. 3. Preparation of Hyper-Immune serum, its aliquots and serum heat inactivation. 4. Preservation and quality control measures of serum. 5. Immunoprecipitation test: single and double immune diffusion 6. Western blotting to analyze the expression of a particular protein in immune cells or tissues.	**30**

	7. Serotying of blood. 8. Project Work and Field Report, field visits will be integral part of the Practical.	

Recommended Readings

Textbooks

•Textbook of Fundamental Immunology- Dr. Varun Kumar Sharma
•Kuby Immunology- Judy Owen, Jenni Punt, Sharon Stranford, and Patricia Jones
•Basic Immunology: Functions and Disorders of the Immune System- Abul Abbas, Andrew H. Lichtman, and Shiv Pillai
•The Immune System- Peter Parham

Reference Books

•Cellular and Molecular Immunology. 10th ed. Abbas AK, Lichtman AH, Pillai S. Philadelphia: Elsevier; 2022.
•Essential Immunology for Surgeons. 1st ed. Wood PJ, Slapak M, Tamimi RM. Cambridge: Cambridge University Press; 2004.
•Clinical Immunology: Principles and Practice. 5th ed. Rich RR, Fleisher TA, Shearer WT, Schroeder HW Jr, Frew AJ, Weyand CM. Philadelphia: Elsevier; 2018.
•The Immune System. 5th ed. Parham P. New York: Garland Science; 2021.
•Ivan M. Roitt, Essentials of Immunology.
•Elgert, Immunology: understanding the immune system, John Wiley, New York
•Smith, Kendall A , The Quantal Theory of Immunity : The Molecular basis of Auto immunity, Leukemia & Vaccines. Cornell University, U.S.A.
•Fundamentals of Immunology, William Paul, NIH, Bethesda, Mary Land, USA

DISCIPLINE SPECIFIC ELECTIVE (DSE - 1) –Human Physiology

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: Human Physiology	4	3	0	1	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: X** **Paper: DSE - 1**
Subject: Zoology		
Course: DSE-1	**Course Title: Human Physiology**	

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 contemporary life-styles, parasitic microorganisms, and health.
5. Understand the anatomy of vertebrates, including their integumentary, circulatory, digestive, respiratory, urinogenital, and nervous systems.
6. Understand the sense organs in vertebrates.

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	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, BMR. Sensory Physiology: Receptors, Pathways and physiology of smell and taste. Human Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	**15**
Unit II	Blood and circulation in Human - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, hemostasis. Cardiovascular System: structure of myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Human Nervous system - Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Nervous Coordination: Structure of neuron, nature, origin and propagation of nerve impulse, Synaptic transmission, Chemistry and functions of neurotransmitters. Sense organs - Vision, hearing and tactile response	**15**
Unit III	Excretory system - Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Muscle	**15**

	physiology: Structure, kinds and characteristics of muscles, Mechanism of muscle stimulation and contraction. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Temperature tolerance, Poikilothermic, Homoeothermic adaptations and regulatory mechanisms. Stress and adaptation. Excretion and osmoregulation: Functions of kidney, Types of nitrogenous wastes in different animal groups and their excretion, renal excretion in vertebrates (urine formation in a mammal in particular), osmoregulation in fish, reptiles, aves and mammals.	
Practical		
	1. Preparation of haemin crystals from human blood 2. Determination of clotting and bleeding time 3. Counting of RBCs in human blood; Counting of WBCs in human blood 4. Determination of haemoglobin percentage in human blood. 5. Recording of blood pressure 6. Examination of radial pulse 7. Electro cardiography; Clinical examination of cardio vascular system 8. Stethography for recording chest movements; Vital capacity; Artificial respiration – ALBP method demonstration 9. Clinical examination of respiratory system; Pregnancy diagnostic tests demonstration; Normal cardiogram of amphibian heart; Effect of	**30**

	temperature on cardiogram. 10.Case History/spotters/calculations	

Recommended Readings

Textbooks

- 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
- Animal Physiology, Fourth Edition- Richard W. Hill, A. Gordon

DISCIPLINE SPECIFIC ELECTIVE (DSE - 2) –Osteology

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-2 : Osteology	4	3	0	1	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's in Zoology	**Year: V**	**Semester: X** **Paper: DSE - 2**

Subject: Zoology		
Course: DSE – 2	**Course Title: Osteology**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand Osteology of Bony fish (*Labeo*), Amphibia (Frog), Reptilia (*Varanus*), Aves (Fowl), Mammalia (Rabbit/Rat) • Understand Vertebral column anatomy.		
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	Introduction, types and characteristics of bones. Study of appendicular bones of Varanus, Fowl and Rabbit: Bones of Pectoral Girdle, Pelvic Girdle, forelimbs and hindlimbs. Bones of Ribs and Sternum, Furcula	**15**
Unit II	Study of skull bones of Varanus, Fowl and Rabbit General characters of skull bone; Cranium: Occipital region, Parietal region, Frontal region, Ethmoidal region; Sense Capsule: Auditory capsule, Oribital	**15**

	capsule, Olfactory capsule; Visceral Skeleton: Mandibular arch Hyoid arch, Branchial arches; Foramina and nerves	
Unit III	Study of Vertebral column bones of Varanus, Fowl and Rabbit General characters of vertebra; Centrum; Cervical region (1- Atlas, 2- Axis, 3-Rest of the vertebrae), Thoracic, Lumbar, Sacral and Caudal regions.	**15**
Practical		
	1. Bones of *Varanus*, Fowl and rabbit. 2. Jaw suspension in *Varanus*, Fowl and rabbit. 3. Study of Different skulls of *Varanus*, Fowl and rabbit.	**30**

Recommended Readings

Textbooks

- A Textbook of Comparative Osteology of Vertebrates by Deepak Rawal, LAMBERT academic Publishing.
- Comparative Study of Bones by Prof. S. C. Agarwal and Dr. J. C. Agarwal; Rajeeva Parkashan Meerut.

