SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

TWO YEAR POSTGRADUATE PROGRAMME

IN ZOOLOGY

FACULTY: SCIENCE AND TECHNOLOGY

M.Sc. I SEM I & II (NEP)

(Courses effective from Academic Year 2023-24)

SYLLABUS

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. ZOOLOGY under FACULTY: SCIENCE AND TECHNOLOGY

Board of Studies in Zoology (Including Apiculture)

Dhote Dr. Jayashri Dipak (Chairman) Shri Shivaji Science College Amravati.	Gadhikar Dr. Yashashri A. G.V.I.S.H. Amravati
Joshi Dr. Pravin Purushottam Amolkachand Mahavavidyalaya, Yeotmal.	Kale Dr. G.B. G.S. Science Arts, Commerce College, Khamgaon, Dist. Buldhana.
Nandurkar Dr. Sou. H.P. Head Deptt. Of Zoology , SGBAU Amravati.	Makode Dr. P.M. Shri. Dr. R.G. Rathod Arts and Science College, Murtizapur, Dist. Akola
Patil Dr. P.S. R.A. Arts, Shri M.K. Commerce and S.R. Rathi Science College, Washim.	Sapkal Dr. Hemant P. Shri Shivaji Arts, Commerce and Science College, Akola.
Zilpe Dr. Suvarna K. Smt. Radhabai Sarda Arts, Commerce College and Science College, Anjangaon Surji Dist. Amravati.	Bobade Dr. Atul D. Department of Zoology Shri Shivaji Science College, Nagpur.
Mali Dr. Rajendra P. Indira Gandhi Senior College, CIDCO New Nanded Dist. Nanded.	Dr. Qureshi Syed Obaid Adarsha Sc., J. B. Arts and Birla Commerce Mahavidyalaya, Dhamangaon Rly. Dist. Amravati.
Karlekar Dr. Mangla B. Bhamburkar Niwas, Old Biyani Square, Camp Amravati.	Virani Dr. Ramzan S. Karimbad Housing Society, Pandharkawada, Dist. Amravati.

Sant Gadge Baba Amravati University Amravati

FACULTY: SCIENCE AND TECHNOLOGY

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (Zoology) following Three Years UG Programme w.e.f. 2023-24

(Two Years-Four Semesters Master's Degree Programme-NEP v23 with **Exit and Entry Option**

M.Sc. (Zoology) First Year Semester-I [Level 6.0]

S.N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory +MCQ Internal	Theory External	Internal	External		Marks Internal	Marks External	Grade
0	*Pre-Requisite Course(s) if applicable/ MOOC/ Internship/ Fiels Work cumulatively, If students wish to opt Minor Course of UG as Major for PG, balance 12 Credits Course will have to be completed (As and when applicable)	Th-Prq		0	0	0	0	Additional Credits to be earned= (1) minus(2) (1). Credit from Major DSC Course in UG (minus) (2). The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG.			2	20	30	-	-	50	08	12	P
1	Research Methodology and IPR	Th-Major	1 ZOO RM	4	-	-	4	4		4	3	40	60			100	16	24	P
2	DSC-I.1 Structure and Function of Invertebrate	Th-Major	1 ZOO 1	4	-	-	4	4		4	3	40	60			100	16	24	P
3	DSC-II.1 General Physiology	Th-Major	1 ZOO 2	4	-	-	4	4		4	3	40	60			100	16	24	P
4	DSC-III.1 Developmental Biology	Th-Major	1 ZOO 3	3	-	-	3	3		3	3	40	60			100	16	24	P
5	DSE-I/ MOOC Tools and techniques in Biology or Wildlife Conservation and Management	Th-Major Elective	1 ZOO 4	3	-	-	3	3		3	3	40	60			100	16	24	P
																	Minimum Passing Marks		
6	DSC I.1 and DSC II.1.(Lab 1)	Pr-Major	1 ZOO 5	-	-	4	4		2	2	6			50	50	100	50		P
7	DSC-III.1.and DSE I (Lab 2)	Pr-Major	1 ZOO 6	-	-	4	4		2	2	6			50	50	100	50		P
8	# On Job Training, Internship/	Related to		120 Hours						4*									P*

	Apprenticeship; Field projects Related to Major @ during vacations cumulatively	**DSC**		**cumulatively during vacation of semester I and semester II**														
9	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and fitness, Cultural Activities, NSS/ NCC, Fine / Applied/ Visual/ Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From SEM I to SEM IV**														
	TOTAL								**22**						**700+50***			

Note: Exit options after M.Sc. I (1st Year PG) : 1 – To students who opt for DSE for Tools and Techniques in Biology (TB) will be awarded PG Diploma in Tools and Techniques in Biology To students who opt for DSE Wildlife Conservation and Management (WCM) will be awarded PG Diploma in Wildlife Conservation and Management on Exit.

L: Lecture, T: Tutorial, P: Practical / Practicum
Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology, Research Project :**RP, Co-curricular Courses :CC.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, Startups, Hackathon, Quiz competitions, Article published, Participation in Summer school /Winter School /Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online /offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eye sight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

Sant Gadge Baba Amravati University Amravati
FACULTY: SCIENCE AND TECHNOLOGY
Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science (Zoology) following Three Years UG Programme w.e.f. 2023-24
(Two Years-Four Semesters Master's Degree Programme-NEP v23 with **Exit and Entry Option**
M.Sc. (Zoology) First Year Semester-II [Level 6.0]

