Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Name of the Faculty: Science & Technology

Syllabus: ZOOLOGY

(As per New Education Policy NEP 2020)

Name of the Course: B.Sc. Part- III (Sem V & VI)

Implemented from June- 2026

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Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
NEP 2020 Compliant Curriculum
B.Sc. (Zoology)
Program Preamble

The Bachelor of Science (BSc) in Zoology is a comprehensive and dynamic program designed to provide students with a deep understanding of the fundamental principles of Zoology, along with the practical skills required to apply this knowledge in various scientific and technological contexts. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, and holistic development. The BSc Zoology program spans four years, with each year offering a progressively advanced curriculum designed to build a strong foundation in Zoology while allowing for specialization and interdisciplinary learning. The curriculum is structured around several key components:

1. Major Courses: These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential Zoology concepts, theories, and methodologies. Students will engage with topics ranging from classical mechanics, electromagnetism, and thermodynamics to quantum Zoology, relativity, and modern Zoology, ensuring a robust and comprehensive education in the discipline.

2. Minor Courses: Students have the opportunity to choose minor courses from related or distinct disciplines, promoting an interdisciplinary approach to learning. This flexibility allows students to complement their Zoology education with insights from fields such as mathematics, computer science, or engineering, enhancing their versatility and broadening their career prospects.

3. Open Electives/General Electives: The program encourages intellectual exploration beyond the core discipline by offering a wide range of elective courses. These electives enable students to pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.

4**. Vocational and Skill Enhancement Courses:** Practical skills and technical proficiency are integral to the program, with vocational and skill enhancement courses providing hands-on experience in areas such as computational Zoology, electronics, and instrumentation. These courses are designed to prepare students for immediate employment and equip them with the tools necessary for career advancement in various scientific and technological fields.

5. **Ability Enhancement Courses (AEC):** Indian Knowledge System (IKS), and Value Education Courses (VEC):In alignment with NEP 2020, the program integrates courses that emphasize the Indian Knowledge System, ethical values, and life skills. These courses foster a deep appreciation for India's rich cultural heritage, while also developing essential communication and ethical decision-making skills that are vital for personal and professional growth.

6. Field Projects/Internships/Apprenticeships/Community Engagement Projects/On-Job Training: To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for field projects, internships, apprenticeships, and community engagement. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in Zoology and related fields.

7. Research Methodology and Research Projects: Research is a critical component of the BSc Zoology

program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in Punyashlok Ahilyadevi Holkar Solapur University, Solapur Faculty of Science & Technology Nep 2020 Compliant Curriculum B. Sc. (Zoology) Program Preamble independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

Multiple Entry and Multiple Exit Options

In accordance with the NEP 2020, the BSc Zoology program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- **Year1:** Upon completion of the first year, students may exit with a Certificate in Zoology.
- **Year2:** After two years, students may choose to exit with a Diploma in Zoology.
- **Year3:** Completion of the third year qualifies students for a BSc Degree in Zoology.
- **Year4:** The fourth year offers an advanced curriculum with a focus on research, allowing students to graduate with an Honors Degree in Zoology.

Eligibility for B.Sc. III Zoology: The candidate passed the B.Sc. Part II course OR having ATKT or Repeater student and the candidate who passed B.Sc. I will be eligible to take admission

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 "B++" Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Faculty of Science & Technology** **NEP 2020 Compliant Curriculum** **B.Sc. (Zoology)** **Program Outcomes (PO)**

Program Outcomes (POs) – Bachelor of Science in Zoology
Students graduating from the Bachelor of Science in Zoology program will be able to:
Major Courses

- **PO1:** Demonstrate in-depth knowledge and understanding of core concepts, theories, and methodologies in Zoology, including animal diversity, physiology, ecology, genetics, and evolutionary biology.
- **PO2:** Apply zoological knowledge to solve complex biological problems, analyze experimental data, and make informed decisions in academic, professional, and research contexts.

Minor Courses

- **PO3:** Acquire complementary knowledge and skills from related or distinct disciplines (e.g., Botany, Environmental Science, Biochemistry), enhancing interdisciplinary understanding and versatility in biological sciences.

Open Electives / General Electives

- **PO4:** Explore diverse subjects beyond Zoology, fostering a broad-based education and cultivating critical thinking, creativity, and holistic scientific perspectives.

Vocational and Skill Enhancement Courses (SEC/VSC)

- **PO5:** Gain hands-on experience and technical proficiency in laboratory techniques, fieldwork, biodiversity documentation, and applied zoological practices, preparing for immediate career opportunities.

Ability Enhancement Courses (AEC), Indian Knowledge System (IKS), and Value Education Courses (VEC)

- **PO6:** Understand and appreciate the rich heritage of the Indian Knowledge System, including traditional ecological knowledge and conservation practices, integrating them with modern zoological education.
- **PO7:** Develop communication skills, life skills, ethical values, social responsibility, and a strong sense of citizenship, contributing positively to society and environmental sustainability.

Field Projects / Internship / Apprenticeship / Community Engagement / On-Job Training

- **PO8:** Apply theoretical zoological knowledge to real-world situations through field projects, internships, wildlife surveys, conservation initiatives, and community engagement, gaining practical experience and problem-solving skills.

Research Methodology and Research Project

- **PO9:** Acquire research skills in Zoology, including data collection, statistical analysis, and scientific interpretation, fostering a research-oriented approach to problem-solving and developing independent project-handling capabilities.

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Students graduating from BSc(Zoology)will able to :

PSO1: Mastery of Core Zoology Concepts: Techniques and Methodologies discussed in the vital topics like Cell Biology, Genetics, Molecular Biology manifest the knowledge in research specific areas and studies by protection of endangered species, Wildlife Management, Climatic changes and Global Management are discussed as a paper to improvise the subject knowledge for identifying any problems related and in helping the impacted environment and biodiversity. **PSO2: Experimental and Analytical Skills:** demonstrate proficiency in designing and conducting experiments, using modern laboratory equipment, and employing analytical techniques to interpret and present scientific data effectively.

PSO3: Application of Zoology in Technology and Research: Exhibit Skills in areas related to their individual specialization like genetic engineering, biotechnology, bioinformatics in relation to current developments and related fields in the domain; helps to apply the knowledge of internal structure of cell, its functions in control of various metabolic functions of organisms.

PSO4: Demonstrated Understanding of Animal Diversity: • Knowledge of scientific classification and evolutionary relationships of major animal groups. • Appreciation of the breadth of animal diversity.

PSO5: Structure-Function Relationships: • Recognized how structure relates to function across different biological levels (molecules, cells, organs, organisms, populations, species) for major animal groups.

PSO6: Applied Biological Sciences and Career Opportunities: Familiarity with applied zoology fields (e.g., sericulture, apiculture, aquaculture, industrial microbiology, DNA technology, medicine) and their career prospects

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below.

For B.Sc. Part-III Zoology Semester V & VI the internal assessment will be based on Internal tests, Home assignment, Tutorials, Seminars, Group discussion, Brain storming sessions etc. as given below.

Scheme of Evaluation As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment of Theory 30 marks and external evaluation (University assessment)of 45 marks.

- **Semester V** –
  No. of theory papers: DSC- 1-7, DSC-1-8 and DSC-9 (UA- 45 (T) marks each and 30(P) marks each).

(a) Internal test-Home assignment/tutorials/seminars/viva/group discussion/ outreach programs. Internal Continuous Assessment:(30marks):

(b)Internal practical test-Scheme of marking:20marks

- Internal Continuous Assessment:(30 marks and 20 (P)marks each for Three papers)

DSE- UA- 30 marks Practical – 15 Marks CA- 20 and 10 (P)

(c)Internal test-Home assignment/tutorials/seminars/viva/group discussion/outreach programs.

(d) Internal test-Home assignment/tutorials/seminars/viva/group discussion/ outreach programs. Internal Continuous Assessment:(20marks):

(e) Internal practical test-Scheme of marking:10marks

Semester – VI –

No. of theory papers: DSC- 1-10, DSC-1-11 and DSC-1-12 (UA- 45 (T) marks each and 30(P) mark each).

(f) Internal test-Home assignment/tutorials/seminars/viva/group discussion/ outreach programs. Internal Continuous Assessment:(30marks):

(g) (a)Internal practical test-Scheme of marking:20marks

DSE- UA- 30 Practical – 15 Marks CA- 20 (T)and 10 (P)

(h) Internal test-Home assignment/tutorials/seminars/viva/group discussion/outreach programs.

(i) Internal test-Home assignment/tutorials/seminars/viva/group discussion/ outreach programs. Internal Continuous Assessment:(20marks):

(j) (a)Internal practical test-Scheme of marking:10marks

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Three Majors in First Year structure as per NEP-2020 Approved in For AC Meeting on 18/04/2024

4- Year Multidisciplinary UG Program with DSC as a Major (4 -Year Bachelor of Science (Honors)/(Honors with Research)

Level/ Difficulty	Sem.	Faculty			Generic/ Open Elective GE/ OE	Vocational and Skill Enhancement Courses (SEC/VSC)	Ability Enhancement Course (AEC), IKS, VEC	Field Project/ RP/CC/Internship/Apprenticeship/ Community Engagement & Services	Credits	Cumulative Credits
		Major		Minor						
		DSC	DSE							
4.5 100-200	I	DSC1-1 (2+2)# DSC2-1 (2+2)# DSC3-1 (2+2)#	-- -- --		GE1/ OE1(2)	SEC1 (2)	L1-1(2) IKS (2) VEC1(2) (Indian Constitution And Democracy)	--	22	**44 UG Certificate (44)**
	II	DSC1-2 (2+2)# DSC2-2 (2+2)# DSC3-2 (2+2)#	-- -- --		GE2/ OE2(2)	SEC 2 (2)	L1-2(2) VEC2(2) (Environmental Studies)	CC1 (2)	22	
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										
5.0/200	III	DSC1-3 (2+1) DSC1-4 (2+1)	--- ---	DSC2-3 (2+1) DSC-2-4 (2+1)	GE3 / OE3(2)	VSC1 (2) (DSC1) VSC2(2) (DSC2)	L2-1 (2)	CC2 (2)	22	**44 UG Diploma (88)**
	IV	DSC1-5 (2+1) DSC1-6 (2+1)	--- --	DSC2-5 (2+1) DSC2-6 (2+1)	GE4/ OE4 (2)	VSC3 (2) (DSC1) VSC4(2) (DSC2)	L2 -2(2)	FP1/CEP1(2)	22	
Exit option: Award of UG Diploma in Major with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major										
5.5/300	V	DSC1-7 (3+2) DSC1-8 (3+2) DSC1-9 (3+2)	DSE1-1 (2+1) or DSE1-2 (2+1)	----	----	VSC3 (2) (Hands on Training related to DSE)	IKS 2 (2) (related to major subject)	--	22	**44 UG degree (132)**
	VI	DSC1-10 (3+2) DSC1-11 (3+2) DSC1-12 (3+2)	DSE1-3 (2+1) or DSE1-4 (2+1)	----	---	VSC4 (2) (Hands on Training related to DSE)		FP2/CEP2/OJT1 (2)	22	
	Total Credits 3 Yrs	**66-8#**	**6**	**12 +8# 20**	**08**	**16**	**16**	**08**	**132**	
Exit option: Award of UG degree in Major with 132 Credits OR Continue with Major										
6.0/400	VII	DSC1-13 (4+2) DSC1-14 (4+2)	DSE1-5 (4+2)	Research Methodology (4)	------	----	----	---	22	**44 UG Honours Degree in Main faculty (176)**
	VIII	DSC1-15 (4+2) DSC1-16 (4+2)	DSE1-6 (4+2)		----	-----	----	OJT/In-house Project/ Internship/ Apprenticeship (4)	22	
	Total 4 Yrs	**90-8#**	**18**	**16+8#**	**08**	**16**	**16**	**12**	**176**	
Award of Bachelor of Science Honors., (B.Sc. Honors.) degree with Major and Minor (176 credits)										

		OR								
6.0/400	VII	DSC1-13 (4) DSC1-14 (4)	DSE1-5 (4)	Research Methodology (4)	------	----	----	Research Project (6)	22	**44 UG Honours with research Degree in Main faculty (176)**
	VIII	DSC1-15 (4+2) DSC1-16 (4+2)	DSE1-6 (4)		----	-----	----	Research Project (6)	22	
	Total 4 Yrs	**86-8#**	**14**	**16+8#**	**08**	**16**	**16**	**20**	**176**	

#Out of the three major courses in the first year, one major (comprising 4 credits for the 1st semester and 4 credits for the 2nd semester) will transition into a minor starting from the second year. Consequently, 8 credits will be reallocated from the major course credit count and added to the minor credit count, thereby meeting the requisite credit criteria for the minor as stipulated in the guidelines.