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

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: X** **Paper: DSE**

Subject: Zoology		
Course: DSE3	**Course Title: Biochemistry**	
Course Outcomes: After studying this course, the students will be able to: 1. Understand the nature of biochemistry. 2. Understand the Physical and chemical properties of molecules as a linkage of biochemistry. 3. Understand the concept and properties of acid-base relationship. 4. Understand the nature of biomolecules. 5. Understand the metabolic pathways of biomolecules.		
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	The molecular basis of life; Buffering mechanisms in biological Systems, Biomolecular organization, Thermodynamic laws applied to biological system, applications of free energy functions, High energy compounds with special reference to ATP, pH, pK, acids, bases, buffers, Henderson – Hasselbalch equation, Bonds (Ionic, Hydrogen, Hydrophobic, Vander Waal interactions), covalent bonds, Basic concept and significance of diffusion, Osmosis, Gibb's Donnan equilibrium, Bioenergetics; Biological oxidation-reduction reactions; Electron transport chain (ETS) and Oxidative Phosphorylation. Inhibitors of ETS and oxidative phosphorylation.	**15**

Unit II	Chemical structure, classification and sources of carbohydrates, Proteins and lipids, Bonding and Functional diversity in proteins, Peptide synthesis, Protein sequencing, Structure and Conformation of proteins (protein structural hierarchy, Ramachandran plot, domains, motif and folds), Enzymes: Nomenclature and classification, kinetics, mechanism of enzyme action, factors influencing enzyme activity, Isozymes, Coenzymes: Chemical structure and significance, Vitamins: Chemical structure, sources and deficiency state of fat soluble and water-soluble vitamins. Minerals: Macro and micro nutrients. Sources and biochemical significance of mineral (Sodium, Potassium, Calcium, Magnesium, Iron, Chloride, Zinc and Phosphorus and selenium)	**15**

Unit III	Carbohydrate Metabolism; various steps of glycolysis and TCA cycle, glucogenesis, gluconeogenesis, pentose phosphate pathway; enzymes and inhibitors, Amino acid metabolism – deamination, decarboxylation, transamination, Inborn errors of aromatic and branched chain amino acid metabolism. (Phenylketonuria, Alkaptonuria, Albinism and Maple syrup urine disease), biosynthesis and regulation of purine and pyrimidine nucleotides - de novo and salvage, lipid metabolism with reference to biosynthesis and utilization of fatty acids of lipids. Significance of ketone bodies and cholesterol.	**15**
Practical		

	1. Qualitative identification of carbohydrate, protein and lipid. 2. Effect of pH and temperature on the action of salivary amylase 3. Qualitative analysis of carbohydrates(Glucose,Fructose, Lactose, Maltose, Sucrose and starch) 4. Quantitative analysis of reducing sugars (DNSA method) 5. Determination of salivary amylase activity 6. Demonstration of protein separation by SDS-PAGE 7. Identification tests for Proteins (albumin and Casein) 8. Paper chromatography of amino acids. 9. Determination of blood sugar 10. Determination of serum total cholesterol	**30**

Recommended Readings Textbooks & Reference Books

• Harper's Biochemistry 32nd edition, 2022, Mc Graw Hill / Medical, pages 816

• Lehninger, A.L. Nelson, D.L. and Cox: Principles of Biochemistry 8th edition, 2021 Publisher- Freeman and Company (New York), pages 1096

• Jeremy Berg, Lubert Stryer, Biochemistry 10th edition, 2023, Publisher, Springer Verlag, Pages 1120

Generic Elective (GE) – Hydro 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		
GE: Hydro Ecology	4	4	0	0	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: X** **Paper: GE**
Subject: Zoology		
Course: GE1	**Course Title: Hydro Ecology**	

Course Outcomes:

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

- Understand the Fundamentals of Hydroecology.
- Describe Aquatic Ecosystems and Their Components.
- Analyze Water Quality and Its Impact on Ecology.

Credits:4		Generic Elective
Max. Marks: As per Univ. rules		**Min. Passing Marks: As per Univ. rules**
Unit	**Topic**	**No. of Hours**
Unit I	History, scope and applications of Hydroecology. Movement, distribution and management of water on Earth. Water cycle, water resources and drainage basin sustainability, maintenance of minimum water flow.Global warming and its aggravations. Impacts of climate change on water sector and agriculture sector. Need for vulnerability assessment, approaches and tools of assessment. Adaptation to climate change by various Mitigation measures for climate change.	**20**
Unit II	Climate change and India; impacts, sectoral and regional vulnerability in India. Evaluation of model simulation over India.Evolution of emission trading and design features, trading mechanisms.	**20**
Unit III	Earth's climate, climate change,Drivers of climate change, change scenarios. Climate Change Policy Framework.Impacts of climate change, Climate variability and natural resources.United Nations Framework Convention on Climate Change (UNFCCC).Kyoto Protocol and the flexibility mechanisms.	**20**

Recommended Readings

Textbooks

- Biology of Fresh Waters – Peter S. Maitland
- Das and Saikia, Irrigation and Hydropower Engineering, PHI Learning Pvt Ltd.
- K.N Sharma, Water Power Engineering, Vikas Publishing House.
- A. Michael, Irrigation Theory and Practice-2Nd Edn, Vikas publishing house, 2009.
- S. K. Garg, Irrigation Engineering and Hydraulic Structures: Water Resources Engineering (Vol. II). Khanna

- Publisher, 2020.
- V.V.N. Murty, and T. Kei, Land and water development for agriculture in the Asia Pacific region. Science Publishers, Inc., 1996.

Generic Elective (GE) – Conservation 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 Course (if any)
		Lecture	Tutorial	Practical/Practice		
GE: Conservation Biology	4	4	0	0	Passed Class XII with Biology	Nil

MASTER'S IN ZOOLOGY		
Programme: Master's In Zoology	**Year: V**	**Semester: X** **Paper: GE**
Subject: Zoology		
Course: GE1	**Course Title: Conservation Biology**	
Course Outcomes:		

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

1. Learn how to identify species, habitats and life cycles of birds, fish, and mammals.
2. Apply conservation strategies to promote biodiversity and mitigate threats. They can also learn how to implement sustainable practices that balance conservation with human needs.
3. Learn how to monitor and survey wildlife.
4. Learn about the principles of wildlife ecology and how to understand wildlife habitats.