S.N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				MaximumMarks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory +MCQ Internal	Theory External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-I.2 Structure and function of Vertebrate	Th-Major	2 ZOO 1	4	-	-	4	4		4	3	40	60			100	16	24	P
2	DSC-II.2 Molecular Cell Biology	Th-Major	2 ZOO 2	4	-	-	4	4		4	3	40	60			100	16	24	P
3	DSC-III.2 Ecology and Environment	Th-Major	2 ZOO 3	3	-	-	3	3		3	3	40	60			100	16	24	P
4	DSE-II / MOOC Advance Tools and techniques in Biology or Advance Wildlife Conservation and Management	Th-Major Elective	2 ZOO 4	3	-	-	3	3		3	3	40	60			100	16	24	P
																	Minimum Passing Marks		
5	DSC I.2 and DSC II.2.(Lab 3)	Pr-Major	2 ZOO 5	-	-	4	4		2	2	6			50	50	100	50		P
6	DSC-III.4.and DSE II (Lab 4)	Pr-Major	2 ZOO 6	-	-	4	4		2	2	6			50	50	100	50		P
7	# On Job Training, Internship/ Apprenticeship; Field projects Related to Major @ during vacations cumulatively	Related to DSC		120 Hours cumulatively during vacation of semester I and semester II						4*									
8	Co-curricular Courses: Health and wellness, Yoga Education, Sports and fitness, Cultural Activities, NSS/ NCC, Fine / Applied/ Visual/ Performing Arts During Semester I, II, III and IV	Generic Optional		90 Hours Cumulatively From SEM I to SEM IV															

				Exit Option with a PG Diploma with 4 Credits On-the-Job training/ internship in the respective Major Subject • **Student has to earn Total minimum 4 Credits cumulatively during Vacation of Semester I and Semester II from internship in order to exit after first year with PG Diploma (42-44 Credits) after Three Year UG Degree**														
	TOTAL									**18+4***						**600**			

Note: Exit options after M.Sc. I (1st Year PG) : 1 – To students who opt for DSE for Tools and Techniques in Biology (TB) will be awarded PG Diploma in Tools and Techniques in Biology To students who opt for DSE Wildlife Conservation and Management (WCM) will be awarded PG Diploma in Wildlife Conservation and Management on Exit.

L: Lecture, T: Tutorial, P: Practical / Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology, Research Project :**RP, Co-curricular Courses :CC.**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, Startups, Hackathon, Quiz competitions, Article published, Participation in Summer school /Winter School /Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online /offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eye sight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

Sant Gadge Baba Amravati University, Amravati
Name of the Programme: M.Sc. (SEM-I) Subject: Zoology (NEPv23)

POs:

The post graduate course of Zoology will provide theoretical as well as experimental knowledge as per the Courses included under the syllabi by which build up creativity in students will lead towards thorough learning and development of ideas of research work and will become ready to face recent challenges. Students can attain the employability skills through the experiences based on their practical knowledge.

After completion of MSc in Zoology successfully, the students would be able to……..

1. Demonstrate the significance of the topics of syllabi and evaluate its relevance. Think creatively for its gravity and develop ideas.
2. Interpret scientific ideas and can do its analysis. Create experiments independently and draw inferences by sharing it with others.
3. Derive information from various digital sources. Develop skills for scientific writing and present the data and analyse it scientifically.
4. Articulate scientific ideas lay down a hypothesis; design the pathway to develop research ideas.
5. Acquaint skills in handling the instruments and different techniques through practicals and developing the scientific temperaments for research.
6. Develop competence through healthy atmosphere and quality intercommunication with different groups.
7. Understand environmental and sustainability issues and its sensitivity in relation to regional relevance.
8. Get the facility of different training and internship programs through job-oriented curriculum
9. Utilize the sources confidently and independently and develop self-sustenance.

PSOs:

Upon completion of the Programme successfully, students would be able to …….

1. Learn to prepare the checklist and inventories through the identification of the fauna in local areas being Melghat Tiger Reserve and Pohra Forest are very nearer to survey.
2. Gain comprehensive knowledge about different animals and develop confidence to handle them during research work.
3. Interpret metabolic pathways, their correlation in concern with prokaryote and eukaryotes.
4. Compare genetic aspects, genetic traits, diseases and their specific causes.
5. Survey and analyse data of the various kinds of diseases in the locality.
6. Understand various strategies and phenomena related to animal reproduction and their development.
7. Get acquainted with conservation strategies and environmental threats to reduce and save energy through Wildlife Week Celebration.
8. Compare the different developmental events during embryogenesis of different animals.

EMPLOYABILITY POTENTIAL

- After Completion of this course Field Biologist or Ecologist in different govt. establishments like NTCA, Division Office, Wildlife Wings Wildlife Consultant EIA Report Designing Firm,
- Wildlife Conservation Educator in NGOs like WWF, WCT, WTI,
- Conservation Geneticist in research organisations,
- GIS Specialist in Govt Establishments,
- Environmental Impact Assessment (EIA) Specialist: Assessing the potential impact of development Projects on wildlife and proposing mitigation measures.
- Wildlife Forensics Specialist in research labs

- Research Associate or Assistant: Assisting senior researchers in wildlife conservation projects and Data analysis.
- Wildlife Photographer or Filmmaker: Using visual media to raise awareness about wildlife Conservation and natural habitats.
- Wildlife Tour Guide or Naturalist: Conducting guided tours in wildlife sanctuaries, national parks, or Eco-tourism sites.
- Wildlife Project Manager: Overseeing and coordinating conservation projects aimed at protecting Specific wildlife species or habitats.
- Environmental Educator: Developing and delivering educational programs related to wildlife Conservation and environmental protection.
- Environmental Scientists, Ecologist, Environmental manager, scientific technical writer, zoo manager, Lab technician

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Examination, Evaluation and Assessment Scheme