B.Sc. Part- III Zoology NEP 2020 Structure w.e.f. June- 2026

SEM	Faculty		GE/ OE	VSC	IKS	Field Project	Credits
	DSC	DSE					
V	DSC1-7 (3+2) **Molecular Biology and Genetics** (45 Period) **G04-DSC1-0510** **Zoology- VII** DSC1-8 (3+2) **Evolutionary Biology and Zoogeography** (45 Period) **G04-DSC1-0511** **Zoology-VIII** DSC1-9 (3+2) **Conservation Biology and wild life** (45 Period) **G04-DSC1-0512** **Zoology-IX**	DSE1-1 (2+1) **Biostatistics** (30 Period) **G04-DSE1-504** Or DSE1-2 (2+1) **Bioinformatics** (30 Periods) **G04-DSE2-504** **Or** DSE1-3 (2+1) **Cyber security**	---	VSC 3 (2) (Hands on Training related to DSE) **Biological Data Analysis** **G04-VSC-504**	IKS 2 (2) (related to major subject) **Animals in Indian Mythology and Culture** **G04-IKS-504**	---	22
VI	DSC1-10 (3+2) **Biorhythm and Behavioral ecology** (45 Period) **G04-DSC1-0610** **Zoology-X** DSC1-11 (3+2) **Developmental Biology** (45 Period) **G04-DSC1-0611** **Zoology-XI** DSC1-12 (3+2) **Comparative anatomy of chordate** (45 Period) **G04-DSC1-0612** **Zoology-XII**	DSE1-3 (2+1) **Introduction to Research Methodology** (30 Period) **G04-DSE3-604** Or DSE1-4 (2+1) **Economic Zoology** (30 Period) **G04-DSE3-604**	---	VSC-4 (Hands on Training related to DSE) **Communication in Science** **G04-VSC-604**	---	FP2/CEP2/ OJT1 (2)	22

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

B.Sc. Part- III Subject: Zoology

[According to NEP 2020 W.E.F. June 2026]

Sem.	Paper With paper code	Title of Paper	Credits		Marks			
			T	PR	T-CA	PR-CA	T-UA	PR-UA
V	DSC 1-7 **(G04-DSC1-0510)**	Molecular Biology and Genetics	3	2	30	20	45	30
	DSC 1-8 **(G04-DSC1-0511)**	Evolutionary Biology and Zoogeography	3	2	30	20	45	30
	DSC 1-9 **(G04-DSC1-0512)**	Conservation Biology and wild life	3	2	30	20	45	30
	DSE 1-1 A **G04-DSE1-504**	Biostatistics	2	1	20	10	30	15
	DSE 1-1 B **G04-DSE1-0504**	Bioinformatics	2	1	20	10	30	15
	DSE 1-1 C **G04-DSE1-0504**	Cyber security	2	1	20	10	30	15
	VSC -5 **G04-VSC-504**	Hands on training related to DSE Biological Data Analysis	---	2	--	20	--	30
	IKS 2 **G04-IKS-0504**	Animals in Indian Mythology and Culture	2	---	20	---	30	---
VI	DSC 1-10 **(G04-DSC1-0610)**	Biorhythm and Behavioral ecology	3	2	30	20	45	30
	DSC 1-11 **(G04-DSC1-0611)**	Developmental Biology	3	2	30	20	45	30
	DSC 1-12 **(G04-DSC1-0612)**	Comparative anatomy of chordate	3	2	30	20	45	30
	DSE 1-3 A **(G04-DSE3-0604)**	Introduction to Research Methodology	2	1	20	10	30	15
	DSE 1-4 B **(G04-DSE4-0604)**	Economic Zoology	2	1	20	10	30	15
	VSC 6 **(G04-VSC6-0604)**	(Hands onTraining related to DSE) Communication in Science	---	2	--	20	--	30
	FP2/CEP2/OJT1	FP2/CEP2/OJT1	---	2	--	20	--	30

SEMESTER- V

DSC1-7 (Molecular Biology and Genetics)

Paper code- G04-DSC1-0510 Zoology-VII

Credits: 3+2 **Lectures: 45**

Course Preamble
Course preamble: Comprehensive disciplinary understanding of scientific concepts and methods; Critical thinking, creativity and problem-solving skills applicable to real-world challenges; Interdisciplinary exposure beyond the core subject to broaden perspectives; Ethical, human and constitutional values that foster responsible and socially aware citizens; Practical skills, research orientation, and lifelong learning mindset essential for careers, entrepreneurship and higher studies.

Course Objectives

1. Provide advanced knowledge of core sciences.
2. Build critical thinking, analysis, and problem-solving skills.
3. Emphasize experiential learning through labs, fieldwork, and projects.
4. Encourage interdisciplinary and real-life applications.
5. Develop practical, technical, and employability skills.
6. Inculcate ethics, environmental awareness, and social responsibility.
7. Promote lifelong learning, adaptability, and digital literacy.
8. Integrate Indian knowledge systems with modern science.

Course Outcomes

After completion of the course students will be able to

1 CO1. Demonstrate advanced conceptual understanding of the core scientific discipline and apply theoretical knowledge to explain biological/physical/chemical phenomena.

CO2. Analyze scientific problems using critical thinking, logical reasoning, and quantitative skills, and propose appropriate solutions.

CO3. Perform laboratory experiments and field-based activities proficiently by applying standard techniques, safety practices, and data interpretation methods.

CO4. Apply interdisciplinary knowledge to relate concepts across different branches of science and real-life situations.

CO5. Design, execute, and present basic research or project work, demonstrating scientific writing, data analysis, and presentation skills.

Unit	Contents	Lectures
I	**DNA Structure, Replication and Repair**	**7**
L	1.1 Structure of DNA (Watson–Crick model) 1.2 Types of DNA (A, B and Z DNA) 1.3 DNA denaturation and renaturation 1.4 DNA replication: Semi-conservative model, Enzymes involved in replication in prokaryotes and eukaryotes 1.5 DNA damage and repair mechanisms	
II	**Transcription, Translation and Regulation of Gene Expression**	**8**
	2.1 RNA types: mRNA, tRNA, rRNA 2.2 Transcription: Mechanism, Transcription in prokaryotes and eukaryotes 2.3 RNA processing (5′ capping, poly-A tailing, splicing); 2.4 Genetic code: Features and deciphering, 2.5 **Translation:** Activation of amino acids, Initiation, elongation and termination of protein synthesis. 2.6 Regulation of gene expression: Operon concept, Lac operon.	
III	**Recombinant DNA Technology and Applications**	**8**
	3.1 Restriction endonucleases and DNA ligase 3.2 Cloning vectors (plasmids and bacteriophages) 3.3 Steps in recombinant DNA technology 3.4 Polymerase Chain Reaction (PCR) 3.5 DNA sequencing (Sanger method – basic principles) 3.6 Agarose Gel Electrophoresis: Principle, preparation, loading of samples and visualization of DNA bands 3.7 Blotting techniques: Southern blotting Applications of molecular biology: Medical diagnostics, Forensic science, Agriculture and biotechnology	
IV	**Mendelian and Post-Mendelian Genetics**	**7**
	4.1 Introduction and scope of Genetics 4.2 Mendel's experiments and laws of inheritance 4.3 Monohybrid and dihybrid crosses 4.4 Incomplete dominance and co- dominance 4.5 Multiple alleles (ABO blood group system) 4.6 Lethal genes	
V	**Linkage and crossing over, Chromosomal Basis of Inheritance**	**7**
	5.1 Concept and types of linkage 5.2 Crossing over: mechanism and significance 5.3 Chromosomal theory of inheritance 5.4 Sex determination mechanisms (XX–XY, XX–XO, ZW–ZZ) 5.5 Sex-linked inheritance (haemophilia, colour blindness) 5.6 Structural and numerical chromosomal aberrations Mutations: mutagens, gene mutation and chromosomal mutation	
VI	**Human Genetics**	**8**
	6.1 Human karyotype and chromosomal disorders: Down syndrome, Turner syndrome, Klinefelter syndrome. 6.2, Pedigree analysis. 6.3 Genetic counselling.	

	6.4 Basics of Eugenics and Euphenics.

References list:

1. Molecular Biology of the Gene – Watson et al., 7th Edition, 2014, Pearson
2. Molecular Biology – Robert F. Weaver, 5th Edition, 2012, McGraw-Hill
3. Genes – Benjamin Lewin, 10th Edition, 2011, Jones & Bartlett
4. Principles of Gene Manipulation and Genomics – Old & Primrose, 7th Edition, 2003, Blackwell Science
5. Molecular Cell Biology – Lodish et al., 7th Edition, 2013, W.H. Freeman
6. Essential Molecular Biology – David Freifelder, 4th Edition, 2004, Narosa Publishing
7. Genetics – M. W. Strickberger, Macmillan Publishing Co., 1996
8.Principles of Genetics – E. J. Gardner, M. J. Simmons & D. P. Snustad, John Wiley & Sons, 2004
9. Concepts of Genetics – W. S. Klug, M. R. Cummings et al., Pearson Education, 2012
10. Genetics: A Conceptual Approach – B. A. Pierce, W.H. Freeman, 2014
11. Genetics – P. S. Verma & V. K. Agarwal, S. Chand & Company, 2010

DSC1-7 (Molecular Biology and Genetics)
Paper code- G04-DSC1-0510-P Zoology-VII-Practical Lab-VII

Course Preamble
1. Molecular Biology and Genetics are central to understanding life at the molecular level. 2. Practical experiments provide hands-on exposure to DNA, RNA, and protein studies. 3. Laboratory work connects theoretical concepts with real-world applications. 4. Genetic experiments illustrate inheritance, variation, and molecular mechanisms. 5. The course nurtures precision, analytical skills, and ethical scientific practice.

Course Objectives
1. To impart knowledge of molecular and genetic principles through practical work. 2. To train students in core techniques such as DNA isolation, PCR, and electrophoresis. 3. To develop analytical and problem-solving skills in interpreting genetic data. 4. To encourage application of molecular biology in biotechnology, medicine, and agriculture. 5. To foster scientific curiosity, research aptitude, and responsible laboratory conduct.

Course Outcomes After completion of the course students will be able to
1. Students will acquire proficiency in molecular biology techniques. 2. They will understand genetic principles and apply them experimentally. 3. They will be able to analyze and interpret molecular and genetic data accurately. 4. They will gain skills relevant to biotechnology, diagnostics, and research careers. 5. They will emerge as scientifically responsible graduates with problem-solving ability

Contents
1. Laboratory Techniques and Instrumentations, Laboratory safety rules and biosafety precautions: Principle, use and care of: micropipette, centrifuge, visible spectrophotometer. 2. Preparation of Solutions (percentage solutions) and Buffers (Tris / Phosphate) 3. Isolation of Genomic DNA 4. Quantitative Estimation of DNA 5. Agarose Gel Electrophoresis: Principle, preparation, loading of samples and visualization of DNA bands (demonstration) 6. Mendelian Crosses - monohybrid and dihybrid cross 7. Problems on Gene Interaction based on: incomplete dominance, co dominance, epitasis (dominant / recessive / complementary) 8. Problems on linkage and crossing over 9. Study of human karyotype and chromosomal disorders: Down syndrome, Turner syndrome and Klinefelter syndrome 10. Problem based on pedigree analysis. (Any two). 11. Visit to biotechnology laboratory/ genetics laboratory and submit the report at the time of practical examination.

Reference Books

- Kumar, P. (2024). *Biophysics and Molecular Biology: Tools and Techniques*, 5th Edition. IFAS Publications. – Practical focus on instrumentation and experimental design.
- atson, J.D., et al. (2014). *Molecular Biology of the Gene*, 7th Edition. Pearson. – Classic reference covering DNA, RNA, and protein techniques.
- Karp, G. (2019). *Cell and Molecular Biology: Concepts and Experiments*, 9th Edition. Wiley. – Strong integration of experimental methods with molecular concepts.
- Lewin, B. (2011). *Genes XI*. Jones & Bartlett Learning. – Detailed coverage of genetic principles and molecular mechanisms.

DSC1-8: (Evolutionary Biology and Zoogeography)
Paper Code- G04-DSC1-0511 Zoology-VIII

Credits: 3+2 **Lectures: 45**

Course Preamble
Evolutionary Biology and Zoogeography form the foundation for understanding the origin, diversification, and distribution of animal life on Earth. This course integrates classical and modern concepts of evolution with principles of zoogeography to explain patterns of biodiversity, speciation, adaptation, and biogeographical distribution of fauna across different regions of the world. Emphasis is placed on evolutionary mechanisms, fossil evidence, molecular evolution, and the influence of geological and climatic factors on animal distribution. The course provides students with conceptual clarity essential for advanced studies in zoology, ecology, conservation biology, and related life science disciplines.

Course Objectives
. After completion of this course, students will be able to: 1. Understand the fundamental principles and mechanisms of evolution. 2. Explain classical and modern theories of evolution with supporting evidences. 3. Analyze evolutionary relationships using morphological, fossil, and molecular data. 4. Understand the principles of zoogeography and factors influencing animal distribution. 5. Study zoogeographical regions, faunal assemblages, and patterns of endemism. 6. Correlate evolution and zoogeography with biodiversity conservation strategies.

Course Outcomes After completion of the course students will be able to
1.Explain origin of life and major evolutionary theories (Lamarckism, Darwinism, Neo-Darwinism). 2.Interpret evidences of evolution (fossils, anatomy, embryology, molecular biology). 3.Analyze mechanisms of evolution (mutation, selection, drift, speciation). 4.Understand principles of zoogeography and factors affecting distribution. 5.Identify zoogeographical realms and their characteristic fauna.

	Section – I Evolutionary Biology	
Unit	**Contents**	**Lectures**
I	**Origin and Evolution of Life**	**7**
	1.1 Life Beginnings: Chemogeny, RNA world, organic evolution, Evolution of eukaryotes. 1.2 Historical Evolutionary Concepts: Lamarckism, Darwinism, Neo-Darwinism	
II	**Evidence, Mechanisms, and Patterns of Evolution**	**8**
	2.1 Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, **2.2** Molecular evolution: - properties of Genetic code and importance of protein synthesis in evolution.	