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 Conservation Biology: Definition, scope, and importance of conservation biology.Levels of biodiversity: Genetic, species, and ecosystem diversity.Threats to biodiversity: Habitat loss, climate change, pollution, overexploitation, invasive species.Conservation approaches: In-situ and ex-situ conservation.	**20**
Unit II	Conservation Strategies and Policies. Protected areas: National parks, wildlife sanctuaries, biosphere reserves.Endangered and endemic species of India. Role of organizations: IUCN, WWF, UNEP, and national agencies. Wildlife Protection Act (1972), Biodiversity Act (2002), and other conservation laws in India. Institutions and Their Role in Conservation:Zoos, Natural History Museums, and Collections.Zoological Survey of India (ZSI) and its regional centers.	**20**
Unit III	Conservation Initiatives and Sustainable Development: Community participation in conservation: Ecotourism, biodiversity hotspots, sacred groves.	**20**

	Species recovery programs: Project Tiger, Project Elephant, Vulture Conservation. Sustainable development and conservation: Climate change mitigation, afforestation, sustainable agriculture. Role of biotechnology in conservation: Cryopreservation, cloning, seed banks, Bioremediation.	

Recommended Readings

Textbooks

- Wildlife Perceptions, Threats and Conservation – Cheryl Ward
- Fundamentals of Wildlife Management – Rajesh Gopal
- Wildlife Conservation: Challenges and Opportunities – Suresh Chandra Sharma
- Wildlife Conservation in India-1 Road to Nowhere – H .S. Pabla
- Forest, Water and Wildlife Management A Futuristic Approach- Dr. Ajay Kumar Singh
- Wildlife Management in Karnataka : A Forester's Perspective- Dipak Sarmah
- Ecology, Wildlife Conservation and Management- Tapashi Gupta
- Wildlife Conservation and Management - Dr. Reena Mathur.
- Textbook of Wildlife Management 3ED – S. K. Singh

ABILITY ENHANCEMENT COURSE (AEC)

DEPARTMENT OF ZOOLOGY

Ability Enhancement Course (AEC) - Aquarium Fish Keeping

No. of Hours – 45

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		
AEC: Aquarium Fish Keeping	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Understand the biology, maintenance and feeding of ornamental fish.
- Learn about the fish keeping industry and aquarium fish production.
- Understand the structure and functioning of the insurance sector.
- Understand the skills needed to set up an aquarium.
- Identify and differentiate between different aquarium fish.

Unit	Topic	No. of Hours
Unit I	The potential scope of Aquarium Fish Industry as a Cottage Industry; Exotic and Endemic species of Aquarium Fish. Study of different species of Aquarium fish and biology (Breeding, Feeding economic importance etc) of exotic and endemic fish. Common characters and sexual dimorphism of Fresh water and marine aquarium fish such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish.	**05**
Unit II	Use of live fish feed organisms (Advantages and disadvantagesof live food), Use of formulated feeds, Types of formulated feed, Formulation and preparation of feed, Advantages and disadvantages of formulated feed.	**05**
Unit III	Live fish transport (Capture and Pre-transport maintenance, capture and handling techniques); Fish packing and transport (Closed and open transport system, Preparation for packaging, Procedure for packaging, Precautions, Post transport maintenance) General handling techniques.	**05**
Practical		
	1. Design and construction of ideal fish farm (aquarium) and its maintenance. 2. Identification and study of common hill stream fishes and ornamental fishes. 3. Study of aquatic weeds.	**30**

	4. Collection and examination of water sample; estimation of dissolved oxygen and free carbon dioxide.	

Recommended Readings

Textbooks

- Freshwater Aquariums For Dummies- Heleine
- Nature aquarium world- Amano and Takashi
- Aquarium Fish Keeping- S. Saha
- Ultimate Encyclopedia of Aquarium Fish and amphibia; Fish Care- M. Bailey
- Aquaponic Gardening- S. Bernstein

Ability Enhancement Course (AEC) - Wildlife Conservation and Management

No. of Hours – 45

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		
AEC: Wildlife Conservation and Management	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Understand the general principles of ecology as how it related to terrestrial and aquatic animal conservation and management.
- Identify species, characteristics, habitat requirements and life cycles of birds, fish, and mammalian wildlife species.
- Impart field-based training to students how it will be applicable to solve problems related to wildlife conservation and management.

Unit	Topic	No. of Hours
Unit I	Indian Wildlife: Introduction, Distribution of Wildlife in Ecological Subdivision of India, IUCN Categories. Protected Area Network: National Parks, Wildlife Sanctuaries, Biosphere Reserves and Zoos in India, Gene Pool, Habit, Habitat and Breeding Biology of Few Mammals (Viz., Elephant and Tiger). Reasons For Wildlife Depletion: Habitat Fragmentation, Habitat Destruction, Commercial Wildlife Exploitation, Overgrazing Etc., Wildlife Conservation (Policies and Programmes), Special Projects for Endangered Species (Project Tiger, Gir Lion Sanctuary Project and Crocodile Breeding Project).	**05**
Unit II	Principle and Practice of Wildlife Management: Management of Special Habitats; Riparian Zones, Grasslands Introduction to Conservation Biology, Conservation Values and Ethics of Conservation of Natural Resources. Conservation of Biodiversity, Patterns and Processes, Concepts of Biodiversity, Levels of Biodiversity, Genetic Diversity, Intra Specific Diversity, Species Richness, Richness of Higher Taxa, Ecosystem and Biome Diversity.	**05**