1. External Theory Examination - 60 Marks (Minimum Passing Marks = 24)

Question Paper Pattern (for example)			
Unit No.	**Question No.**	**Question Type for Unit**	**Marks**
Three long answer questions of 10 mark each with either OR, from (any Three units out of six units) as example shown in Question Type.		**a) Long answer question.** **OR** **b) Long answer question.**	**10** **10**
A set of Two short answer questions of 05 mark each with either OR, from (any three units out of six units) as example shown in Question Type.		**c) Short answer question.** **d) Short answer question.** **OR** **e) Short answer question.** **f) Short answer question.**	**05** **05** **05** **05**

2. Internal Assessment Marks (Theory) - 40 Marks

- Internal assessment marks (Theory) shall be based on two class tests (20 marks each), student will have to score at least 40 % Marks, that is, 16 Marks for passing the theory internal course.
- In case, even after completing the requisite term-work, the student is unable to score minimum prescribed marks in Internal Theory Examination, that is, 16, he/she will be declared as Fail.
- Now, MCQ, if any, will be part of the Internal Assessment only.
- However, the concerned college/institute/university department shall give one more opportunity to such failure students.
- Thus, failure students will get another chance to clear their theory courses/subjects.
- The remedial re-examination of such failure students shall be conducted before the commencement of end-semester university examinations, so that the concerned college/institute/university department can submit the revised internal marks of such failure students to the University in due course of Time as instructed by the university.

M. Sc. Zoology (NEPv23) Semester-I

Course: Research Methodology and Intellectual Property Rights Th-Major		
Subject Code: 1 ZOO RM	**No. of Credits: 4**	**No. of hours per week: 4**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 60**

COs: 1ZOO (RM)

Upon completion of this course successfully, students would be able to get

1. Fundamental knowledge and skills required to conduct effective research in the field.
2. Covers various research methodologies, experimental design, analysis, interpretation, scientific Communication and ethics in research.
3. Understand the role of research methodology in Science/Zoology.
4. Understand literature review process and formulation of a research problem.
5. Understand data collection methods and basic instrumentation.
6. Learn various statistical tools for data analysis.
7. Learn technical writing and communication skills required for research.
8. IPR aims to equip students with a comprehensive understanding of intellectual property laws, principles and practices.
9. Create awareness about intellectual property rights and patents.

Unit	Contents	Hours
Unit-I	1.1 Definition of research, characteristics of research 1.2 Research process: Steps, objectives, and types of research 1.3 Identifying research problems and formulating research questions 1.4 Problem Formulation, objectives of research problems, Hypothesis 1.5 Literature review and conducting a systematic review of relevant literature	**10**
Unit-II	2.1 Sources of data: Primary, Secondary and Tertiary 2.1 Observation methods in research 2.3 Survey methods and questionnaires in research 2.4 Conducting wildlife surveys and biodiversity assessments 2.5 Mark-recapture methods and population estimation in Zoological studies 2.6 Remote sensing and GIS applications in Zoological research.	**10**
Unit-III	3.1 Introduction to statistical analysis using software packages (e.g., RSPSS) 3.2 Descriptive statistics 3.3 Inferential statistics: Parametric and non-parametric tests in research. 3.4 Data visualization techniques 3.5 Designing and conducting experiments in Zoological studies 3.6 Animal handling, ethics, and welfare in experimental research 3.7 Analysis of data collected from field experiments and laboratory experiments in Zoology.	**10**
Unit-IV	4.1 Scientific writing: Writing of Review of literature for thesis. 4.2 Writing Research articles, 4.3 Preparing reports and project proposals. 4.4 Preparing effective visuals and presentations for conferences 4.5 Writing review articles.	**10**
Unit-V	5.1 Research data bases: Scopus, web of science, Google scholar etc., 5.2 Methods to search required information effectively, 5.3 Reference Management Software like Zotero / Mendeley, Software for paper Formatting like LaTeX/ MS Office.	**10**

	5.4 Peer-review process and publication ethics in research 5.5 Plagiarism- Software for detection of Plagiarism.	
Unit-VI	6.1 Introduction of Intellectual Property Rights (IPR). 6.2 Introduction to TRIPS and WTO. 6.3 Kinds of Intellectual property rights-Copy Right, Patent, Trade Mark, Geographical Indication and Traditional Knowledge. 6.4 Patent: Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. 6.4 Copy Right: Definition &Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with Special reference to software.	**10**

References:

1. Ranjit Kumar, "Research Methodology: A Step-by-Step Guide for Beginners SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.",
3. C.R. Kothari, “Research Methodology: Methods and Trends", New Age International,2004.
4. S.D. Sharma, "Operational Research", Kedar Nath Ram Nath & Co., 1972.
5. B.L. Wadehra, "Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
6. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.
7. https://youtu.be/ur-pIS0CxOg
8. https://www.youtube.com/live/qEFHM_uBwo8?feature
9. https://youtu.be/5o57j4FEIpM

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Course: DSC I.1 Structure and Functions of Invertebrates Th- Major		
Subject Code: 1 ZOO 2	**No. of Credits: 4**	**No. of hours per week: 4**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 60**

COs: 1 ZOO 2

Upon completion of this course successfully, students would be able to ---------

1. Describe various methods of taxonomy.
2. Differentiate between different methods of taxonomy.
3. Identify different types of feeding in invertebrates.
4. Describe mechanisms of chemoreception and photoreception in invertebrates.
5. Conjecture the stage of metamorphosis in insects from concentrations of different hormones.
6. Differentiate between different modes of reproduction.