	2.3 Sources of Variation: Heritable variations and their role in evolution Microevolution and macroevolution: mechanism of macroevolution, patterns of macroevolution.	
III.	**Population Genetics and Evolutionary Mechanisms**	**7**
	3.1 Population Genetics: Hardy-Weinberg Law, application of law to human Population. 3.2 Evolutionary forces that upset H-W equilibrium. 3.3 Speciation -allopatric, sympatric & parapatric. 3.4 Genetic Drift: Mechanism, founder effect, bottleneck phenomenon; 3.5 Extinctions: Back ground and mass extinctions: causes and effects K-T extinction. 3.6 Adaptive radiations- Darvin finches Homologous organs and analogus organs.	
	Section – II Zoogeography	
I	**Zoogeography: Principles and Patterns of Animal Distribution**	**8**
	4.1 Principles of Zoogeography: -Definition, scope, and history of zoogeography 4.2 Factors affecting animal distribution: Geological, Climatic, Ecological, Endemism, Continental drift and plate tectonics, Island biogeography (basic concept)	
II	Zoogeography and Biogeography: Patterns, Processes, and Conservation	**7**
	5.1 **Zoogeographical regions**-Palearctic, Nearctic, Neotropical, Oriental, Australian and Ethiopian regions - their Climatic and faunal peculiarities 5.2 Significance of Wallace line, Discontinuous distribution; continental drift and species distribution. 5.3 **Island Biogeography:** Patterns in Species Richness with examples. 5.4 Conservation Biogeography: Biogeography and the geography of extinction, conservation biogeography.	
III	Biogeographic Zones of India: Diversity and Conservation	**8**
	6.1 Biogeographic Zones of India: Introduction and basis of classification (Geographic gradients of height, isolation, latitude and habitat area). • Trans-Himalayan, Himalayan zones & North East: unique species with examples, threats and conservation. • Indian Desert and Semi-arid Region: unique species with examples, threats and conservation. • Western Ghats, Deccan Plateau, Gangetic Plain and coastal region, Andaman and Nicobar	

Reference Books :

1) Biogeography, 3rd edition. 2006. Mark V. Lomolino, Brett R. Riddle, and James H. Brown.
2) Futuyama, D. J. (1986). Evolution, Systematics and Animal Behaviour. Evolutionary Biology. Sinauer Associates Inc.
2. Strickberger, M. W. (2007). Evolution. CBS Pub.
3) Colbert, E. H.; Morales, M. &Minkoff, E. I. (2001). Evolution of the Vertebrates, Science. 4. Moody, P. A. (2002).
4) Dobzhansky, T.; Ayala, F. J.; Stebbins G. L. and Valentine, J. W. (1979). Evolution, Surjeet Pub.
5) Mayr, E. &Ashlock, P. D. (1991) Principles of Systematic Zoology (2nd edition) McGraw Hill Int.
6) Simpson, G. G. (1962) Principles of Animal Taxonomy, Oxford IBH.
7) Darlington, P. J. (1966) Zoogeography (4th edition) John Wiley.
8) organic evolution Saras publication

DSC1-8: (Evolutionary Biology and Zoogeography)
Paper Code- G04-DSC1-0511- P Zoology-VIII

Course Preamble
The practical course in *Evolutionary Biology and Zoogeography* is designed to provide students with experiential learning that connects theoretical concepts with real-world evidence. Through laboratory work, field observations, and analytical exercises, learners explore the origin, diversification, and distribution of life forms across time and space. Fossil studies, genetic variation analysis, and biogeographic mapping help students understand evolutionary forces and species distribution patterns. The course emphasizes scientific reasoning, critical observation, and ethical responsibility, while fostering awareness of biodiversity conservation and ecological balance. By integrating evolutionary principles with zoogeographic insights, students gain a holistic understanding of life's history and its relevance to contemporary challenges.

Course Objectives
1. To impart practical knowledge of evolutionary principles and biogeographic concepts. **2.** To train students in analyzing fossil records, genetic variation, and species distribution. **3.** To develop skills in interpreting evolutionary forces such as selection, drift, migration, and speciation. **4.** To encourage application of biogeographic knowledge in biodiversity conservation and ecological studies. **5.** To foster scientific curiosity, analytical ability, and ethical responsibility in evolutionary research.

Course Outcomes After completion of the course students will be able to
1. Students will gain practical proficiency in studying evolutionary processes and biogeographic zones. 2. They will understand the role of genetic variation, natural selection, and speciation in shaping biodiversity. 3. They will be able to analyze species distribution patterns and interpret biogeographic regions. 4. They will develop skills relevant to biodiversity conservation, ecological management, and research careers. 5. They will emerge as competent graduates with scientific temper, problem-solving ability, and awareness of global biodiversity challenges.

Contents
1. Study of types of fossils using samples available in Zoology and Geology Lab./or models (for eg. Limulus, Peripatus, Dipnoi, Sphenodon, *Archaeopteryx*, examples based on: Molluscan, Echinoderms, Brachiopods and as available in laboratory). 2. Study of Zoogeographical Regions of world to understand the concept of speciation with examples. 3. Study of biogeographic zones of India to study evolutionary variation and adaptation in species with examples. 4. Study of macroevolution using Darwin‘s Finches using charts/models. 5. Study of homologous organs from suitable specimens/models in the museum . 6. Study of analogous organs from suitable specimens/ models in the museum. 7. Study of adaptive radiation in mammals from museum specimens/models. 8. Examples based on Hardy Weinberg Law (04 examples) 9. Construction of phylogenetic tree using bioinformatic tools/software (Searching sequences of any five genes or proteins using biological databased (NCBI, GenBank or DDBJ, construct phylogenetic tree using Clustal X, Phylip, NJ & submit the report). 10. Visit to museum for study of fossils/ review article/ Bioinformatic lab. (Submit the visit report at the time practical examinations).

Reference Books :

1. Choudhary, K., & Saran, R.P. (2026). Evolution and Animal Behaviour: Complete Reference Textbook. IFAS Publications.
2. SIA Publishers (2026). Ecology, Zoogeography & Evolution (Zoology Paper-VI B.Sc. III Year).
3. Verma, P.S., & Agarwal, V.K. (2019). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Publications.
4. Kotpal, R.L. (2018). Modern Textbook of Zoology: Vertebrates. Rastogi Publications.
5. Arora, M.P. (2017). Practical Zoology. Himalaya Publishing House
6. Futuyma, D.J. (2017). *Evolution*, 4th Edition. Sinauer Associates. – Internationally acclaimed text
7. Ridley, M. (2004). *Evolution*, 3rd Edition. Blackwell Publishing.
8. Mayr, E. (2001). *What Evolution Is*. Basic Books

DSC 1-9: Zoology-IX (Conservation Biology and Wildlife)
Paper code - G04-DSC1-0512 Zoology-IX

Credits: 3+2 **Lectures: 45**

Course Preamble
Conservation Biology and Wildlife is an interdisciplinary field that integrates ecology, genetics, environmental science, and ethical principles to safeguard biodiversity and natural ecosystems. The course emphasizes understanding threats to biodiversity, strategies for conservation, restoration ecology, and wildlife management practices. It prepares students to critically analyze conservation challenges and apply scientific approaches to protect species, habitats, and ecological processes.

Course Objectives
1. Provide foundational knowledge of conservation biology, its history, principles, and ethical dimensions. 2. Examine threats to biodiversity, including extinction drivers, habitat degradation, and global conservation challenges. 3. Explore conservation genetics and its role in maintaining viable populations. 4. Introduce restoration ecology and wildlife conservation approaches at ecosystem, population, and landscape levels. 5. Develop practical skills in wildlife monitoring, habitat management, and conflict mitigation using modern tools.

Course Outcomes After completion of the course students will be able to
1. **Explain** the principles, scope, and ethical foundations of conservation biology. 2. **Analyze** biodiversity threats and extinction patterns using ecological and biogeographical models. 3. **Apply** genetic and ecological concepts to conservation practices such as captive breeding, reintroduction, and habitat restoration. 4. **Evaluate** conservation strategies at ecosystem, population, and landscape levels, including protected area management. 5. **Demonstrate** practical knowledge of wildlife monitoring techniques, habitat management, and use of technology in conservation.

Unit	Contents	Lectures
I	**Introduction to Conservation Biology**	**7**
	1.1 Introduction, History, and Evolution of Conservation Biology 1.2 Principles of Conservation Biology 1.3 Origin of Conservation Biology (Case study: Sea turtles as an interdisciplinary approach) 1.4 Ethical Principles in Conservation Biology 1.5 Scope of Conservation Biology	
II	**Threats to Biodiversity: Extinctions and Habitat Degradation**	**8**
	2.1 Extinction of Biodiversity 2.2 Patterns of Extinction- Background extinction, Mass extinction. Causes of extinction. 2.3 Estimating Extinction Rates: Island Biogeography Model 2.4 Vulnerability to Extinction (Endemic species, rarity, causes, classifications) 2.5 IUCN Red List of Threatened Species (Goals, categories, criteria, limitations)	
III	**Conservation Genetics**	**8**
	3.1 Importance of Genetic Diversity 3.2 Genetic Variations (individual, population, metapopulation levels) 3.3 Conservation Genetics Applications (forensics, taxonomy, captive breeding, reintroduction) 3.4 a)Positive Factors Affecting Genetic Diversity (mutation, heterozygosity, natural selection, Effective population size (Ne), outbreeding) b) Negative Factors Affecting Genetic Diversity (bottleneck, founder effects, drift, homozygosity, inbreeding depression)	
IV	**Restoration of Biodiversity**	**7**
	4.1 Principles of Restoration Ecology: Concepts and Principles 4.2 Restoration of Degraded Wildlife Populations (rescue, rehabilitation, animal hospitals) 4.3 In-situ Restoration (e.g., relocation of human settlements) 4.4 Reintroduction and Translocation (definition, process, types, Nepalese case studies) 4.5 Restoration of Degraded Habitats/Ecosystems (enhancement, replacement, rehabilitation, restoration)	
V	**Wildlife: Approaches and Application of Conservation**	**8**
	5.1 Approaches Against Conservation Problems 5.2 Ecosystem-Level Approaches (Protected Areas, conservation outside PAs, resilience of ecosystems) 5.3 Population and Landscape-Level Approaches (metapopulation, source-sink, viability assessment) 5.4 Wildlife Monitoring Techniques and Their Applications 5.5 Species Diversity Estimation and Niche Modeling	
VI	**Wildlife Conservation and Habitat Management**	**7**

	6.1 Habitat Management (mapping, suitability analysis, grassland management, invasive control, waterholes) 6.2 Translocation, Conservation Breeding, Surplus Hunting, and Culling Disaster Management and Human Dimensions of Wildlife Management (Technology for conflict mitigation, drones, surveillance tools).

Reference Books:

1. Hunter Jr, M. L., & Gibbs, J. P. (2006). Fundamentals of conservation biology. John Wiley & Sons.
2. Caughley, G., & Gunn, A. (1996). Conservation biology in theory and practice. Cambridge, Mass., Blackwell Science.
3. Fiedler, P.L. & Jain, S.K. (1992). Conservation Biology: Theory and Practice of Conservation, Preservation and Management. Chapman and Hall, New York.
4. Hudson, W. E. (Ed.). (1991). Landscape linkages and biodiversity. Island Press
5. Silvy, N. J. (2012). The Wildlife Techniques Manual (7th Edition). Vol 1. & 2. The Johns Hopkins University Press. Baltimore,
6. Coetzee, K. (2016). Practical Techniques for Habitat & Wildlife Management: A Guide for Game Ranches, Conservation Areas and Farmland. New Voices Publishing Services.
7. Krausman, P.R. & Cain, J.W. (eds) (2013). Wildlife management and conservation: contemporary principles and practices. JHU Press
8. Shaw, J. H. (1985). Introduction to Wildlife Management. McGraw Hill.
9. Magurraan ,A. (2003). Measuring Biological Diversity. Blackwell Publishing Co. London.

DSC 1-9: Zoology-IX (Conservation Biology and Wildlife)
Paper code - G04-DSC1-0512- P Zoology-IX

Course Preamble
The practical course in *Conservation Biology and Wildlife* is designed to provide students with experiential learning that integrates ecological principles with applied conservation practices. Through laboratory exercises, field observations, and data analysis, learners explore biodiversity assessment, species monitoring, habitat evaluation, and conservation strategies. The course emphasizes the importance of wildlife protection, sustainable resource use, and ecological balance. By engaging with real-world conservation challenges, students develop scientific reasoning, ethical responsibility, and practical skills essential for biodiversity management. This training prepares them to contribute meaningfully to conservation research, policy, and community-based initiatives.

Course Objectives
1. To impart practical knowledge of biodiversity assessment and wildlife monitoring techniques. 2. To train students in ecological data collection, analysis, and interpretation for conservation planning. 3. To develop skills in identifying threats to wildlife and ecosystems and proposing mitigation strategies. 4. To encourage application of conservation principles in habitat management and species protection. 5. To foster scientific curiosity, ethical responsibility, and awareness of global and local conservation issues.