Unit III	International Conventions on Conservation (Ex-Situ and in-Situ Conservation, Conservation Breeding (E.G. Vulture, Pygmy Hog, Gharial, Etc.), Institutions and their Role in Conservation (Zoos, Natural History Museums and Collections, Zoological Survey of India and Its Regional Centres. National and International Zoological Institutes, Societies and Academic Bodies. Brief Account of Wildlife Acts and Their Amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	**05**
Practical		
	1. Case studies of Zoo, wild life sanctuary, National parks. 2. Project work on endangered and endemic fauna of Uttarakhand. 3. Studies on role of scientific institution and academic bodies on wild life conservation. 4. Study of major faunal groups of India. 5. Wild life photography.	**30**

Recommended Readings

Textbooks

- Ecology, Wildlife Conservation andamp; Management- T. Gupta
- Human Conflict and Wildlife Conservation- K. Sharma
- Sustainable Development of Natural Resources and Wildlife Conservation- A. K. Dubey
- Wildlife Ecology, Conservation, and Management (Wiley Desktop Editions)- M. J. Fryxell, A. R. ESinclair and G. Caughley
- Reminiscences of Indian Wildlife- R. S. Dharma kumar sinhji

Ability Enhancement Course (AEC) –Fish Farming

No. of Hours – 45

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		
AEC:Fish Farming	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- To introduce the learner to different types of freshwater fishes and the significance of Fisheries in the region of study
- Knowledge of the different types of Integrated Fish Farming practices.
- To learn about the different feeds and feeding for culture fisheries
- A thorough knowledge of the mechanism of preservation and processing of fish.
- To allow the learner to get exposed to the different diseases affecting the fishes
- To capacitate the learner on the water quality parameters analysis important for Fisheries.

Unit	**Topic**	**No. of**

		Hours
Unit I	Introduction to Fish, Types of Fish, Small Indigenous Fish species, Air breathing Fishes, Snake heads etc. and Fisheries: Its importance, Types of fisheries. Morphology of some commonly available Fish, Meristic and Morphometric analysis of Fish and its significance, Importance of growth and age studies. Overview of national and international aquaculture systems. Systems of aquaculture - pond culture, cage culture, running water culture, zero water exchange system, raceway	**05**
Unit II	Classification of fish based on food and feeding habits, Digestive system and process of digestion, Gut analysis and Gastrosomatic Index and its relevance.Reproductive organs of fishes, Morphological Differentiating features of Males and Female fishes, Transportation and Rearing of brood fish. Wet and Dry Bundh methods for Induced breeding of Carps. Diseases of fish with special reference to the diseases in the region and its management. Use of herbal medicine in fish disease management	**05**
Unit III	Fish production: Monoculture, polyculture and integrated culture systems. Integrated Fish farming- Agro Based and Livestock based. Composite Fish culture and its benefits. Floating, semifloating, sinking and stable feeds for aquaculture, Feed making methods. High energy feeds, Alternative protein sources for feeds, maturation diets to enhance breeding efficiency, Larval feeds. Nutritional requirements of cultivable fishes, feed formulation. Commonly used feed ingredients.	**05**

	Novel feed ingredients, estimation of quality of feed ingredients. Selection of ingredients, formulation of feeds,	
Practical		
	1. To identify the freshwater species. 2. To study the traditional and modern fish gears and crafts. 3. Permanent preparation of fish scales. 4. Calculation of Gonado-somatic index (GSI) of fish	**30**

Recommended Readings

Textbooks

- A text book of fish, fisheries and technology – K. P. Biswas
- Indian Council of Agricultural Research. Handbook of fisheries and aquaculture, 1stedition, 2006. S.Ayyappan, J. K. Jena, A. Gopalakrishnan and A. K. Pandey
- Publisher Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, 2006.

Ability Enhancement Course (AEC) - Economic Zoology

No. of Hours – 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credits	Credit distribution of the Course	Eligibility criteria	Pre-requisite of

Title		Lecture	Tutorial	Practical/Practice		the Course (if any)
AEC: Economic Zoology	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Remember the biology of silk worms, Honey bees, Earth worm and Pearl oyster.
- Apply the methods used for culturing various useful organisms for commercial purposes.
- Analyze the technical aspects of different animal cultures.
- Evaluate the prospects of Sericulture, Vermiculture, Apiculture and Pearl culture.

Unit	Topic	No. of Hours
Unit I	Introduction to: • Pisciculture: Cultivable fishes. • Sericulture: *Bombex mori*, types of silk worm and its rearing. • Apiculture: Types of honey bees, typical honey and culture of *Apis melifera* and natural enemies. • Lac culture • Pearl culture • Piggery • Poultry • Vermiculture	**05**

Unit II	Bionomics and control measures of the common pests of fruits (*Papilio demoleus*and *Quadraspidiotusperniciosus*), Vegetables (*Thrips tabaci* and *Aulacophorafoveicollis*) and stored grains (*Callosobruchus chinensis* and *Trogoderma granarium*). Polyphagous pests (Locust and Termites).	**05**
Unit III	Pest management, including insect pest control and integrated pest management.	**05**
	Practical	
	1. Identification of honey bee species and hive management. 2. Project work on apiculture, pisciculture, sericulture and vermiculture. 3. Study of major insect pest of crops, vegetable and stored grains	**30**

Recommended Readings

Textbooks

- Applied Zoology- N. Arumugam and T. Murugan
- Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests andtheir Controls- P. Jabde
- Applied and Economic Zoology- Tripurari Mishra
- Applied and Economic Zoology- Ashok Kumar

VALUE ADDITION COURSE (VAC)

DEPARTMENT OF ZOOLOGY

Value Addition Course (VAC) - Food, Nutrition and Health

No. of Hours – 30

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		
VAC: Food, Nutrition and Health	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

1. Learn the nutritional care concepts of dietetics.
2. Study the chemistry of food and how cooking, processing, and preservation affect food quality.
3. Understand the fundamentals of nutrition science in relation to macro and micro nutrients.
4. Learn how to manage dietary departments in organizations.