Unit	Contents	Hours
Unit-I	1.1 Origin, development and utility of systematics (taxonomy) 1.2 Artificial System of classification, Phenetic taxonomy and phylogenetic classification 1.3 Advantages and Disadvantages of molecular taxonomy 1.4 Taxonomic Categories 1.5 Species as a category	**10**
Unit-II	2.1 Organization of coelom: Acoelomates, pseudocoelomates and Coelomates 2.2 Ultrastructure and mechanism of movement of protozoan flagella and cilia 2.3 Hydrostatic movements in Annelida and Echinodermata 2.4 Patterns of feeding and digestion in lower metazoa 2.5 Filter feeding in Polychaeta	**10**
Unit-III	3.1 Organs of Respiration: Gills and Trachea 3.2 Aquatic Respiration in Pila 3.3 Tracheal Respiration in Insects 3.4 Circulatory system in Prawn 3.5 Water vascular system in Echinodermata	**10**
Unit-IV	4.1. Excretion in Protozoa 4.2 Excretory structures and functions in Annelids 4.3 Malpighian tubules: structure and functions in Insects 4.4 Primitive nervous system: Coelenterata and Echinodermata 4.5 Advanced nervous system: Annelida and Arthropoda	**10**
Unit-V	5.1 Mechanoreceptors in Non-chordates 5.2 Chemoreception in invertebrates 5.3 Photoreception in invertebrates 5.4 Eyes in Platyhelminthes, Annelida and Cephalopoda 5.5 Functional Morphology of compound eye in Insects	**10**
Unit-VI	6.1 Reproductive mechanisms in Paramecium and Obelia 6.2 Sexual Reproduction in Cockroach 6.3 Metamorphosis in insects 6.4 General account and affinities of Ctenophora and Rotifera 6.5 Larval forms in Echinodermata: Metamorphosis and Phylogenetic Significance.	**10**

Suggested Readings:

1. Hyman, L.H. The invertebrates. Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd.,London.
3. Jagerstein, G.Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The invertebrates. Vol.2. Mc Graw Hill Co., New York.
5. Hyman, L.H. The invertebrates Vol.8.McGraw Hill Co., N.Y. and London.
6. Barnes, R.D. Invertebrate Zoology, III edition. W.B. Saunders Co., Philadelphi
7. Russel-Hunter, W.D.A biology of higher invertebrates, the Macmillan Co.Ltd., London.
8. Hyman, L.H. The invertebrate's smaller coelomate groups, Vol. V. McGraw Hill Co., New York.
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A. A. Student text book of Zoology. Vol, I, II and III. Central Book Depot, Allahabad.
11. Parker, T.J. Haswell, W.A. Text Book of Zoology, Macmillan Co., London.
12. Borradaile, L.A. and F.A. Potts: The Invertebrates: Asia Publishing
13. House, Bombay, London Nigam: Biology of non-chordata, S. Nagin Chand.
14. Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2 nd ed. Oxford University Press.
15. Ruppert, E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. 7 th ed. Brooks Cole.
16. Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd ed. ELBS & Nelson.
17. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4 th ed. Sinauer Associates.
18. Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.
19. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.
20. Hickman, C.P., Roberts, L.S., Larson, A., I'Anson, H., Eisenhour, D.J. (2006) Integrated Principles of Zoology, 13th Ed. McGraw Hill
21. Moore, J. (2006). An Introduction to the Invertebrates. 2nd Edition Cambridge University Press.
22. Jordan, E.L. and Verma, P.S. (2009). Invertebrate Zoology. S. Chand Publications
23. Kotpal, R. L. (2018). Modern Textbook of Zoology (11th Edition). Rastogi Publications
24. Tembhare, D. B. (20) Modern Entomology. Himalaya Publications

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Course: DSC II.1 General Physiology Th- Major		
Subject Code: 1 ZOO 2	**No. of Credits: 4**	**No. of hours per week: 4**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 60**

COs: 1 ZOO 2

Upon completion of this course successfully, students would be able to ---------

1. To develop a deep understanding of enzymes, hormones, respiratory pigments and neurotransmitters.
2. To understand the concept of Thermoregulation, osmoregulation, chemi-luminescence and camouflage with suitable examples.
3. To understand the various functional components of an organism.
4. To explore the complex network of these functional components.
5. To comprehend the regulatory mechanism for maintenance of function in the body.
6. To understand the concept of special senses.

Unit	Contents	Hours
Unit-I	1.1. Nomenclature and Classification of enzymes, mechanism of enzyme action, Factors affecting rate of enzyme-catalysed reaction, Regulation of Enzyme action. 1.2 Respiratory pigments in animals- types and their functions. 1.3 Classification of hormones; mechanism of hormone action. 1.4 Types of neurotransmitter ; Mechanism of transmission through synapse and Neuromuscular junction.	**10**
Unit-II	2.1 Thermoregulation: Exothermic and endothermic regulation 2.2 Osmoregulation in fishes and amphibians. 2.3 Mechanism of chemo luminescence in invertebrates. 2.4 Camouflage mechanism: types - physiology and significance.	**10**
Unit-III	3.1 Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, Glycogenolysis, Glycogenesis. 3.2 Metabolism of lipids: oxidation of saturated fatty acids with even and odd number of Carbon-atoms. 3.3 Catabolism of amino acids: Transamination, deamination, urea cycle. 3.4 Mechanical and chemical digestion of carbohydrates, proteins and lipids.	**10**
Unit-IV	4.1 Types of Muscle: Ultra structure, chemical composition, mechanism of contraction. 4.2 Structure and types of neurons: Resting membrane potential, action potential, Impulse Transmission through myelinated and unmyelinated nerve fibers. 4.2 Mechanism of reflex action. 4.3 Hormones and their functions- pituitary, pineal, thyroid, pancreas and adrenal.	**10**
Unit-V	5.1 Mechanism of respiration, pulmonary ventilation, transport oxygen and Carbon dioxide in blood. 5.2 Control of Respiration 5.3 Composition of blood and their functions:; haemopoesis, Blood clotting mechanism 5.4 Structure of mammalian heart, cardiac cycle, ECG, Blood pressure and it regulation.	**10**
Unit-VI	6.1 Structure of kidney and its functional unit; mechanism of urine formation. 6.2 Special Senses- Smell- receptor, pathway, Taste- taste buds, pathway. 6.3 Special Senses- Vision- Structure of eye ball, retina, image forming mechanism, Colour vision and color blindness. 6.4 Special sense- Hearing- Functional anatomy of ear, function of middle ear, Organ of corti.	**10**