Course Outcomes After completion of the course students will be able to
1. Students will gain proficiency in biodiversity assessment and wildlife monitoring methods. 2. They will understand ecological principles underlying conservation biology and apply them in practice. 3. They will be able to analyze conservation challenges and propose evidence-based solutions. 4. They will develop skills relevant to wildlife management, ecological research, and conservation careers. 5. They will emerge as responsible graduates with scientific temper, problem-solving ability, and commitment to biodiversity protection.

Practical
1. Construct questioner to assess major threats of habitat transformation in nearby areas through structured and semi-structured interviews. (Analysis of the data collected through the interview). 2. Conduct a study of faunal diversity (Aves/Insects) from the campus/local area using standardized methods (Line transect, quadrat and sweep netting). 3. Calculate species richness, abundance, and Shannon diversity indices from collected field data. 4. Identify and practice handling equipment used for wildlife population surveys and habitat management (GPS, Compass, binoculars,). 5. Study endangered species of India, their bio-geographic distribution, and conservation status (e.g., Great Indian Bustard, Jerdon's Courser, Lesser Florican, Asian Elephant, Nilgiri Tahr, Lion-tailed Macaque, Nilgiri Langur, Lion, Sarus Crane, Ganges River Dolphin, Hoolock Gibbon). (Use chart/photograph/model/ sketch) 6. Collect and analyze faecal samples (e.g., rabbit, mouse deer, sambar, porcupine, spotted deer), including storage, maintenance of test components, and microscopic examination. 7. Identify animals through pugmarks and prepare casts of pugmarks of common animals using plaster of Paris in and around the campus. 8. Conduct a field study on the biodiversity of Non-chordate / chordate animals within the college campus. **Instructions:** a) Perform **sampling** using appropriate field methods. b) Carry out **in-situ data collection** on species richness/abundance, and habitat details. c) Undertake analysis through identification, classification, and diversity assessment. d) Submit an analysis report at the time of the practical examination.

Reference Books:

- Verma, P.S. & Agarwal, V.K. – *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*
- Kotpal, R.L. – Modern Textbook of Zoology: Vertebrates
- Arora, M.P. – Practical Zoology
- SIA Publishers – Ecology, Zoogeography & Evolution
- Sharma, P.D. – Ecology and Environment
- Primack, R.B. – Essentials of Conservation Biology
- Hunter, M.L. & Gibbs, J.P. – *Fundamentals of Conservation Biology*
- Futuyma, D.J. – Evolution
- Ridley, M. – Evolution
- Brown, J.H. & Lomolino, M.V. – Biogeography
- Sutherland, W.J. – Ecological Census Techniques: A Handbook

DSE1-1A: Biostatistics

Paper Code- G04-DSC1-0504 Zoology-DSE1

Credits: 2+1 **Lectures: 30**

Course Preamble
Biostatistics is a vital discipline that applies statistical methods to the study of biological, medical, and health sciences. It provides tools for designing experiments, analyzing biological data, and interpreting results with scientific rigor. This course equips students with the ability to apply statistical reasoning to real-world biological problems, fostering skills in data collection, hypothesis testing, and decision-making. By integrating theory with practical applications, students will gain competence in using biostatistics for research, public health, and clinical studies.

Course Objectives
The objectives of this course are to: 1. Introduce fundamental concepts of statistics and their applications in biology and health sciences. 2. Develop skills in data collection, organization, and graphical representation. 3. Train students in statistical methods for hypothesis testing and estimation. 4. Apply biostatistical techniques to biological experiments, epidemiological studies, and clinical trials. 5. Enhance analytical and critical thinking abilities for interpreting biological data.

Course Outcomes After completion of the course students will be able to
After successful completion of the course, students will be able to: 1. Explain the role and importance of biostatistics in biological and health sciences. 2. Organize and summarize biological data using descriptive statistics and graphical tools. 3. Apply probability distributions and statistical tests to analyze biological problems. 4. Interpret results of statistical analyses in the context of biological and medical research. 5. Demonstrate the use of biostatistical methods in designing experiments, surveys, and clinical studies..

	Content	Lectures
Unit I	Classification and Tabulation	**7**
Unit II	Frequency distribution & Graphical representation	**8**
Unit III	Measures of Central Tendency - Mean, Median and Mode. Dispersion –Standard Deviation & Standard Error, Student-T-test, ANOVA and Chi square test.	**7**
Unit IV	**Correlation** **a.** Scatter diagram b. Types of correlation & Correlation coefficient. i) Spearman's Rank Correlation Coefficient. ii) Karl Pearson's Correlation Coefficient.	**8**

Reference books

a) Intuitive Biostatistics – Harvey Motulsky Beginner-friendly, focuses on concepts and interpretation rather than heavy math.
b) Biostatistics: A Foundation for Analysis in the Health Sciences – Wayne W. Daniel & Chad L. Cross Classic text, widely used in university courses; balances theory and practice.
c) Fundamentals of Biostatistics – Bernard Rosner Comprehensive and rigorous; suitable for advanced students and researchers.
d) Practical Statistics for Medical Research – Douglas G. Altman Emphasis on real-world medical data analysis; excellent for clinicians and applied researchers.
e) Applied Biostatistics for the Health Sciences – Richard J. Rossi Case-study driven, practical applications in public health and medicine.
f) Biostatistics: A Guide to Design, Analysis, and Discovery – Ronald N. Forthofer, Eun Sul Lee, Mike Hernandez Focuses on study design and applied analysis in biomedical research.
g) Statistical Methods in Biology – Norman T.J. Bailey Classic reference for biological sciences, ecology, and zoology applications.
h) Modern Epidemiology – Kenneth J. Rothman, Sander Greenland, Timothy L. Lash Not purely biostatistics, but essential for statistical methods in epidemiology.
i) Mahajan's Methods in Biostatistics for Medical Students and Research Workers – Yogesh K. Singhal
j) Essentials of Biostatistics and Research Methodology – Indian academic authors (popular in MBBS/PG courses)
k) Statistics in Biology and Psychology – Indian editions widely used in UG courses
l) Textbook of Biostatistics and Research Methodology – Dr. Ankur Agrawal, Rajiv Yadav, Nancy Mathur, Srikanth Kumar Karumanchi, Prashant Chandra (2024 edition)

DSE1-1A: Biostatistics

Paper Code- G04-DSE-1-0504- P- Zoology-DSE1

Course Preamble
Biostatistics is the backbone of biological research, providing the tools to analyze, interpret, and validate experimental data. In practical biostatistics, students learn not only statistical theory but also its direct application to biological problems. This course emphasizes hands-on experience with data collection, statistical testing, and interpretation, enabling learners to transform raw observations into meaningful scientific conclusions. By integrating statistical methods with biological inquiry, students develop critical thinking, precision, and confidence in handling real-world research challenges.

Course Objectives
1. To introduce students to fundamental statistical concepts and their relevance in biological sciences. 2. To train students in designing experiments and collecting reliable biological data. 3. To develop skills in applying statistical tests for hypothesis validation in biological research. 4. To familiarize students with statistical software/tools for data analysis. 5. To cultivate the ability to critically interpret statistical results in the context of biological phenomena.

Course Outcomes After completion of the course students will be able to
1. Apply appropriate statistical methods to analyze biological data. 2. Design and conduct experiments with proper sampling techniques. 3. Use statistical software to process and visualize biological datasets. 4. Interpret statistical results to draw valid biological conclusions. 5. Demonstrate critical thinking and problem-solving skills in biostatistical applications.

Practical
1) Example based on classification (3 examples) **2)** Examples based on tabulation (3 examples) **3)** Examples based on correlation (4 examples) **4**) Calculation of mean, mode & median using given data by using MS-EXCEL **5)** Graphical representation & submission of given data using MS-EXCEL

References Books:

1. Khan, I.A., & Khanum, A. *Fundamentals of Biostatistics*. Ukaaz Publications.
2. Zar, J.H. *Biostatistical Analysis*. Pearson Education.
3. Daniel, W.W. *Biostatistics: A Foundation for Analysis in the Health Sciences*. Wiley.
4. Sokal, R.R., & Rohlf, F.J. *Biometry: The Principles and Practice of Statistics in Biological Research*. W.H. Freeman.
5. Gupta, S.C. *Fundamentals of Statistics*. Himalaya Publishing House.
6. Rangaswamy, R. *A Textbook of Agricultural Statistics*. New Age International Publishers.

DSE1-1B: Bioinformatics

Paper Code- G04-DSE-2-504 Zoology-DSE2

Credits: 2+1 **Lectures: 30**

Course Preamble
This course is designed to introduce students to the fundamental concepts, methods, and tools of bioinformatics. Emphasis is placed on understanding biological databases, sequence analysis, and computational techniques used in genomics and proteomics. Through theoretical concepts and practical exposure to widely used bioinformatics resources, the course prepares students to apply computational approaches to solve biological problems in research and biotechnology.

Course Objectives
a) Encourage understanding of ethical, legal, and social issues associated with biological data and bioinformatics research. b) Develop skills in sequence analysis, including alignment, similarity searches, and theme identification. c) Introduce students to the fundamental principles and scope of bioinformatics and its role in modern biological research.

Course Outcomes After completion of the course students will be able to
1. Understand fundamental concepts of bioinformatics**,** including biological databases, sequence analysis, and computational approaches in molecular biology. **2.** Retrieve, manage, and analyze biological data from public databases such as Gen Bank, UniProt, and PDB. **3.** Apply sequence alignment and similarity search tools (e.g., BLAST, FASTA) to analyze DNA, RNA, and protein sequences. **4.** Interpret bioinformatics results to draw meaningful biological conclusions in genomics and proteomics studies.

Unit	Contents	Lectures
I	**Introductory Concepts**	**7**
	Bioinformatics as an Emerging Discipline, Various definitions of bioinformatics, history of bioinformatics, Applications of Bioinformatics in Various Areas and scope of bioinformatics.	
II	**Biological Databases**	**8**
	Protein Sequence and Structural Databases, Nucleotide Sequence Databases; NCBI, PubMed, Protein Data Bank(PDB), PIR, UniProt, EMBL, GenBank, DDBJ, SRA, Uni Gene.	
III	**Methods of Sequence Analysis**	**8**
	Pairwise sequence alignment methods; Heuristic Methods; BLAST and its variants, Statistics of Sequence Alignment Score; E-Value, P-Value, Scoring matrix, PAM, BLOSUM and Gap Penalty.	
IV	**Bioinformatics Resources**:	**7**
	Overview of Available Bioinformatics Resources on the Web, Protein and Genome; Information Resources and Analysis Tools; Established Techniques and	

	Methods; Sequence File Formats FASTA, GenBank, FASTQ and Structured File Formats

Reference Books :

1. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
2. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
3. Baldi, P. and Brunak, S. 1998 Bioinformatics. The MIT Press.
4. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
5. Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.
6. Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004 Bioinformatics: Concepts, Skills & Applications.CBS Publishers & Distributors, New Delhi.
7. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
8. Patterson, B.K., Techniques in Quantification and Localization of Gene Expression.
9. Mont, D.W., Bioinformatics: Sequence and Genome Analysis.
10. Evens, W.J. and Grant, G.R., Statistical Methods in Bioinformatics: An Introduction.
11. Pierre Baldi and Soren Brunak, Bioinformatics: The Machine Learning Approach.

DSE1-1B: Bioinformatics

Paper Code- G04-DSE-2-504- P

Course Preamble
Bioinformatics is an interdisciplinary field that merges biology, computer science, and statistics to analyze and interpret biological data. With the rapid growth of genomic, proteomic, and molecular datasets, bioinformatics has become essential for modern biological research. This practical course equips students with hands-on skills in computational tools, databases, and algorithms used to study DNA, RNA, and protein sequences. It emphasizes problem-solving, data management, and the application of bioinformatics techniques to real-world biological questions, preparing learners for research and applied sciences.

Course Objectives
1. To introduce students to fundamental concepts and tools of bioinformatics. 2. To train students in accessing and utilizing biological databases effectively. 3. To develop skills in sequence alignment, phylogenetic analysis, and molecular modeling. 4. To familiarize students with software and computational approaches for analyzing biological data. 5. To cultivate the ability to integrate bioinformatics methods into biological research and problem-solving.

Course Outcomes After completion of the course students will be able to
1. Demonstrate proficiency in using bioinformatics databases and tools for biological data retrieval. 2. Perform sequence alignment and phylogenetic analysis to study evolutionary relationships. 3. Apply computational methods to analyze genomic and proteomic datasets. 4. Interpret bioinformatics results to support biological research and experimental findings. 5. Integrate bioinformatics approaches into diverse fields such as genetics, molecular biology, and conservation biology.

Practical
1 Study of the sitemap of NCBI and study the resources available on NCBI. 2.Use of different browsers, search engines for desired data retrieval & its study 3.Study of NCBI/Gen Bank, Entrez, SRS, DBGET/LinkDB etc. and perform retrieval of-DNA/Protein. 4.Phylogenetic tree analysis of available gene /protein/ RNA from NCBI 5. Retrieving DNA and/or protein sequences of a given item (by name or accession number) from GENBANK. Performing a sequence similarity search using the BLAST. 6. Visit and report on bioinformatics research institute/company

Reference Books:

1. Xiong, J. *Essential Bioinformatics*. Cambridge University Press.

2. Ghosh, Z., & Mallick, B. *Bioinformatics: Principles and Applications*. Oxford University Press.
3. Singh, S. *Bioinformatics: Genomics and Proteomics*. Kalyani Publishers.
4. Lesk, A. M. *Introduction to Bioinformatics*. Oxford University Press.
5. Rashidi, H., & Buehler, M. *Fundamentals of Bioinformatics*. Jones & Bartlett Learning.
6. Mount, D. W. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press.
7. Baxevanis, A. D., & Ouellette, B. F. F. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. Wiley-Interscience.