5. Learn how to evaluate patient medical records and interpret medical history.
6. Have a better understanding of the association of food and nutrition in promoting healthy living.
7. Think more holistically about the relationship between nutrition science, social and health issues.

Unit	Topic	No. of Hours
Unit I	Basic concept of food and nutrition Food Components and food-nutrients, Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly. Food Pyramid, Nutritional anthropometry- BMI, waist-to-hip ratio, skin-fold test and bioelectrical impedance; interpretation of these measurements	**10**
Unit II	Food Biochemistry Carbohydrates, Lipids, Proteins; their dietary source and role. Vitamins- their dietarysource and importance. Minerals- their biological functions. Dietary Fibers- Definition,their dietary source and nutritional importance. Elementary idea of Probiotics, Prebioticsand Organic Food.	**10**
Unit III	Health Definition and concept of health, major nutritional deficiency diseases-(kwashiorkor and marasmus), deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, atherosclerosis and obesity; their	**10**

	causes and prevention through dietary and lifestyle modifications. Social health problems- smoking, alcoholism, drug dependence and common ailments- cold, cough, and fevers, their causes and treatment.	

Recommended Readings
Textbooks:

- Food, Nutrition and Health- S. Goyal and P. Gupta
- Food, Nutrition and Health- L. Tapsell
- Introduction to Nutrition and Metabolism- David A. Bender and Shauna M. C. Cunningham
- Nutrition and Dietetics- Shubhangini A. Joshi
- Textbook of Food Science and Nutrition- Sunita Roy Chowdhury and Bani Tamber Aeri
- Nutrition Science 7th Edition – B. Srilakshmi
- The Nutritionist: Food, Nutrition, and Optimal Health- Robert Wildman

Value Addition Course (VAC) – Intellectual Property Rights

No. of Hours – 30

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credits	Credit distribution of the Course	Eligibility criteria	Pre-requisite of

Title		Lecture	Tutorial	Practical/Practice		the Course (if any)
VAC: Intellectual Property Rights	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Understand the meaning and evolution of Intellectual property law, and also the importance of protecting Intellectual property.
- Understand the concept and registration process of a patent and also the recent developments in patent system.
- Understand the concept of Trademarks and Copyrights, and also know the registration process along with infringement, offences, and penalties.

Unit	Topic	No. of Hours
Unit I	Introduction to IPR Meaning of intellectual property, Origin, Nature, Meaning of Intellectual Property Rights. Introduction of the Trade-Related Aspects of Intellectual Property Rights (TRIPS), Agreement and the role of the World Trade Organization (WTO) in shaping international IPR regulations, highlighting the implications of TRIPS compliance at both national and global levels. Kinds of Intellectual property rights - Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	**10**

Unit II	Patent rights and copy rights Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies and Penalties. Copy Right - Origin, Definition and Types of Copy Right, Registration procedure, Assignment and license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to softwares.	**10**
Unit III	Trade marks Origin, Meaning and Nature of Trade Marks, Types, Registration of Trade Marks, Infringement and Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space. Design- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor, Integrated circuits and layout design Act-2000.	**10**

Recommended Readings

Textbooks

- Intellectual Property Rights - P. Narayanan
- Intellectual Property Rights - Volume. 1and2 - J. Rattan
- Intellectual Property Rights and the Law, Gogia Law Agency - G. B. Reddy
- Law relating to Intellectual Property, Universal Law Publishing Co - B. L. Wadehra
- IPR - P. Narayanan
- Law of Intellectual Property, Asian Law House - S. R. Myneni.

Value Addition Course (VAC) - Public Health and Hygiene

No. of Hours – 30

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		
VAC:Public Health and Hygiene	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

1. Get a holistic overview of the interdisciplinary nature of public health.
2. Understand public health issues in India particularly related to Malnutrition, sanitation issues and related burden of infectious disease, and the role of pollution as a public health concern.
3. Get knowledge on personal and public hygiene.

Unit	**Topic**	**No. of Hours**

Unit I	Nutrition – definition, importance of Carbohydrate, Protein, Lipids and Minerals. Balanced diet - Basics of meal planning, Concept of energy, calories. Food adulteration and food fortification. Maternal health, Population control and family welfare. Sexually transmitted diseases – HIV/AIDS, syphilis, gonorrhea. Management of diseases like Obesity, Diabetes mellitus, Cardiovascular disorders.	**10**
Unit II	Communicable/Contagious, Non-Communicable, Vector Borne, Sexually transmitted diseases and other social health problems Communicable and vector borne diseases and prevention: Malaria, Typhoid, Hepatitis (Jaundice), Dengue, chikunguniya: Causes and prevention methods. HIV/AIDS, syphilis, gonorrhea. Management of diseases like Obesity, Diabetes mellitus, Cardiovascular disorders. Effects of smoking, alcoholism, substance abuse and drug abuse.	**10**
Unit III	Ill effects of smoking, alcoholism, substance abuse and drug abuse. Hygiene: Definition, personal hygiene- body odour, oral hygiene, grooming, feminine hygiene, hand washing, toiletry. Community Hygiene, Environmental Sanitation and Sanitation in Public places occupational hygiene.	**10**

Recommended Readings

Textbooks

- Textbook of Environmental Hygiene for Nursing Students – K. K. Gill
- A Short Book of Public Health – V. K. Muthu
- Hygiene and Public Health- George Moses
- Principles of Occupational Health and Hygiene: An Introduction- Cherilyn Tillman
- Health and Hygiene: with Anatomy and Physiology- Swami Sivananda
- A College Textbook of Health and Hygiene- Arvind Kumar Goel

Value Addition Course (VAC) – Research Publication Ethics

No. of Hours – 30

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		
VAC: Research Publication Ethics	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

1. Have awareness about the publication ethics and publication misconducts along with the philosophy of science and ethics, research integrity and publication ethics.
2. Identify research misconduct and predatory publications, plagiarism tools; and understand indexing and citation databases, open access publications, research metrics (citations, h-index, impact Factor, etc.).