Suggested Readings:

1) Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK.
2) Barrington, E.J.W.1975. An Introduction to General and Comparative Endocrinology. Clarendon Press,
3) Bentley, P.J.1971. Endocrine and osmoregulation, Springer Verlag, New York.
4) Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA
5) General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India.
6) Guyton, A.C. and Hall, J.E.; Text book of medical physiology, 10th Ed, Saunders, Harcourt, India.
7) Hoar, W.S. General and comparative physiology, Prentice, Hall Inc./England Wood cliffs, New Jersey.
8) Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, springer-verlag, Berlian Heidelberg, New York.
9) Herkat, P.C.and Mathur, P.N.1976. Text Book of Animal Physiology.S.Chand Co. Pvt, Ltd., New Delhi.
10) Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7th Edn, Cambridge University
11) Palmen,J.D. Brown, I.R and Hastings, J.W.1970. Biological clocks, Academic Press,London.
12) Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2 nd Ed. W.B. Sunders, Philadelplina.
13) Ruegg, J.C., Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York. 25
14) Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London.
15) Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.
16) Welson, A. 1979. Principles of Animal Physiology.McMillan Publishing Co. Inc. New York.

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Course: Pr- Major Laboratory 1 (DSC I.1- Structure and Functions of Invertebrates + DSC II.1 -General Physiology)		
Subject Code: 1 ZOO 5	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Structure and Functions of Invertebrates:

1. Museum Study:- Taxonomy of animal specimens/charts / photographs/ models/ video clipping available in the laboratory representing major orders of Non-chordate, other than studied during previous courses.
2. Anatomy of Any 2 Systems by demonstration and labelling with available resources like C.D./chart/ models/ Video clippings/ PPT/ Preserved dissected specimens etc. from Earthworm/ Cockroach/Prawn or similar available non-chordate animals. (Any 1 Animal)
3. Mounting / Stained permanent preparations:-
   i. Paramecium, Vorticella, Euglena
   ii. Rotifers from fresh water
   iii. Mouth parts of mosquito, housefly or any pest /vector insect.
   iv. Wings of small insects (Mosquito, Drosophila, housefly)
4. Photographic collection and Comments on campus/local faunal diversity with reference to their ecology.
   a. Earthworms used in Vermiculture (any three species)
   b. Any five butterfly species
   c. Any five dragonfly species
5. Qualitative analysis of Zooplanktons
6. Identification of diversity of mosquitoes from local area and description of their morphological characters.
7. Study of available Permanent stained slides/ ICT based sources: Whole mounts of larval forms: *Planula, Redia, Cercaria, Cysticercus, bladder worm, Trochophore, Nauplius, Zoea, Mysis, Veliger, Bipinnaria, Echinopluteus, Auricularia, Tornaria.*

B) Practicals for General Physiology

1. Demonstration of action of salivary amylase, trypsin and pepsin.
2. Demonstration of hemoglobin concentration in normal and pathological condition.
3. Estimation of glucose in blood by spectrophotometer or colorimeter. (Source of sample: local recognized pathology laboratory).
4. Estimation of total blood proteins by spectrophotometer or Colorimeter. (Source of sample: local recognized pathology laboratory).
5. Demonstration of rate of O2 consumption in aquatic animals under various environmental stresses.
6. Counting of RBC in blood using Haemocytometer.
7. Counting of WBC in blood using Haemocytometer.
8. Qualitative detection of nitrogenous waste products (Ammonia, urea, uric acid) in given sample.
9. Demonstration of kymograph unit, Respirometer through available resources.
10. Measurement of Blood pressure.

The examinee shall be required to produce at the practical examination the following:

Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Structure and Functions of Invertebrates

1. Anatomical labelling ……..04 Marks
2. Experiment from Section 5 or 6……. 04 Marks
3. Identify given Spots 3 slides & 3 specimens …….12 Marks

Experiments from Section B) Practicals for General Physiology

4. Major physiology experiment…….. 12 Marks
5. Minor physiology experiment…….. 08 Marks
6. Viva Voce …….. 10 Marks

TOTAL **50 Marks**

Internal Marks

1. Certified Practical Record : 20 marks
2. Submission of Permanent slides/Photographic collection : 10 marks
3. Survey based on Practicals : 10 Marks
4. Student Performance : 10 Marks

TOTAL **50 Marks**

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Course: DSC III.1 Developmental Biology Th- Major		
Subject Code: 1 ZOO 3	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 1 ZOO 3

Upon completion of this course successfully, students would be able to ---------

1. Study spermatogenesis and oogenesis in eukaryotes.
2. Determine different events and their mechanisms during fertilization and its consequent changes.
3. Learn assisted reproduction techniques to overcome infertility.
4. Understand Ex vivo and In vivo gene therapy etc.
5. Learn about contraception and methods