DSE1-1C: Cyber Security

Paper Code- G04-DSE-2-504

Provided by Udhyam P. A. H. Solapur University, Solapur

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Third Year B. Sc. (Zoology)** **Semester- V** **Vertical: IKS -2 (2)** **Course Code:** **Course Name: Animals in Indian Mythology and Culture**
***Teaching Scheme Practical:02Hours/week, 01Credit**	***Examination Scheme** **UA: 45 Marks** **CA: 25 Marks**

Course preamble: The course intends to provide a general overview of faunal knowledge in ancient India. India, with its rich history and cultural heritage has contributed immensely in understanding and perpetuating knowledge about wild animals in its scriptures and sculptures. Understanding this rich store of knowledge may help us in better conservation of wild animal through theory and practice.

Course Objectives: Understand the religious and philosophical significance of animals in Hinduism, Jainism, Buddhism, Christianity, and Islam.

Analyse cultural beliefs and practices associated with animals.

Explain the treatment and welfare of animals in Hinduism, including the status of gods, humans, and animals, and the principles of animal science and cultural significance..

Course Outcomes:

CO1. Students evaluate the historical role of animals in human society, including hunting, sacrifices, transportation, art, architecture, inscriptions, coins, and temple symbolism across various dynasties.

Total Lecture – 30

Unit-1 Historical Significance of Animals	**Number of Lectures- 8**

a) The Significance of Animals in Hinduism (Vedas, Upanishads and Puranas, Ramayana and Mahabharata),
b) The Significance of Animals in Jainism, Buddhism, Christians and Muslims religious texts.
c) Historical significance of animals under various dynasties for Hunting, Sacrifices, Transportation, welfare, status, symbols, coins, pillar and rock edicts, sculpture, temple architectures, inscriptions, paintings

Unit -2 Historical Animal keeping	**Number of Lectures- 7**

a) History of Animal Keeping in Ancient India and it's Socio-Economic, Scientific applicability in 21st Century
b) Animals revered in Indian culture; Conservation values inscribed in Ashoka pillar edicts
c) History of portrayal of 'Hunting' in Environmental History of India

d) Wildlife represented in Indian mythology, Indus valley civilization, Vedic period, Maurya period, Chalukya period,Maratha period.Mughal period, Jahangir period and British rule

Unit-3 Animals in National Identity and Symbolism and sacred animals	**Number of Lectures- 7**
a)National symbols: tiger (national animal), peacock (national bird), lion emblem (Ashoka's capital) b) Animals in state emblems, postal stamps, and currency notes c) Sacred animals in Puranas (Garuda, Nandi, Matsya, Kurma, Varaha avatars)	

Unit-4 Animals in Everyday Life and Folk Culture	**Number of Lectures- 8**
a)Domesticated animals in agriculture and rural economy (oxen, buffalo, goats) b) Role of animals in festivals (Pongal, Nag Panchami, Bail Pola) c) Folk deities and animal companions (Khandoba's horse, village guardian dogs) d) Philosophical debates on animal rights in Indian thought	

Suggested reading:

1) Brown, Percy. *Indian Architecture (Buddhist and Hindu Period)*.

2) Michell, George. *The Hindu Temple: An Introduction to Its Meaning and Forms*.

3) Ray P., Zoology in Ancient and Medieval India. In: Ray, P. Sen, S.N. (Eds.) The Cultural Heritage of India, Vol.VI. The Ramakrishna Mission Institute of Culture, Calcutta, India (1978)

4) Sayan Bhattacharya., Forest and biodiversity conservation in ancient Indian culture: A review based on old texts and archaeological evidences, International Letters of Social and Humanistic Sciences Online: 2014-06-16 ISSN: 2300-2697, Vol. 30, pp 35-46

5) Sayan LODH., Portrayal of 'Hunting' in Environmental History of India. ALTRALANG Journal Volume 02 Issue 02 / December 2020

6) Swarnendu Chakraborty., History of Animal Keeping in Ancient India and it's Socio-Economic, Scientific Applicability in 21st Century-British Journal of Philosophy, Sociology and History, BJPSH 3(1): 06-102023

Sem.-V: VSC-III (Hands on Training related to DSE)

Biological Data Analysis

Paper code - G04-VSC-504 Zoology VSC- III

Course Preamble
The coming biology era like in the past will be more data-driven. Modern zoology will increasingly produce more structured data from field surveys, laboratory experiments, biodiversity assessments, ecological monitoring, environmental studies and allied integrated subjects from other science and social science subjects. A course on **Biological Data Analysis** is necessary to equip UG students for applied interdisciplinary course that equips students with foundational skills to organize, interpret, visualize, and scientifically reason biological data. This will bridge the gap between raw biological observations and meaningful scientific inferences without excessive mathematical/computational complexity to equip them with for modern zoological research, biodiversity studies, ecological assessments, and biological sciences.

Course Objectives
a) Understand the nature and types of biological data generated in **zoological studies**. b) Learn methods of data organization, cleaning, and structuring. c) Apply basic analytical techniques to biological datasets. Visualize, interpret and reporting skills of biological data using appropriate graphical tools.

Course Outcomes After completion of the course students will be able to
a) Research and analytical skills b) Data literacy, data collection and organization c) Field–lab integration d) Scientific communication and research readiness e) NEP-2020 competencies

Practical
1) To perform & understand various '<u>Sampling Methods</u>' for recording wildlife (Any two) a) Random sampling: for example random quadrat placement of various size in grassland (Insect/Bird). b) Systematic sampling: Insect/Bird count after every 100 or 200 meters c) Stratified sampling: Sampling pond/forest/grassland separately. (Any two) **2) To perform collection of biological data (Any two)** Ex-1: Field Based **Primary Biological Data:** Butterfly & bird diversity survey in campus **OR** Ex-2: Laboratory Experiment Based Primary **Biological Data:** Effect of Temperature on Heartbeat Rate in Frog Model (virtual or ethical model or dummy data) **OR** Ex-3: Secondary Biological Data Collection: Forest Cover Data of Maharashtra Districts (from reports/books/portals) or Tiger count data from Indian states (from reports/books/research papers/Census data). **3) To convert raw data/Collected data into structured digital format in spreadsheets** For example:

Obs. No.	Species	Species Count/ Abundance	GPS Location	Habitat	Time	Behavior	Threats	Env. Variables

4) To perform '<u>Data Classification</u>' of collected ecological / physiological / biological data from field or lab. (Any two) For example:

5) To perform '<u>Qualitative Data Classification</u>' of field data. For example (Any one)

a) Behavior of animals (aggressive, calm, territorial) b) Habitat type (forest, grassland, wetland)
c) Nest type (ground nest, tree nest, burrow nest) d) Feeding habit (herbivore, carnivore, omnivore),

6) To perform '<u>Quantitative Data Classification</u>'. For example (Any one)

a) Number of birds in a habitat b. Morphometry of fishes.

7) To understand 'Data Ethics and Scientific Integrity' in Zoological studies

a) Moral principles in **collection, use, and reporting** of data (No animal cruelty, ethical sampling, permission for wildlife data, no habitat destruction, responsible field behavior etc.)
b) **Honesty and transparency** in research: Violations of data fabrication, data manipulation, false reporting plagiarism, fake observations, copying data etc.

8) Basic biological data summarization: Mean, range, percentage, proportion using field/laboratory data collected by students (one example each)

9) Data visualization in biology using: Line graphs, Pie charts and Histogram

10) Introduction to biological data reporting: Understanding research paper in biology using sample research paper. (Submit the report at the time of practical examination).

Reference Books:

a) **Sutherland, W.J. (Ed.).** *Ecological Census Techniques: A Handbook* Cambridge University Press
b) **Krebs, C.J.** *Ecological Methodology,* Pearson Education
c) **Southwood, T.R.E. & Henderson, P.A.** *Ecological Methods,* Wiley-Blackwell
d) **Zar, J.H.** *Biostatistical Analysis,* Pearson Education
e) **Misra, R.** *Ecology Workbook,* Oxford & IBH Publishing

SEMESTER VI

DSC1-10 Zoology-X: Biorhythm and Behavioral Ecology
Paper Code- G04-DSC1-0610 Zoology-X

Credits: 3+2 **Lectures: 45**

Course Preamble
The course Behavioral ecology and Biorhythms explore the scientific study of how animals interact with their environment, conspecifics, and other species, alongside the biological rhythms that regulate their activities. It emphasizes the mechanisms underlying behaviour, evolutionary adaptations, ecological significance, and the role of circadian and seasonal rhythms in survival and reproduction. Students will gain insights into experimental approaches, behavioural ecology, and chronobiological principles, preparing them to apply these concepts in research, wildlife management, and conservation.

Course Objectives The objectives of this course are to:
1. Introduce fundamental concepts of animal behavioral ecology and biorhythms. 2. Examine behavioural adaptations in ecological and evolutionary contexts. 3. Explore mechanisms of biological rhythms, including circadian, seasonal, and annual cycles. 4. Train students in observational and experimental methods for studying behaviour and rhythms. 5. Develop critical thinking skills to connect behavioural and chronobiological knowledge with applied fields such as conservation, animal welfare, and biomedical sciences.

Course Outcomes After completion of the course students will be able to
1. Explain the principles and scope of animal behavioural ecology and biorhythms. 2. Analyze behavioural patterns in animals with respect to ecological and evolutionary significance. 3. Describe mechanisms of biological rhythms and their role in regulating animal activities. 4. Apply observational and experimental methods to study animal behaviour and biological clocks. **5.** Evaluate the relevance of behavioural and chronobiological studies in conservation, animal welfare, and biomedical research**.**

Section- I

Unit	Contents	Lectures
I	**Introduction to Behavioral ecology**	**7**
	1.1 Origin and history of Ethology. Proximate and ultimate causes of behavior. 1.2 Brief profiles of - Karl Von Frish; Ivan Pavlov; Konrad Lorenz and Niko Tinbergen.	
II	**Patterns of Behaviour**	**8**
	2.1 Innate Behaviour 2.2 Learned Behaviour 2.3 Reproductive Behaviour 2.4 Adaptive Behaviour 2.5 Stereotyped Behaviors 2.6 Associative learning, 2.7 classical and operant conditioning, 2.8 Habituation, 2.9 Imprinting.	
III	**Social Behaviour**	**8**
	3.1 Concept of Society 3.2 Communication and the Senses 3.3 Altruism 3.4 Insect Societies (Honeybee as Example) 3.5 Foraging and Dance Language in Honeybee – Advantages	

Section- II

IV	**Introduction to Biorhythms**	**7**
	4.1 Historical Developments in biorhythms – emergence of the field and key milestones. 4.2 Biological Oscillations – concepts of average, amplitude, phase, and period. 4.3 Adaptive Significance of Biological Clocks – role in survival, reproduction, and ecological interactions.	
V	**Biological Rhythms**	**8**
	5.1 Types and Characteristics of Biological Rhythms – short-term and long-term rhythms. 5.2 Circadian Rhythms – daily cycles of activity and physiology. 5.3 Tidal and Lunar Rhythms – behaviour linked to ocean tides and moon phases. 5.4 Photoperiodism – regulation of seasonal reproduction in vertebrates. 5.5 Role of Melatonin – hormonal control and regulation of biological rhythms. 5.6 Disorders of biological clock (sleep disorders, jet lag, shift work)	
VI	**Biological Clocks and biorhythms**	**7**
	6.1 Relevance of Biological Clocks – importance in regulating physiological and behavioural processes.	

	6.2 Chronopharmacology – influence of biological rhythms on drug absorption, metabolism, and efficacy. 6.3 Chronomedicine – application of biological timing in diagnosis and treatment of diseases. 6.4 Chronotherapy – optimizing medical treatments by aligning with biological rhythms.	

Reference Books:

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer
5. Associate Inc., Massachusetts, USA. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J.
6. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D.
7. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
8. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer- Verlag, Germany.
9. McFarland, D. (1985). *Animal Behaviour*. Pitman Publishing Limited, London, UK.
10. Manning, A., & Dawkins, M. S. (1992). *An Introduction to Animal Behaviour*. Cambridge University Press, Cambridge, UK.
11. Alcock, J. (2001). *Animal Behaviour*. Sinauer Associates Inc., Sunderland, MA, USA.
12. Sherman, P. W., & Alcock, J. (1997). *Exploring Animal Behaviour*. Sinauer Associates Inc., Massachusetts, USA.
13. Dunlap, J. C., Loros, J. J., & DeCoursey, P. J. (Eds.) (2004). *Chronobiology: Biological Timekeeping*. Sinauer Associates Inc., Sunderland, MA, USA.
14. Saunders, D. S., Steel, C. G. H., Afopoulou, X., & Lewis, R. D. (Eds.) (2002). *Insect Clocks* (3rd ed.). Barnes and Noble Inc., New York, USA.
15. Kumar, V. (2002). *Biological Rhythms*. Narosa Publishing House, Delhi / Springer-Verlag, Germany.