Unit	**Topic**	**No. of**

		Hours
Unit I	Philosophy and Ethics i. Introduction to Philosophy: definition, nature and scope, concept, branches ii. Ethics: Definition, moral philosophy, nature of moral judgments and reactions.	**10**
Unit II	Scientific Conduct i. Ethics with respect to science and research ii. Intellectual honesty and research integrity iii. Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) iv. Redundant publications: duplicate and overlapping publications, salami slicing v. Selective reporting and misrepresentation of data	**10**
Unit III	Publication Ethics i. Open access publications and initiatives ii. SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies iii. Software tool to identify predatory publications developed by SPPU: UGC-CARE list of journals iv. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.	**10**

Recommended Readings

Textbooks

- Philosophy of Science – A. Bird
- Ethics in Competitive Research: Do not get scooped; do not get plagiarized - P. Chaddah
- National Academy of Sciences, National Academic of Engineering and Institute of Medicine. (2009). *On being a Scientist: A Guide to Responsible Conduct in Research*, Third edition, National Academic Press.
- Indian National Academic of Science (INSA), Ethics in Science, Education, Research and Governance

(2019). ISBN: 978-81-939482-1-7.
- Beall, J. (2012). *Predatory publishers are corrupting open access*. Nature, 489(7415), 179.

Value Addition Course (VAC) – Mind Body Medicine

No. of Hours – 30

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		
VAC: Mind Body Medicine	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Gain a comprehensive knowledge of the mind–body techniques/practices and its use in health promotion and maintenance.
- Gain knowledge of a variety of tools and techniques to achieve optimal health.

Unit	Topic	No. of Hours
Unit I	History, scope and significance of mind-body medicine. Practices such as meditation, breathing techniques, tai chi, or yoga interactions among the mind, body and behaviour. Mind–body techniques as psychological techniques, emotional therapies or	**10**

	spiritual healing.	
Unit II	Mind Body Wellness Elective for MBBS students Mind-body medicine, lifestyle modification including diet, exercise and yoga. Stress and resilience building,	**10**
Unit III	Fundamentals of mind body medicine and lifestyle modifications with scientific foundations. Mind body medicine techniques like meditation, biofeedback, exercise and yoga. Stress Management and Resilience Technique (SMART).	**10**

Recommended Readings

Textbooks

- Lifestyle As Medicine - A. Thomas, S. Hansdak, D. Alexander and H. Giebel
- Healthy Mind, Healthy Body (New Thoughts On Health- The Ultimate Medicine) – R. Powell, Nisargadatta and P. Madill
- Yoga for the Body, Mind and Soul: S. Mukundananda
- Quantum Healing: Exploring the Frontiers of Mind/Body Medicine: D. Chopra

Value Addition Course (VAC) – Emotional Intelligence

No. of Hours – 30

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		
VAC: Emotional Intelligence	2	2	0	0	Passed Class XII with Biology	Nil

Learning Outcomes:

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

1. Have Self-awareness, self-management, social awareness and relationship management.
2. Discover Personal competence and technique of building emotional intelligence.
3. Gain insights into establishing positive relationship.

Unit	Topic	No. of Hours
Unit I	Nature and significance Models of Emotional Intelligence: ability and trait Building block of emotional Intelligence: Self-awareness, self-management, social awareness and relationship management.	**10**
Unit II	Self-awareness: Observing and recognizing one's own feeling, knowing one's strengths and area of development Self-management: Managing emotions, anxiety, fear and anger.	**10**
Unit III	Social Awareness: Others perspective, empathy and compassion	**10**
Recommended Readings **Textbooks**		

- Self-Discipline: Life Management – D. Johnson
- HBR's 10 Must Reads on Emotional Intelligence (2015)
- HBR's 10 Must Reads on Managing Yourself (2015)

Value Addition Course (VAC) – Animal Husbandry (Goat and Sheep)

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		
SEC: Goat and Sheep farming	2	1	0	1	Passed Class XII with Biology	Nil

- **Learning Outcomes:**

  After studying this course student will able to understand:

  1. To Identify different breeds of Goat and Sheep for Goat and Sheep Farming.
  2. To Structure goat and Sheep housing focusing on waste management.
  3. To Prepare for fodder cultivation & feeding for goats and Sheep maintaining constituents of livestock feed component.
  4. To Manage overall Goat and sheep health and diseases.

Unit	Topic	No. of Hours
Unit I	Introduction to Goat and sheep Farming. Brief history of goat and sheep farming in Uttarakhand and India. Importance of goat and sheep farming. Employment potential in goat and sheep farming. Concept of breed and	**10**

	Breeding system (different Meat, Milch and Dual breeds of Goat).	
Unit II	Indigenous goat and sheep breeds of economic importance. Exotic breeds of goats and Sheep experienced in India. Essential Tools/Equipment for goat and sheep housing and management. Different methods of waste handling and waste disposal in goat farming. The routine cleaning of goat and sheep shed.	**10**
Unit III	Various types of goat and sheep farms, and fodder. Cost effective ratio of feed formulation for newborn, grower, buck and doe. Different systemic diseases of goats and Sheep and their management. Study of different parts of goat and Sheep (male/female). Identification of impotent breeds of goat and sheep. Study of important characteristics of exotic and indigenous goat and sheep	**10**

Recommended Readings

Textbooks:

- Goat, Sheep and Pig: Production and management- Jagdish Prasad
- Comprehensive Book on Goat Farming – Gupta and Amrutkar'

SKILL ENHANCEMENT COURSE (SEC)

DEPARTMENT OF ZOOLOGY

Skill Enhancement Course (SEC) – Pearl Culture

No. of Hours – 45

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		
SEC: Pearl Culture	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Gain overall idea about Pearl *Unio*- its biology, morphology especially the histology of mantle, pearl formation etc.
- Recognize the suitable speciesof*Unio*forpearlcultureinIndia.
- Setupapearlculturesysteminpond/tanks.
- StartentrepreneurshiponPearlculture.
- Start-upwiththehelpofexistingGovernmentfunding.