Unit	Contents	Hours
Unit-I	**Gametogenesis** 1.1 Spermatogenesis in mammals and its regulation. 1.2 Gamete specific gene expression. 1.3 Formation and composition of semen. 1.4 Oogenesis in mammals and its regulation. 1.5 Ovarian follicular growth: Morphology, endocrinology and molecular biology. 1.6 Ovulation and its regulation	**07**
Unit-II	**Fertilization** 2.1 Cell surface molecules in sperm-egg recognition. 2.2 Reaction of sperm: Sperm motility, capacitation, chemotaxis, acrosome reaction, Fusion of sperm and egg plasmalemma. 2.3 Reaction of egg: Formation of fertilization cone, 2.4 Amphimixis.	**07**
Unit-III	**Creating Multicellularity** 3.1 Patterns of cleavage. 3.2 Blastulation in Amphioxus, Frog and Chick. 3.3 Gastrulation in Amphioxus, Frog, Chick and Mammals. 3.4 Genomic imprinting	**08**
Unit-IV	**Biology of sex determination** 4.1 Sex determination in Mammals and Drosophila. 4.2 Differentiation of gonads in Mammals. 4.3 Secondary sex determination in Mammals. 4.4 Environmental sex determination	**08**
Unit-V	**Assisted Reproduction Techniques:** 5.1 Causes of infertility in humans. 5.2 In vitro fertilization: Superovulation, collection and cryopreservation of gametes, In vitro gamete maturation, Preimplatation genetic diagnosis, Procedure of IVF. 5.3 ICSI, GIFT and ZIFT. 5.4 Disadvantages of assisted reproduction. 5.5 Cloning of animals by nuclear transfer.	**08**
Unit-VI	**Contraception:** 6.1 Physical barriers. 6.2 Hormonal methods. 6.3 Emergency contraceptives. 6.4 Surgical methods.	**07**

	6.5 Intrauterine contraceptive devices (IUCDs). 6.6 Concept of immunocontraception.	

Suggested Readings:

1) Long J.A.Evan H.M.1922:the oestrous cycle in the Rat and its associated phenomenon.
2) Nalbandou. A.C. – Reproductive physiology
3) Prakash A.S. 1965-66 Marshall's, Physiology Reproduction (3 Vol.)
4) Gilbert, S.F. Developmenal Biology, Sinauer Associated Inc. Massachulsetts.
5) Ethan Bier, thecold Spring.Thecoldspring Harbor laboratory Press, New York.
6) Balinsky B.I. Introduction to Embryology sanders, Phliedelphia.
7) Berril N.J. and Karp. G .Development Biology. McGraw Hill New York.
8) Davidson ,E.H. GeneActivity During Early Development. Academic Press, New York.
9) Wolpert Principles of Development10. Slack Essential Developmental Biology-.
10) Principles of Development, 3rd edition (2007), LewisWolpert, Publisher- Oxford University Press.
11) An Introduction to Embryology, 5th edition(2004), B.I.Balinsky. Publisher–Thomas Asia Pvt.Ltd
12) Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.
13) Concepts of Genetics,9th edition (2008),William S. Klug, Michael R. Cummings, Charlotte Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
14) Genes IX, 9th edition (2008), Benjamin Lewin, Publisher-Jones and Barlett Publishers Inc.
15) Principles of Genetics, 4thedition, (2006),Snustad D.Peter and Simmons J. Micheal, Publisher-John Wiley and Sons. Inc.
16) Genetics,(1999),Daniel J. Fairbanks, W. Ralph Andersen Publisher-Brooks/Cole Pub Co.
17) Principles of Genetics, 8th edition(1991), Eldon J. Gardner, D. P. Snustad, M.J. Simmons, and D. Peter Snustad Publisher-John Wiley and Sons. Inc.
18) Microbial Genetics,(1987), David Freifelder,Publisher-Jones & Bartlett
19) General Genetics,(1985),Leon A. Snyder,David Freifelder, Daniel L. Hartl Publisher-Jonesand Bartlett.
20) Genetics, 3rdedition, MonroeW. Strickberger,(1968), Publisher- Macmillan Publishing Co.

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Course: DSE- Tools and techniques in Biology Th- Major Elective		
Subject Code: 1 ZOO 4 (TB)	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 1 ZOO 4 (TB)

Upon completion of this course successfully, students would be able to ---------

1. Student will develop real time problem solving skills using techniques like electrophoresis, chromatography based applications based questions and projects.
2. The course will help to understand the principles and applications of different biophysical techniques.
3. The Course will able to differentiate in between structure, size, shape, dynamics, polarity, and modes of interaction of biological molecules.
4. To get acquainted with Cytological and histological techniques.

Unit	Contents	Hours
Unit-I	1.1 Light microscope and phase contrast microscope. 1.2 Electron microscope. 1.3 Microtechnique: Tissue fixation, Dehydration, clearing, embedding, Block-making, Trimming. 1.4 Microtome: Rotary. 1.5 Methods of staining and mounting.	**07**
Unit-II	2.1 Basic operation of digital weighing balance. 2.2 Working of autoclave and Oven. 2.3 Handling of Pipettes and Micropipettes. 2.4 Hot Water Bath. 2.5. C.O.D. and B.O.D. Incubators.	**07**
Unit-III	3.1 Density gradient centrifugation. 3.2 Unit gravity centrifugation. 3.3 Affinity adsorption. 3.4 Anchorage-based techniques	**08**
Unit-IV	4.1 Paper and Thin Layer Chromatography. 4.2 Gas chromatography. 4.3 Ion exchange chromatography and its uses 4.4 Affinity chromatography and its uses	**08**
Unit-V	5.1 Cellulose acetate paper electrophoresis and its uses. 5.2 Separation of DNA by Agarose gel electrophoresis. 5.3 Separation of proteins by SDS-PAGE electrophoresis. 5.4 Capillary electrophoresis.	**08**
Unit-VI	6.1 Principle and uses of Colorimeter. 6.2 Spectrophotometer and its uses. 6.3 Fluorescence Spectrophotometer and its uses. 6.4 Atomic Absorption Spectroscopy and its uses.	**07**