DSC1-10 Zoology-**X:**
Biorhythm and Behavioral Ecology
Paper Code- G04-DSC1-0610- P Zoology-X- Practical Lab-XI

Course Preamble
Animal Behaviour and Chronobiology are integral fields of Zoology that explore how organisms interact with their environment through behavioural patterns and biological rhythms. Practical training in these areas provides students with hands-on experience in observing, recording, and analyzing animal behaviour, as well as understanding the mechanisms and adaptive significance of biological clocks. These practicals bridge theory with real-world applications in ecology, conservation, and biomedical sciences.

Course Objectives
1. To introduce students to the methods of studying animal behaviour and biological rhythms. 2. To develop skills in observation, data collection, and analysis of behavioural patterns. 3. To understand the proximate and ultimate causes of behaviour and their ecological relevance. 4. To explore the role of biological clocks in regulating physiological and behavioural processes. 5. To apply behavioural and chronobiological knowledge in conservation, wildlife management, and biomedical contexts.

Course Outcomes After completion of the course students will be able to
1. Prepare and interpret ethograms for different species. 2. Demonstrate understanding of communication systems, social behaviour, and foraging strategies in animals. 3. Record and analyze circadian, tidal, lunar, and seasonal rhythms in selected organisms. 4. Explain the adaptive significance of biological clocks and their role in health and disease. 5. Apply behavioural and chronobiological concepts to conservation practices, ecological studies, and biomedical research.

Practical
Practical: (Use: **Chart/ Model/ Photograph/Diagram)** 1. Study of classical ethologists and their experiments. 2. Study of nests and nesting habits of selected bird species and social insects. 3. Observation and analysis of caste differentiation in ants and honey bees. 4. Investigation of behavioral responses of animals- a. Hydro-taxis Snails – Response to Moisture Gradient b. Negative photo-taxis Mosquito Larvae – Response to Light c. Phototaxis behavior of Earthworms – Response to Light. d. Chemo-taxis behavior -Insects (Ants) – Response to Sugar vs Plain Surface 5. Examination of geotaxis behavior in earthworms. 6. Documentation of nest parasitism in the Asian koel (*Eudynamys scolopaceus*). 7. Assessment of circadian functions in humans by monitoring heart rate and respiration rhythm at different times of the day.

8. Recording and analysis of body temperature rhythms in humans at regular intervals over a 24-hour cycle.
9. Study of sleep and wake cycle.
10. Study of the permanent slides/ picture/ chart of endocrine glands: Pineal gland, Adrenal gland

Reference Books :

1. Khan, I.A., & Khanum, A. *Fundamentals of Biostatistics*. Ukaaz Publications.
2. Zar, J.H. *Biostatistical Analysis*. Pearson Education.
3. Daniel, W.W. *Biostatistics: A Foundation for Analysis in the Health Sciences*. Wiley.
4. Sokal, R.R., & Rohlf, F.J. *Biometry: The Principles and Practice of Statistics in Biological Research*. W.H. Freeman.
5. Mahajan, B.K. *Methods in Biostatistics*. Jaypee Brothers Medical Publishers.
6. Gupta, S.C. *Fundamentals of Statistics*. Himalaya Publishing House.
7. Singh, H.R. *Animal Behaviour*. Rastogi Publications.
8. Reena, R., & Sharma, P. *Practical Zoology: Ethology and Chronobiology*.
9. Rawat, V. *Animal Taxonomy, Behaviour and Chronobiology*.

DSC1-11 Zoology-XI: Developmental Biology
Paper Code- G04-DSC1-0611 Zoology-XI

Credits: 3+2 **Lectures: 45**

Course Preamble
Developmental Biology explores the processes by which organisms grow, differentiate, and form complex structures from a single cell. Practical training in this field enables students to observe embryonic development, analyze cellular differentiation, and understand the molecular and genetic mechanisms underlying growth. These exercises provide a foundation for careers in research, medicine, and biotechnology.

Course Objectives
1. To introduce students to experimental methods in embryology and developmental biology. 2. To develop skills in observing and documenting developmental stages in model organisms. 3. To understand cellular differentiation and morphogenetic processes. 4. To explore the role of genes, hormones, and environmental factors in development.

Course Outcomes After completion of the course students will be able to
1. Identify and describe key stages of embryonic development in selected organisms. 2. Demonstrate techniques for preparing and analyzing developmental specimens. 3. Interpret the role of genetic and environmental factors in developmental processes. 4. Relate developmental mechanisms to evolutionary and biomedical applications. 5. Apply practical knowledge to research, conservation, and applied biology.

Unit	Contents	Lectures
UNIT – I	Gametogenesis- Spermatogenesis and Oogenesis	**7**
UNIT - II	General Mechanism of fertilization	**8**
UNIT - III	Types of eggs and cleavages	**7**
UNIT- IV	Development of Chick- a. Structure of Egg and Sperm b. Fertilization, cleavage, blastulation and Gastrulation c. Fate map of blastula d. Structure of 24 hrs. Chick embryo. e. Structure of 33 hrs. Chick embryo. f. Structure of 48 hrs. Chick embryo. g. Structure of 72 hrs. Chick embryo.	**8**
UNIT – V	Chick Foetal membranes or extra embryonic membranes (Amnion, Chorion, Allontois and Yolk sac) & their significance.	**8**
UNIT – VI	a. Types and significance of placenta in mammals. b. Study of amniocentesis and applications of ultra-sonography	**7**

Reference Books :

1. An Introduction to Embryology 2003, Balinsky B.L., Saunders College, Philadelphia.
2. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.
3. Developmental Biology, 2004, 3rd Edition, Gilbert S.F. Saunder Associates Inc. U.S.A.
4. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. & Williams, R.J. Saunders College, Publications, London.
5. A Text Book of Embryology, Dr. Puranik P. G. , S. Chand & Co.
6. Developmental Biology, 1984, Browder L.W. , Saunders College Publications, U.S.A.
7. Development of Chick embryo, 1972, Lillie.
8. Developmental Biology –P S Salunkhe
9. Human Embryology: Inderbir singh & G.P. Pal
10. Medical Physiology: A.C. Guyton

DSC1-11 Zoology-XI: Developmental Biology
Paper Code- G04-DSC2-0611 - P Zoology-XI-Practical Lab-XI

Course Preamble
Developmental Biology examines the processes by which a single cell transforms into a complex organism through growth, differentiation, and morphogenesis. Practical exercises in this field provide students with direct experience in observing embryonic stages, analyzing cellular and tissue development, and understanding the genetic and environmental factors that regulate these processes. Such training builds a foundation for careers in research, medicine, and biotechnology.

Course Objectives
1. o introduce experimental approaches in embryology and developmental biology. 2. To train students in observing and documenting developmental stages in model organisms. 3. To understand mechanisms of cell differentiation and morphogenesis. 4. To explore the role of genes, hormones, and environmental cues in development. 5. To apply developmental biology concepts in biomedical and biotechnological contexts.

Course Outcomes After completion of the course students will be able to
1. Identify and describe major stages of embryonic development. 2. Demonstrate techniques for preparing and analyzing developmental specimens. 3. Interpret the influence of genetic and environmental factors on development. 4. Relate developmental mechanisms to evolutionary and biomedical applications. 5. Apply practical knowledge to research, conservation, and applied biology.

Practical
1) - Study of types of eggs: Eggs of Insects, Amphioxus, Frog and Chick with the help of Permanent slides/ Model/museum specimens/CD/Chart/ **2)** Preparation of drosophila culture and study of its life cycle. **3)** – Study of cleavage: Radial, Spiral, Bilateral cleavage with the help of CD/Chart/Model/Permanent slides **4)** - Study of Whole Mounts: 24, 33, 48, and 72 hrs Chick embryos with the help of CD/Chart/Model/Permanent slides **5)** - Study of T.S. of 24, 33, 48, and 72 hrs. Chick embryos with the help of CD/Chart/Model/Permanent slides **6)-** Study of Embryology: 'procedure to understand embryological stages of chick: Demonstration of structure of egg of chick (shell, shell membrane, air space, albumen, yolk and position of blastodisc).

7)- Demonstration of procedure for chick embryo mounting using CD/Model/Chart (During regular practical students are expected to learn demonstration along with flow chart for the whole mount of chick embryo starting from incubation of egg - location of embryo -transferring of embryo on glass slide-fixation-dehydration-staining-identification-drawing-labeling and submission. At the time examination students will be provided a permanent slide of any one developmental stage (hrs.' 24/33/48/72) of chick embryo to identify, draw, label and write the procedure for making a whole mount and defend viva-voce).

8) – Study of foetal membranes with the help of CD/Chart/Model

9)-Study of placenta: Rat/ Human using museum specimen/CD/Chart/Model (spotters)

10)-Study of human embryology: Principle and mechanism of ultra sound or ultra-sonography with the help of photograph/flow-chart/Chart.

11) Visit to Sonography Center / IVF to Understand Procedure of Detection and Protocol. (submit the visit report at the time of practical exam).

Reference books

1. A Text Book of Embryology, Dr. Puranik P. G. , S. Chand & Co.
2. Developmental Biology, 1984, Browder L.W. , Saunders College Publications, U.S.A.
3. Development of Chick embryo, 1972, Lillie.
4. Developmental Biology –P S Salunkhe
5. Human Embryology: Inderbir singh & G.P. Pal

Practical Lab-XI

DSC 1-12: Zoology -XII -Comparative Anatomy of Chordates

Paper Code- G04-DSC1-0612- Zoology-XII

Credits: 3+2 **Lectures: 45**

Course Preamble
The course Zoology is basic science. It is necessary as a fundamental subject for regarding various purposes. This course provides broad view to produce sufficient knowledge and subject expert to solve urgent problems of the any reason by using Zoology

Course Objectives
1. To develop Awareness and knowledge of Zoology in Students. 2. To provide an intensive learning in the field of Zoology. 3. To train the students, to take up wide variety of roles like Researchers, Scientists, Consultants, Entrepreneurs, Academicians, Industry Leaders and Policy etc. 4. To understand the scientific techniques in Zoology.

Course Outcomes After completion of the course students will be able to
1. To Understand the comparative anatomy of major organ systems in vertebrates. 2. To Understand Explanation of structural variations of organs and related functions and their habitats in vertebrates. 3. To Understand Identification Interpretation of Anatomy in vertebrates using specimens, models, charts, and permanent slides. 4. To Understand Applications of theoretical and practical knowledge of Zoology to solve problems in biological sciences.

	Contents	Lectures
Unit I.	Integument and its derivatives in Vertebrates- (epidermal derivatives)	**7**
Unit II.	Comparative study of digestive system in vertebrates alimentary canal and associated glands(Pisces, Amphibia, Reptile, Aves and Mammal)	**8**

Unit III.	Comparative study of Respiratory System in vertebrates. a) Cutaneous Respiration b) Gills Respiration c) Lungs Respiration d) Air sacs in birds.	**8**
Unit IV	Comparative study of Circulatory System in vertebrates: a. Aortic arches (Pisces, Amphibia, Reptile, Aves and Mammal) b. Evolution of heart and. (Pisces, Amphibia, Reptile, Aves and Mammal)	**7**
Unit V	Study of different kinds of kidney (Pronephros, mesonephric and metaphoric Kidney) with suitable example	**8**
Unit VI	a. Comparative study of Vertebrate Brain. (Pisces, Amphibia, Reptile, Aves and Mammal).	**7**

Note- . Brief summary of comparative anatomy of vertebrate with respect to Pisces- Scoliodon , Amphibia- frog, Reptile- calottes , Aves- Pigeon and Mammal- Rat

Reference Books:

1. Kent, G. C. & Carr, R. K. Comparative Anatomy of the Vertebrates. McGraw-Hill.
2. Romer, A. S. & Parsons, T. S. The Vertebrate Body. Saunders College Publishing.
3. Young, J. Z. The Life of Vertebrates. Oxford University Press.
4. Hildebrand, M. & Goslow, G. Analysis of Vertebrate Structure. John Wiley & Sons.
5. Weichert, C. K. & Presch, W. Elements of Chordate Anatomy. McGraw-Hill.
6. Bhatnagar, S. P. & Saxena, A. P. Textbook of Zoology: Chordates. S. Chand & Company.
7. Verma, P. S., Agarwal, V. K. & Tyagi, B. S. Chordate Zoology. S. Chand & Company.
8. Kotpal, R. L. Modern Textbook of Zoology: Vertebrates. Rastogi Publications.

DSC 1-12: Zoology -XII (Comparative Anatomy of Chordates)
Paper Code- G04-DSC1-0612- P Zoology-XII -Practical Lab-XII

Course Preamble
The comparative study of chordates provides insights into the diversity, adaptations, and evolutionary relationships among vertebrates. Through practical exercises, students gain hands-on experience in examining external morphology, internal anatomy, and organ systems of representative chordates. This approach helps in understanding structural variations, functional significance, and evolutionary trends across different groups..

Course Objectives
1. To introduce students to comparative methods in chordate biology. 2. To develop skills in dissection, observation, and documentation of chordate structures. 3. To understand similarities and differences in organ systems across representative classes. 4. To explore evolutionary adaptations and their ecological relevance. 5. To relate comparative anatomy to functional biology and phylogeny.