Unit	Topic	No. of Hours
Unit I	Introduction to pearl culture: History and scope of pearl culture. Global Status of pearl Industry with special reference to India. Identification of pearl producing species from phylum Mollusca. Morphology and anatomy of *Unio*. Structure and histology of mantle. Formation of pearls, mussels producing pearls.	**05**
Unit II	Ecobiology of *Unio* Construction and maintenance of pond for Pearl Culture. Pearl Surgery and Insertion technique foreign particles/bead of for pearl formation.Postoperationalcare.	**05**
Unit III	Harvesting of pearl. Processing of pearl. Sorting of pearl. Economic viability of Pearl culture. Marketing and economical concern of pearl industry.	**05**
Practical		
	1. Identification of pearl producing species from phylum Mollusca. 2. Construction and maintenance of pond for pearl culture. 3. Collection of pearl, bleaching, cleaning and sorting of pearl, quality	**30**

	assurance of pearl. 4. Surgery and insertion technique foreign particles/bead of for pearl. 5. Physicochemical parameters necessary for pearl culture. 6. Marketing of pearl.	

Recommended Readings

Textbooks

- Fishery Science and Indian Fisheries. C. B. L. Srivastava and S. Srivastava
- Pearls: Natural, Cultured and Imitation (Butterworths Gem Books) – A. E. Farn
- Aquaculture farming and husbandry of freshwater and Sorting of Pearl. Marketing and economicsconcerned with Pearl Culture. Generation marine organisms - J. E. W. Bardach
- Pearl Farming. Australia (Nat Geographic; Mag publication) – D. Dobilet

Skill Enhancement Course (SEC) - Vermiculture

No. of Hours – 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

CourseTitle	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the Course (if any)**
		Lecture	Tutorial	Practical/Practice		
SEC:	2	1	0	1	Passed Class XII with	Nil

Vermiculture					Biology	

Learning Outcomes:

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

- Learn about earthworm biology and role of earthworm in soil in association with microorganism.
- Identify different species of earthworms and compare their characteristics.
- Learn about biodiversity: Students can learn about the biodiversity of local earthworms.

Unit	Topic	No. of Hours
Unit I	Introduction of earthworms: Habit, habitat, external features, classification, Taxonomic position andcocoon formation of earthworms. Earthworms as indicator of soil fertility, as plant growth promoters, as soil health regulators. Ecological habitat grouping – Epigeic, Endogeic and Anecic. Earthworms as environment protectors, Earthworm in organic farming and decomposition, food, medicine, and baits.	**05**
Unit II	Vermiculture at small scale (kitchen, home garden etc.). Commercial viability at large scale. Advances and recent developments in vermicomposting. Farm waste as vermicomposting materials. Selection of efficient and abundant earthworm species for vermicomposting. Applications of vermicomposting.	**05**
Unit III	Vermicompost: Acomparative analysis with chemical fertilizers in terms ofcrop yield and eco-friendly nature. Earthworms in bio-remediation, as protein source. Earthworm and as model organism for current researchspecial reference to soil toxicology.Role of Earthworms in organic waste management, microbial interactions in the decomposition of organic matter.	**05**

Practical		
	1. Construction of vermicompost pit 2. Staking and cultivation of Earthworm species. 3. Physicochemical parameter of soil for vermicomposting. 4. Collection and identification of caste and cocoon from compost pit. 5. Economical importance of vermicompost and its marketing viability.	**30**

Recommended Readings
Textbooks:

- Biology and Ecology of Tropical Earthworms - Priya Shankar Chaudhari and S.M. Singh
- Vermiculture and Vermi-Biotechnology- Dr.Rajiv K. Sinha
- Vermitechnology: The Biology of Earthworms -R. K. Dutta
- Principles of Organic Farming- E. Somasundaram, D. Udhaya Nandhini
- Vermicomposting For Sustainable Agriculture- R. K. Pawar

Skill Enhancement Course (SEC) - Sericulture

No. of Hours – 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credit	Credit distribution of the Course	Eligibility criteria	Pre-requisite of

Title	s	Lecture	Tutorial	Practical/Practice		the Course (if any)
SEC: Sericulture	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Understand overall aspects of sericulture
- Creates awareness among students about the economic importance and suitability of sericulture in India.
- Learn various technologies involved in sericulture.

Unit	Topic	No. of Hours
Unit I	Introduction to sericulture: History development and economic significance of silk production. Introduction to non-violent aspect of sericulture and its promotion. Major silkworm species and their life cycles: mulberry silkworm (Bombyx mori), Tasar, Eri, Munga. Environmental conditions required for silkworm rearing.	**05**
Unit II	Importance of Mulberryleavesin sericulture.Propagation, planting, irrigation, and disease management in mulberry farming. Requirements, maintenance and Disease Pest control of silk worm. Silk worm Production and Harvesting: Formation, methods, factors, preservation, quality, Cocoon sorting and marketing.	**05**
Unit III	Silk Reeling and Processing: Methods of silk reeling: Charka, Filature, Automatic reeling. Quality assessment of silk. Diseases and Pest Management in Sericulture.	**05**

	Economic and commercialization viability of sericulture.	
Practical		
	1. Various aspects of Sericulture in field. 2. Maintenance/Rearing techniques of Silk worm in laboratory conditions food and feeding behavior of Silk worm (Mulberry and Non-Mulberry) 3. Physicochemical parameters for silk moth rearing Silk worm 4. Production and Harvesting. 5. Marketing of silk products.	**30**
Recommended Readings **Textbooks:** • Handbook of Practical Sericulture – U.J. Nagaraj • Sericulture in India: Economics and Opportunities – K. M. Reddy		

Skill Enhancement Course (SEC) – Biofloc Fish Culture

No. of Hours – 45

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		
SEC:Biofloc Fish Culture	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Learn about the basics of Biofloc technology and it's important as a skill for self-sustainable and self-employment
- Learn production of fish in the larger scale with minimum use of water source and land to help in the total production of fish for human consumption in India.
- Learn about how to set-up the technology looking into the different conditions and availability of space and training.
- Understand the fundamental concept of running this system with the biological knowledge of bacteria culture, water quality management
- To learn the types of fish species, types of feed and feeding, density of fish to be maintain in the particular volume of water etc.