Suggested Readings:

1) Molecular cell Biology, J. Darnell , H. Lodish & D. Baltimore , Scientific American Book , Inc. USA.
2) Molecular cell Biology of the cell , B Alberts , D Bray , J. Lewis , M. Raff , K. Roberts and J. D. Watson . Garland Publishing Inc. New York.
3) The cell a molecular approach: Cooper
4) Molecular cell biology: Gerald Karp
5) Animal Cell Culture – A practical approach, Ed. John R.W.Masters. IRL Press.
6) Introduction to instrumental analysis, Robert Braun. McGraw Hill International Editions.
7) A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
8) Foundation in microbiology : Talaro
9) Microbiology: Pelczar
10) Biology of micro- organisms : Madigan, Martinko and Parker.
11) Biophysical chemistry- Principles and technique: Upadhyay, Nath
12) Developing Bioinformatics Computer Skills: An Introduction to Software Tools for Biological Applications: Gibas, Cynthia, Jambeck, Per:
13) Introduction to Computational Biology : MAPS, Sequences and Genome : By Michael S.Waterman, Published by CRC Press; (June 1, 1995).
14) Data Analysis and Classification for Bioinformatics by A.Jagota, Published by Bioinformatics by the Bay Press; (August 1, 2000) ISBN0970029705.
15) Molecular Modelling and Simulation by Tamar Schlick, Published by Springer Verlag (August 19, 2002) ISBN : 038795404X.

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Course: Pr- Major Laboratory 2. (DSC III.1- Developmental Biology + DSE- Tools and techniques in Biology)		
Subject Code: 1 ZOO 6	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Developmental Biology :

1. Morphology and histology of non-chordate and chordate ovary and testis (insects, snails, frog and rat).
2. Study of mammalian/avian oogenesis and spermatogenesis through histological preparation.
3. Preparation and submission of permanent slide of testis, ovary, uterus, epididymis, prostate, and seminal vesicles.
4. Study of different types of eggs on the basis of their yolk content.
5. Collection and rearing of frog and toad spawn, embryos and larvae up to metamorphosis in the laboratory, preparation and study of developmental stages.
6. Study of cleavage in Lymnaea in laboratory.
7. Mounting of parasitic larvae in Lymnaea / Bellamya.
8. Study of development of Amphioxus, Frog, Chick and Pig through histological slides and whole mounts.
9. Whole mounting of chick embryo through window method.
10. Sperm counting.
11. Counting of abnormal sperm.
12. Semen analysis-Quantitative determination of fructose in semen.
13. Study of effect of antifertility drugs on various part of reproductive tract through estimation of Ascorbic acid.

B) **Practicals for Tools and techniques in Biology**

1. Preparation of fixatives - Alcohol, Acetone, Formalin, Bouin's fluid, Conroy's fluid.
2. Preparation of Alcoholic grades, dehydration and clearing of tissues.
3. Embedding, block making and trimming of block.
4. Honing and stropping Knives
5. Section cutting and spreading.
6. Preparation of various stains -Borax carmine Acetocarmin, Aceto-orcein, Haematoxyline, eosin.
7. Staining of the sections, (Double Staining), mounting.
8. Determine absorption spectrum of Haemoglobin.
9. Spectrophotometric determination of dyes (different colour compound).
10. Separation of emulsion by simple centrifugation.
11. Sedimentation of red blood cell by centrifugation.
12. Paper chromatography of amino acids.
13. Thin layer chromatographic separation of sugars.
14. Separation of DNA mixture by Agarose gel electrophoresis.

The examinee shall be required to produce at the practical examination the following:

Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a Bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Developmental Biology

1. Major Experiment ……..12 Marks
2. Minor Experiment…… 08 Marks

Experiments from Section B) Practicals for Tools and techniques in Biology

3. Major Experiment ……..12 Marks
4. Minor Experiment…… .08 Marks
5. Viva Voce …….. 10 Marks

TOTAL **50 Marks**

Internal Marks

1. Certified Practical Record : 20 marks
2. Submission of Permanent slides/Photographic collection : 10 marks
   Whole Mounts/Developmental Stages
3. Survey based on Practicals : 10 Marks
4. Student Performance : 10 Marks

TOTAL **50 Marks**

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Course: DSE- Wildlife Conservation and Management Th- Major Elective		
Subject Code: 1 ZOO 4 (WCM)	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 1 ZOO 2 (WCM)

Upon completion of this course successfully, students would be able to ---------

1. Define and Explain Wildlife Conservation: Students will articulate the definition and Significance of wildlife conservation, discussing its role in preserving biodiversity and ecological Balance.
2. Examine Wildlife Management Techniques: Students will demonstrate the ability to apply wildlife Management techniques, including assessing wildlife populations, habitat management, and the Establishment of wildlife corridors.
3. Analyze Legal and Policy Frameworks: Students will analyze the legal and policy frame works Governing wildlife conservation, with an understanding of international conventions and the roles of governmental and non-governmental organizations.
4. Evaluate Human-Wildlife Interactions: Students will evaluate the interactions between humans and Wildlife, identifying potential conflicts and proposing strategies for mitigation.
5. Design Sustainable Wildlife Tourism Practices: Students will design and justify sustainable Wildlife tourism practices, considering economic benefits and ethical considerations.
6. Promote Conservation Awareness through Education: Students will design educational initiatives to raise conservation awareness, emphasizing responsible wildlife viewing practices and ethical Wildlife management.