Course Outcomes After completion of the course students will be able to
1. Identify and compare external and internal features of representative chordates. 2. Demonstrate dissection techniques and prepare anatomical records. 3. Analyze structural variations in organ systems and interpret their functions. 4. Explain evolutionary relationships among chordate groups. 5. Apply comparative knowledge to taxonomy, ecology, and evolutionary biology.

Practical
1. Comparative study of integuments in vertebrates. a) T.S/V. S. of Skin, b) Scales in fishes. c) Study of Feathers in Birds. 2. Comparative study of Digestive System in vertebrates. a. Dentition of Herbivore, Carnivore and Omnivore animals. b. Alimentary canal Herbivore, Carnivore and Omnivore animals. 3. Comparative study of Respiratory Organs in vertebrates. a. Skin of amphibia b. Gills of fishes c. Lungs- frog, lizard, mammal d. Air sacs in bird

4. Study of Aortic arches (Pisces, Amphibia, Reptile, Aves and Mammal)

5. Study of Heart of vertebrates. (Pisces, Amphibian, Reptiles, Aves, Mammal.)

6. Comparative study of brain of vertebrates. (Pisces, Amphibian, Reptiles, Aves, Mammal.)

7. Comparative study of kidney of vertebrates. (Pisces, Amphibian, Reptiles, Aves, Mammal.)

Reference Books

1. Verma, P.S. *A Manual of Practical Zoology: Chordates*. S. Chand & Co.
2. Moorthi, M., Senthil Kumar, A., & Govindarajan, M. *Practical Zoology (Invertebrates & Chordates)*.
3. Manual of Practical Zoology: Chordates (11th Edition) – Standard dissection and comparative anatomy guide.

DSE1-3A: Introduction to Research Methodology

G04-DSE3-604 - Zoology-DSE-3

Credits: 2+1 **Lectures: 30**

Course Preamble
This course provides fundamental and industrial knowledge of synthetic polymers, sugar and alcohol industries, green chemistry, and chromatographic techniques. It covers the preparation and applications of polymers and rubbers, industrial manufacturing processes, sustainable chemical practices, and modern separation techniques. The course connects theoretical concepts with industrial, environmental, and analytical applications.

Course Objectives
1. To understand the synthetic polymers and rubbers. 2. To know basics of sugar and alcohol industries. 3. To learn the principles and applications of green chemistry. 4. To know about chromatographic techniques. 5. To get information regarding industrial awareness.

Course Outcomes After completion of the course students will be able to
1. Understand the preparation, properties, and uses of synthetic polymers and rubbers. 2. Know the processes involved in sugar and alcohol manufacture and identify their by-products. 3. Understand the principles of green chemistry. 4. Learn about paper, column, thin layer, and gas chromatography. 5. Understand the application of chemistry in industry, environment, and analysis.

Unit	Contents	Lectures
I	**Basic Concepts of Research**	**07**
	1.1 Definition of Research 1.2 Overview of types of Research 1.3 Descriptive & Analytical Research 1.4 Applied & Fundamental Research 1.5 Quantitative & Qualitative Research	
II	**Research Methodology**	**08**
	2.1 Literature review & its consolidation 2.2 Library research 2.3 Field research 2.4 Laboratory research 2.5 Structure and format of reports and article	
III	**Documentation of Data**	**07**
	3.1 Types of data 3.2 Tabulation 3.3 Generation of graphs	
IV	**Overview of Biological Problem**	**08**
	4.1 History 4.2 Research areas of Biology 4.3 Model organisms in Biology	

Reference Books:

1. Chaitali Ghosh and Mamtesh Singh (2020) Research Methodology, Rastogi Publications
2. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
3. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientist – a training reference manual. West Africa Rice Development Association, Hong Kong.
4. Kothari and Garg (2024) Research Methodology: Methods and Techniques

DSE1-3A: Introduction to Research Methodology

Paper code- G04-DSE3-604-P

Course Preamble
Research is the cornerstone of innovation and academic excellence. A practical course in research methodology equips learners with the essential skills to design, conduct, and analyze research systematically. It bridges theory with application, enabling students to critically evaluate information, adopt appropriate methods, and contribute meaningfully to knowledge creation. This practical component emphasizes hands-on experience in data collection, analysis, interpretation, and presentation, preparing learners for academic projects, dissertations, and professional research work.

Course Objectives
1. To familiarize students with the fundamental concepts of research methodology. 2. To develop skills in identifying research problems and formulating hypotheses. 3. To train students in designing research projects and selecting suitable methods. 4. To provide practical exposure to data collection techniques and statistical tools. 5. To enhance the ability to analyze, interpret, and present research findings effectively.

Course Outcomes After completion of the course students will be able to
1. Identify and define research problems with clarity. 2. Formulate hypotheses and select appropriate research designs. 3. Apply suitable methods for data collection and sampling. 4. Use statistical tools and software for data analysis. 5. Interpret results and draw valid conclusions. 6. Prepare well-structured research reports and presentations.

Practical
1. Prepare a flow chart illustrating the essential requirements and structure of a research article. 2. Draw a flow chart depicting the key steps involved in the research methodology process. 3. Write review of research paper. (any 3-research paper / article) 4. Analyze the given table of animal diversity and interpret the distribution of species across different groups or habitats. (Any table related to diversity) 5. Tabulation Using MS Excel a. Enter raw data (e.g., age, gender, marks in various subjects) into rows and columns. b. Use sorting and filtering tools.

6. Prepare a graphical presentation of student performance in science subjects using MS-Excel. (Use the collected dataset of marks obtained by each student in **Zoology, Botany, Chemistry, and Physics**. Or any suitable example from population of wild life fauna,

Roll No.	Zoology	Botany	Chemistry	Physics
01				
02				
03				
04				
05				

7. **Comparison of Animal Diversity in Different Habitats**
   Collect data on the number of species observed in three habitats:
   - **Forest**
   - **Grassland**
   - **Wetland**

Habitat	Mammals	Birds	Reptiles	Amphibians	Insects
Forest					
Grassland					
Wetland					

(Use **Bar Charts** to compare diversity of each animal group across habitats.)

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8. Animal Diversity in a Forest Habitat (Species Count)

Animal Group	Number of Species
Mammals	
Birds	
Reptiles	
Amphibians	
Insects	

(Use **Pie Charts** to show the proportion in percent of different animal groups within habitat.)

9. Design a questionnaire to collect data from your local area on a chosen topic (e.g., education, health, environment, or biodiversity, etc.). Conduct a survey, organize the responses into tables, perform statistical analysis, and present the findings in graphical form. Submit the analysis report at the time of practical examination

Reference Books:

1. Kothari, C.R. *Research Methodology: Methods and Techniques*. New Age International Publishers.
2. Kumar, R. *Research Methodology: A Step-by-Step Guide for Beginners*. SAGE Publications.
3. Sinha, S.C., & Dhiman, A.K. *Research Methodology in Science*. Ess Ess Publications.
4. Creswell, J.W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.
5. Leedy, P.D., & Ormrod, J.E. *Practical Research: Planning and Design*. Pearson Education.
6. Walliman, N. *Research Methods: The Basics*. Routledge.
7. Ghosh, B.N. *Scientific Method and Social Research*. Sterling Publishers.

DSE1-4 B: Economic Zoology

Paper Code- G04-DSE4-604 Zoology-DSE4

Credits: 2+1 **Lectures: 30**

Course Preamble
Course preamble: Applied Zoology is an interdisciplinary and skill-oriented branch of Zoology that integrates biological knowledge with its practical applications for human welfare, sustainable livelihoods, and environmental conservation. In alignment with the National Education Policy (NEP) 2020, this course emphasizes outcome-based education, experiential learning, entrepreneurship, and employability, exposing students to animal-based industries, pest and vector management, and sustainable utilization of animal resources. The course prepares learners for higher education, research, and careers in agriculture, fisheries, animal husbandry, sericulture, apiculture, and allied sectors.

Course Objectives
Course Objectives: 1. To impart conceptual and applied knowledge of zoological principles relevant to socio-economic development. 2. To introduce students to animal-based production systems and their scientific management. 3. To develop understanding of pest management, vector biology, and public health relevance. 4. To promote skill development, entrepreneurship, and self-employment in applied biological sectors.

Course Outcomes After completion of the course students will be able to
1. Explain the scope and societal relevance of Applied Zoology in agriculture, industry, and public health. 2. Apply scientific principles to the management of economically important animal resources. 3. Analyze pest and vector problems and recommend sustainable control strategies. 4. Evaluate animal-based enterprises with respect to sustainability and economic feasibility. 5. Demonstrate applied knowledge and basic entrepreneurial skills relevant to zoological professions.

Unit	Contents	Lectures
I	**Apiculture and Sericulture**	**08**
	A. **Apiculture:** 1.1 species of honey bees, 1.2 Caste of honey bees 1.3 Bee management techniques, 1.4 Bee products. **B. Sericulture:** 1.5 Types of silkworms and host plants, 1.6 Life cycle of silkworm, cocoon formation, 1.7 silk production, and basic silk processing 1.8 Silkworm rearing appliances and maintenance 1.9 Silkworm rearing methods and rearing houses 1.10 Common diseases of silkworm	
II	**Fisheries and Aquaculture**	**07**
	2.1 Scope and importance of fisheries and aquaculture in food production 2.2 Introduction to marine & freshwater fisheries with reference to - a) Coastal fishery- Sardine, Mackerel, Bombay duck b) Crustacean fishery- Lobsters, Crabs, Shrimps c) Inland Fishery- Indian Major Carps 2.3 Economic importance of Fish Products and byproducts a) Induced breeding, hatchery management, and fish seed production techniques b) Common fish diseases, their management, and post-harvest handling (introductory)	
III	**Poultry Science**	**07**
	3.1 Types and economically important breeds of poultry birds 3.2 Poultry housing systems, feeding, breeding, and health management practices 3.3 Poultry diseases, vaccination schedules, and biosecurity measures in poultry farms.	
IV	**Animal Husbandry and Dairy Science**	**08**
	4.1 Principles, scope, and importance of animal husbandry in livestock-based industries 4.2 Indigenous and exotic breeds of cattle used in dairy. 4.3 Housing, and management practices in dairy farms 4.4 Milk production, processing, preservation, value-added dairy products. 4.5 Common livestock diseases, preventive measures, and basic farm biosecurity	

Reference Books:

1. Shukla, G. S., & Upadhyay, V. B**.** (2018). *Economic Zoology* (5th ed.). Rastogi Publications, Meerut.
2. Tembhare, D. B. (2017). *Modern Entomology*. Narendra Publishing House, New Delhi.
3. Nigam, H. R. (2014). *Applied Zoology*. S. Chand Publishing, New Delhi.
4. Vasanthraj, D., & Thangavelu, K. (2016). *Textbook of Economic Zoology*. PHI Learning Pvt. Ltd., New Delhi.
5. Kumar, D. (2011). *Fisheries Biology and Aquaculture*. Narendra Publishing House, New Delhi.
6. Snedecor, G. W., & Cochran, W. G**.** (1994). *Statistical Methods* (8th ed.). Iowa State University Press. *(For animal production data analysis)*
7. FAO. **(**2011). *Aquaculture Development: FAO Technical Guidelines for Responsible Fisheries*. Food and Agriculture Organization of the United Nations, Rome.
8. UGC. (2019). *Learning Outcomes-Based Curriculum Framework (LOCF) for Undergraduate Programme in Zoology*. University Grants Commission, New Delhi.
9. Government of India. (2020). *National Education Policy (NEP) 2020*. Ministry of Education, New Delhi.

DSE1-4 B: Applied Zoology
Economic Zoology
Paper Code- G04-DSE4-604- P Zoology-DSE4

Course Preamble
Applied Zoology focuses on the practical applications of zoological knowledge in areas such as agriculture, aquaculture, apiculture, sericulture, pest management, and conservation biology. The practical component provides hands-on experience in techniques, tools, and methods used to study and utilize animals for human welfare. It bridges theoretical concepts with real-world practices, enabling students to understand animal diversity, management, and sustainable utilization.

Course Objectives
1. To introduce students to the applied aspects of zoology relevant to agriculture, aquaculture, sericulture, apiculture, and pest control. 2. To provide practical training in identifying, handling, and managing economically important animals. 3. To develop skills in data collection, tabulation, and analysis related to animal diversity and productivity. 4. To cultivate awareness of sustainable practices and ethical considerations in animal use. 5. To prepare students for careers in zoology, life sciences, and allied industries through experiential learning.

Course Outcomes After completion of the course students will be able to
1. Identify and classify economically important animals and their role in human welfare. 2. Demonstrate practical skills in apiculture, sericulture, aquaculture, and pest management techniques. 3. Collect, tabulate, and analyze survey data related to animal diversity and productivity. 4. Apply zoological knowledge to solve real-world problems in agriculture and allied fields. 5. Understand the ecological and economic importance of animals in sustainable development.

Practical
1. Study of species of Honeybees (Apis dorsata, Apis cerana, Apis mellifera, Apis florea). (Chart/model/photograph) 2. Study of Bee-Hive Equipment (Bee boxes, frames, smokers, protective gear). 3. Study of life cycle of silk worm and its product. 4. Study of Dairy Cattle and Buffalo Breeds. (Chart/model/photograph) 5. Study of Value-Added Dairy Products (Paneer, Ghee, Flavored Milk, flavored Yogurt, honey-based product.) 6. Study of freshwater carp (Rohu, Catla and Mrigal) and fish product (Fish oil, Fish manure, Fish meal, Shagreen) 7. Study of Poultry Breeds (Use chart/model/ photograph) 8. Industrial / Field Exposure Visit (visit to dairy industry/ visit to Apiculture unit/ sericulture unit/ aquaculture unit.)