Unit	Topic	No. of Hours
Unit I	Introduction to basics of Biofloc technology and its applications in aquaculture industry, Standard operating procedure, Microbial Role in Biofloc System, Design Set-up and installation of Biofloc system, Biosecurity, Advance over pond aquaculture.	**05**
Unit II	Monitoring water quality parameters: Floc volume,Floc water preparation Monitoring and management of Dissolved Oxygen level and aeration, pH,	**05**

	Conductivity, Temperature, Salinity, Ammonia, Nitrate, Nitrite, TDS optimum for management of Biofloc Culture. Role of Bacteria in management of water quality.	
Unit III	Criteria of Suitable species selection, Pre-stocking and post stockingmanagement,Food and feeding management, Production performance, Nursery rearing days, Survival (%),Average body weight at harvesting period, feed conversion ratio. C:N ratio management, Nutritional requirements and protein levels in the food. Source of carbon, calculation of carbon and nitrogen ratio, suitable C:N ration management in the initial floc preparation and during culture days. Selection of species-specific food with optimum protein level, foodsize, quantity of feed according to per cent body weight, feeding rate.	**05**
Practical		
	1. Construction and maintenance quality of Biofloc fish tank. 2. Physicochemical parameters optimum for Biofloc fish culture. 3. Stocking, harvesting and marketing of Biofloc product.	**30**

Recommended Readings

Textbooks:

- Ezhilmathi, S and S FelixIntensiveBiofloc Nursery System for Vannamei Shrimp by Ezhilmathi, S and SFelix, Scholars World (Scholars World)
- Biofloc Technology (BFT): A Review for Aquaculture Application and Animal Food Industry
- MaurícioEmerenciano, Gabriela Gaxiola and Gerard Cuzon

Skill Enhancement Course (SEC) - Immunodiagnostics

No. of Hours – 45

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		
SEC: Immunodiagnostics	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

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

- Understand the Fundamentals of Immunodiagnostics.
- Analyze the Role of Immunodiagnostics in Disease Detection.
- To learn about autoimmune diseases, Cancer and Infectious diseases.

Unit	Topic	No. of Hours
Unit I	Immunodiagnostics – introduction, basics of antigen-antibody reactions. Serology, serum preparation. Serodiagnosis, immunodiagnosis, coprodiagnosis. Precipitation techniques, Blotting techniques.	**05**
Unit II	Microscopy-based techniques (immunofluorescence). Cell-analysis techniques. Preparation of antibodies.	**05**

Unit III	Immunodiagnosis, Cytokine and cellular immunotherapy of tumors; Immunotherapy of tumors with antibodies; Tumor vaccines.	**05**
	Practical	
	1. Preparation of Hyper Immune serum, its aliquots and serum heat inactivation. 2. Preservation and quality control measures of serum. 3. Immunoprecipitation test: single and double immune diffusion . 4. Haemagglutination assay.	**30**

Recommended Readings

Textbooks:

- Ivan M. Roitt, Essentials of Immunology.
- Elgert, Immunology: understanding the immune system.
- Kuby Essentials of Immunology 6th Ed. (2007). Freeman and Company,New York

Skill Enhancement Course (SEC) – Hematological Techniques

No. of Hours – 45

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course	Credit	Credit distribution of the Course	Eligibility criteria	Pre-requisite of

Title	s	Lecture	Tutorial	Practical/Practi Ce		the Course (if any)
SEC: Hematological Techniques	2	1	0	1	Passed Class XII with Biology	Nil

Learning Outcomes:

Unit	Topic	No. of Hours
Unit I	Introduction to Hematology: Introduction to Blood, Functions of blood (Transport Functions, protective function, Regulatory Functions, Homeostatic and Miscellaneous Functions). Composition of blood:Erythrocyte Parameters: RBC count, Hemoglobin (Hb), Hemoglobin estimation (Methods: Sahli's, Cyanmethemoglobin, etc.). Hematocrit (Hct). Leukocyte Parameters: WBC count, Differential countPlatelet count.Erythrocyte Sedimentation Rate (ESR).	**05**
Unit II	Hemopoiesis (Blood cell formation): Definition of hempoiesis, sites of hempoiesis, Types of hemopoiesis, Regulation and disorders of hemopoiesis. Blood collection techniques in chordates (Vertebrates). Anticoagulants used in hematology. Blood Coagulation and Blood Typing: Mechanism of blood coagulation. Bleeding time and clotting time. Prothrombin time (PT) and Activated Partial Thromboplastin Time (APTT). Blood groups and Rh factor determination	**05**

Unit III	Hematological Disorders and Diagnostic Techniques: Common hematological disorders: Anemia, Leukemia, Thrombocytopenia. Blood parasites in chordates (e.g., Plasmodium, Trypanosoma). Immunohematology and role of blood in immunity. Advanced techniques in hematology: Flow cytometry, Hematological analyzers. Clinical significance of hematological tests.	**05**
Practical		
	1. WBC and RBC cell count. 2. Bleeding time, Clotting time, 3. Haemoboglobin Estimation. 4. Total Leukocyte count, Differential Leukocyte count. 5. Estimation of ESR in human blood	**30**

Recommended Readings

Textbooks:

- "Fundamentals of Hematology" – P. Chakraborty
- "Textbook of Hematology" – Shirish M. Kawthalkar
- "Essentials of Hematology" – Purnima D. Kharkar
- "Comparative Hematology: Studies in Animals and Humans" – P.N. Campbell
- "Hematology: Clinical Principles and Applications" – Bernadette Rodak