Reference Books:

1. **Shukla, G. S., & Upadhyay, V. B.** (2018). *Economic Zoology* (5th ed.). Rastogi Publications, Meerut.
2. Tembhare, D. B. (2017). *Modern Entomology*. Narendra Publishing House, New Delhi.
3. Nigam, H. R**.** (2014). *Applied Zoology*. S. Chand Publishing, New Delhi.
4. Kumar, D. (2011). *Fisheries Biology and Aquaculture*. Narendra Publishing House, New Delhi.
5. Snedecor, G. W., & Cochran, W. G. (1994). *Statistical Methods* (8th ed.). Iowa State University Press. *(For animal production data analysis)*
6. FAO. (2011). *Aquaculture Development: FAO Technical Guidelines for Responsible Fisheries*. Food and Agriculture Organization of the United Nations, Rome.
7. Dr. V.G. Jhingran, Fish and Fisheries of India.
8. Narinder Singh Dhariwal, Fish of India

Sem.-VI: VSC-IV (Hands on Training related to DSE)

Communication in Science

Paper code - G04-VSC-604 Zoology-VSC-IV

Contact Hours: 60

Course Preamble
Science advances through discovery, but its true impact depends on effective communication. This course introduces students to the principles and practices of scientific communication, enabling them to present ideas clearly, share research responsibly, and engage diverse audiences through written, oral, and visual formats.

Course Objectives
1. To develop skills in writing scientific reports, papers, and abstracts with clarity and precision. 2. To train students in oral communication, including seminars, presentations, and poster sessions. 3. To familiarize learners with modern tools of science communication such as infographics, digital media, and outreach platforms. 4. To instill ethical practices in scientific writing and dissemination.

Course Outcomes After completion of the course students will be able to
1. Write structured scientific documents (reports, articles, proposals) adhering to academic standards. 2. Deliver effective oral presentations using visual aids like PowerPoint, posters, and infographics. 3. Translate complex scientific concepts into accessible formats for non-specialist audiences. 4. Apply ethical and professional standards in scientific communication. 5. Collaborate and communicate effectively in team-based scientific projects.

Practical
1. Designing a research Proposal 2. "Design a poster or infographic to communicate a scientific concept. Explain your choice of visual elements 3. Oral presentation on Autobiography: any scientist (Practical is based on science and storytelling activities; to improve spoken communication and developing skills in gathering scientific information- one-way activity) 4. Seminar presentation based on any one topic from syllabus. (Practical is based on seminar in science communication; engage with science

communication faculty and staffs, campus resources - two-way activity)

5. Drafting of two to five review papers.
   (Practical is based on introduction to science communication; to improve reading as well as writing skill by approaching research papers, newsletters, magazines article's, natural resources)
6. Writing a short article based on current news.
   (Practical is based on observation and strong communication skill)
7. Interview techniques: a) Arrangement departmental activity for facing interview like Forest officer job **or** b) Interview of any scientific community.
8. Designing short video or reels (about 60 Sec) in scientific way and marketing agricultural products.
   (Practical is based to improve strong communication skill in field marketing focus on innovation example like vermicompost/ animal product/ Dairy product/ aquaculture)

Reference Books:

1. A Concise Guide to Communication in Science and Engineering – David H. Foster
2. Scientific Writing and Communication: Papers, Proposals, and Presentations – Angelika H. Hofmann
3. Communicating Science: A Practical Guide – T. L. Brownell & S. M. Brownell
4. The Craft of Scientific Communication – Joseph E. Harmon & Alan G. Gross
5. Communicating Science Effectively: A Research Agenda – National Academies of Sciences, Engineering, and Medicine
6. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded – Joshua Schimel
7. Communicating Science: A Global Perspective – Toss Gascoigne et al.
8. Handbook of Science Communication

Zoology- FP2/CEP2/OJT1

1) Field Project (FP)-2

Class	:	B.Sc.-III Zoology
Total Credits	:	2
Total Hours	:	60 Contact Hours
Course Type	:	Service learning / Social engagement
Nature	:	Society–science interface
Total Marks	:	

- **PREAMBLE:**

The Field Project (FP) course is designed to introduce undergraduate zoology students to real-world biological research problems faced by region through direct field-based investigations. The course develops scientific observation, data collection, ecological understanding, analytical thinking, and research ethics by taking students in natural habitats, ecosystems, and biodiversity-rich environments. It allows students to connect theoretical zoology with real ecological systems and prepares them for higher research, conservation studies, and field-based careers.

- **Course Objective - Students will be able to:**

a) Apply zoological knowledge in real field conditions.
b) Develop scientific observation and documentation skills.
c) Learn ecological data collection and sampling methods.
d) Understand biodiversity, habitats, and species interactions.
e) Practice ethical field research.
f) Develop basic research reporting skills.

- **Course Outcomes- After completion, students will be able to:**

a) CO-1: Conduct structured or methodological biological field surveys.
b) CO-2: Collect and organize ecological and biological data.
c) CO-3: Apply sampling and observation techniques.
d) CO-4: Analyze field data scientifically, interpret ecological patterns and relationships.
e) CO-5: Prepare scientific field project reports.

- **Expected Activities (Examples):**

a) Wildlife diversity surveys
b) Forest and wetland biodiversity documentation
c) Habitat assessment study
d) Nesting ecology study
e) Human–wildlife interaction mapping
f) Any applied aspect such as: agro-biodiversity, eco-tourism, conservation, GO and NGO activities etc.

- **Report Structure/Format**

1) Title Page
2) Certificate
3) Index

4) Introduction about Field Project, objectives of FP
5) Methodology: Study area description, methods used to sample wildlife and other variables, data collection methods etc.
6) Results:
- Observations
- Tables and graphs
- Photographic documentation
- Interpretation

7) Discussion and Conclusion
8) References

➢ Evaluation Methods:

- **College Assessment:** Attendance and participation, field diary & observations
- **University Assessment:** Report submission, presentation, viva-voce

2) Community Engagement Program-2 (CEP-2)

Class	:	B.Sc.-III Zoology
Total Credits	:	2
Total Hours	:	60 Contact Hours
Course Type	:	Service learning / Social engagement
Nature	:	Society–science interface
Total Marks	:	

Preamble:

The Community Engagement Program (CEP) aims to integrate zoological knowledge with community needs, local ecology, public health, environmental awareness, and sustainability practices and other related issues of community. This course sensitizes students to societal issues, human–environment relationships, and biodiversity conservation while promoting social responsibility, communication skills, and participatory learning. It transforms students from learners into responsible citizens of India.

- **Course Objectives: Students will be able to:**

- Apply UG knowledge in real world field conditions to gain insights on community problems.
- Develop scientific observation and documentation skills.
- Practice ethical field research.
- Learn data collection and sampling methods.
- Understand how issues are linked together and gain insights on solution to problems.
- Develop basic research reporting skills.

- **Course Outcomes- After completion, students will be able to:**

CO-1: Conduct structured biological field surveys.
CO-2: Collect and organize community and issue related data on social and biological aspects.
CO-3: Apply sampling and observation techniques & analyze field data scientifically.
CO-5: Interpret ecological patterns and relationships.
CO-6: Prepare scientific field project reports.

- **Expected Activities (Few Examples):**

- Government schemes/Programs on education, empowerment, health, environment, water etc.
- Visit to agro-ecosystem, schools, gram-panchayat etc.
- Pollution, water conservation, organic farming
- Biodiversity at local level and its values (Preparation of PBR reports)
- Issues of wetland in villages / Habitat assessment study
- Human–wildlife interaction mapping

- **Reporting Style or Format:**

1) Title page
2) Certificate Page
3) Index
4) Introduction: Study area description, Objectives
5) Methodology: sampling method, tools used, data collection and data analysis

6) Result:
- Observations
- Tables and graphs
- Interpretation

- Photographic documentation

7) Discussion & Conclusion
8) References

➢ **Evaluation Methods:**

- **College Assessment:** Attendance and participation, field diary & observations

- **University Assessment:** Report submission, presentation, viva-voce

3) On-Job Training-1 (OJT-1):

Class	:	B.Sc.-III Zoology
Total Credits	:	2
Total Hours	:	60 Contact Hours
Course Type	:	Service learning / Social engagement
Nature	:	Society–science interface
Total Marks	:	

- **Preamble:**

The On-Job Training (OJT) course provides students with real workplace exposure in zoology-related institutions, organizations, and individuals. It aims to develop professional skills, work ethics, technical competencies, discipline, and career readiness. It offers structured training in laboratories, NGOs, research institutes, veterinary services, fisheries, zoos, wildlife centers, and environmental organizations, and learners gain hands-on experience and professional orientation.

- **Course Objective:** Students will be able to-

a) Gain professional practical exposure.
b) Develop technical and laboratory skills.
c) Learn organizational work culture.
d) Understand professional ethics.
e) Build employability skills.
f) Apply zoology knowledge in professional settings.

- **Course Outcomes: After completion, students will be able to-**

a) CO-1: Work effectively in professional biological environments.
b) CO-2: Apply zoological skills practically.
c) CO-3: Follow professional ethics and discipline.
d) CO-4: Demonstrate technical competence & develop career readiness skills.

- **Expected Activities (Some Examples):**

a) Training in pathology labs / Hospitals
b) Fisheries hatchery training, Zoo and wildlife rescue centers
c) Biodiversity parks / Forest department training
d) Environmental NGOs
e) Water testing labs
f) Agricultural pest management units / Agro-ecosystem / Farms
g) Research laboratories
h) Industries

- **Reporting Format:**

1) Title Page
2) Certificate
3) Index

4) Introduction: Organization profile, Training objectives, Duration and schedule, Nature of work
5) Methodology: Methods observed and studied, Tools and techniques learned, Responsibilities handled
6) Result: Learning outcomes achieved, Skills acquired and significance.
7) Supervisor certification
8) Student reflection (two to three pages)
9) Discussion and Conclusion
10) Appendices I to IX as per NP-formats

- **Evaluation Methods:**

- **College Assessment:** Attendance and participation, field diary & observations

- **University Assessment:** Report submission, presentation, viva-voce and certification by host organization

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology.

B. Sc. (Part-III) w.e.f. Year 2026-27

DSC- University Assessment **(UA)**

Paper code:

Nature of Question Paper

Time: Total Marks:45

Instructions

1) All Questions are compulsory.

2) Figure to right indicate full marks.

Q.1.A)

Rewrite the following by choosing the correct alternative 5 Marks

1)

a) b) c) d)

2)

a) b) c) d)

3)

a) b) c) d)

4)

a) b) c) d)

5)

a) b) c) d)

Q.1.B)

Choose correct alternative (True /False) 4 Marks

1)

2)

3)

4)

Q.2.

Answer the following (Any Three) 9 Marks

1)

2)

3)

4)

Q.3.A)

Answer the following (Any One) 5 Marks

1)

2)

Q.3.B)

Answer the following (Any One) 4 Marks

1)

2)

Q.4.A)
Answer the following (Any One) 5 Marks
1)

2)

Q.4.B)
Answer the following (Any One) 4 Marks
1)

2)

Q.5.
Answer the following (Any One) 9 Marks
1)

2)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology.

B. Sc. (Part-III) w.e.f. Year 2026-27

DSE- University Assessment **(UA)**

Paper code:

Nature of Question Paper

Time **30 Marks**

Instructions 1) All Questions are compulsory.

2) Figure to right indicate full marks.

Q .1. Rewrite the following by choosing the correct alternative: 06 marks

1.

a) b) c) d)

2.

a) b) c) d)

3.

a) b) c) d)

4.

a) b) c) d)

5.

a) b) c) d)

6.

a) b) c) d)

Q 2. Short answer any three 06 Marks

1.

2.

3.

4.

Q.3.Answer the following (Any Two)

A. 03 Marks

B. 03 Marks

C. 03 Marks

Q.04. Answer the following (Any Two)

A . 03 Marks

B . 03Marks

C. 03 Marks

Q .05. Answer any one 06 Marks

A.

B.

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

EQUIVALENT SUBJECT FOR OLD SYLLABUS

Name of the Course:

Sr. No.	Paper No. & Name of the Old Paper	Paper No. & Name of the New Paper
1	DSE-IX - **DSE-1A -Molecular Biology**	**DSC1-7 Molecular Biology and Genetics**
2	DSE-X -**DSE- 2 A –** **Principles of Genetics**	**DSC1-7 Molecular Biology and Genetics**
3	DSE-XI DSE- 3A – **Endocrinology**	**No Equivalence**
4	**DSE-XII DSE 4 A-** **Wildlife Conservation & Management**	DSC1-9(3+2) **Conservation Biology and wild life**
5	DSE- -XIII DSE- 1B – **Animal Physiology: Life Sustaining Systems**	**No equivalence**
6	DSE-XIV -**DSE- 2B-** **Evolutionary Biology**	DSC1 8 (3+2) **Evolutionary Biology and Zoogeography**
7	DSE-XV- **DSE- 3 B-** **Animal Behaviour And Chronobiology**	DSC1 10 (3+2) **Animal Behavior and Chronobiology**
8	DSE-A XVI DSE 4B- Applied Zoology	**No equivalence**