Unit	Contents	Hours
Unit-I	**Foundations of Wildlife Conservation and Management** 1.1 Definition, Importance, Scope, and Challenges of Wildlife Conservation 1.2 Historical Perspectives and Key Milestones 1.3 Biodiversity: Concept of Diversity, Rarity, and Endemism 1.4 Biodiversity Assessment Tools & Techniques	**07**
Unit-II	**Wildlife Ecology and Behaviour** 2.1 Concept of the Niche 2.2 Feeding Ecology 2.3 Group Size, Mate Selection, and Signals/Communication 2.4 Birth and Death Rates	**07**
Unit-III	**Protected Areas and Wildlife Management** 3.1 Protected Area Network in India 3.2 Conservation of keystone species 3.3 Habitat Management in Protected Areas 3.4 Ecotourism & Community Participation	**08**
Unit-IV	**Human-Wildlife Conflict Management** 4.1 Causes and Consequences of Human-Wildlife Conflicts 4.2 Conflict Resolution Techniques: Proactive & Reactive Management of Conflict 4.3 Community-Based Approaches to Conflict Management 4.4 Policy Frameworks and Legal Mechanisms	**08**
Unit-V	**Wildlife Laws and Policies** 5.1 Overview of National and International Wildlife Conservation Laws and Conventions 5.2 Role of Governmental and Non-Governmental Organizations in Wildlife Conservation	**08**

	5.3 Ethical Considerations in Wildlife Management and Conservation 5.4 Enforcement Mechanisms and Challenges in Implementing Wildlife Laws and Policies	
Unit-VI	**Conservation Education and Outreach** 6.1 Importance of Public Awareness and Education in Wildlife Conservation 6.2 Participation in Wildlife Conservation & Participative Platforms 6.3 Designing Effective Conservation Education Programs: Outreach Techniques 6.4 Role of Citizen Science and Volunteer Programs.	**07**

Suggested Readings:

1. Wildlife Management in India by Rangarajan M. (Publication: Oxford University Press)
2. Ecology and Wildlife Management by Kailash Chandra Bebarta (Publication: PHI Learning Pvt. Ltd.)
3. Wildlife Conservation in India by Hemendra Singh Panwar (Publication: Oxford University Press)
4. Wildlife Biodiversity Conservation: A Book of Abstracts by Chandrakasan Sivaperuman, C. Selvanayagam, and R. Raghunathan (Publication: Daya Publishing House)
5. Indian Forestry: A Breakthrough Approach to Forest Service by K. Manikandan and S.Prabhu (Publication: PHI Learning Pvt. Ltd.)
6. Indian Wildlife Insights by Ashok Kumar (Publication: Indus Publishing Company)
7. Conservation at the Crossroads: Science, Society, and the Future of India's Wildlife edited by Ghazala Shahabuddin and K. Sivakumar (Publication: Permanent Black)
8. Conservation Biology: Foundations, Concepts, Applications by Fred Van Dyke (Publication: Springer)
9. The Diversity of Life by Edward O. Wilson (Publication: Harvard University Press)
10. Sustaining Life: How Human Health Depends on Biodiversity by Eric Chivian and Aaron Bernstein (Publication: Oxford University Press)
11. Wildlife Ecology, Conservation, and Management by John M. Fryxell, Anthony R. E. Sinclair, and Graeme Caughley (Publication: Wiley-Blackwell)
12. Principles of Conservation Biology by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll (Publication: Sinauer Associates)
13 Introduction to Conservation Genetics by Richard Frankham, Jonathan D. Ballou, and David A. Briscoe (Publication: Cambridge University Press)
14. Wildlife Management and Conservation: Contemporary Principles and Practices by Paul R. Krausman and James W. Cain III (Publication: Johns Hopkins University Press)
15. The Sixth Extinction: An Unnatural History by Elizabeth Kolbert (Publication: Henry Holt and Co.)
16. Saving the World's Wildlife: WWF's First Fifty Years by David Shepherd (Publication: Collins)
17. Wildlife Conservation in India by Prakash Saini and K.K. Sharma (Publication: Daya Publishing House)
18. "Ecology and Behaviour of Indian Vertebrates" by H.S. Pabla
19. "Animal Behavior: Concepts, Methods, and Applications" by Shawn E. Nordell and Thomas J. Valone
20. "Population Ecology of Indian Animals" by A.J.T. Johnsingh and Nima Manjrekar
21. A History of Conservation in India edited by Mahesh Rangarajan (Publication: Permanent Black)
22. Feeding Ecology of Wild Herbivores by R. J. Hudson and M. R. Drew (Publication: Academic Press)
23. Indian Wildlife Sanctuaries and National Parks by S.C. Sharma (Publication: Daya Publishing House)
24. Keystone Species and Ecosystem Functioning edited by Michel Loreau, Shahid Naeem, and Pablo Inchausti (Publication: Oxford University Press)
25. Ecotourism and Sustainable Development: A Case Study of Indian Tourism by S.K. Sharma and R.K. Dixit (Publication: Indus Publishing Company)
26. Community Participation in Wildlife Conservation by A.K. Sharma and S. Gupta (Publication: Daya Publishing House)
27. Human-Wildlife Conflicts in India: Causes, Consequences and Management Strategies by R.K. Sharma and R. Gopal (Publication: Daya Publishing House)

28. Wildlife Laws in India by S. C. Sharma (Publication: Daya Publishing House)
29. Role of NGOs in Wildlife Conservation by P. S. Mathur and R. K. Sharma (Publication: Daya Publishing House)
30. Conservation Organizations in India by S.K. Sharma and R.K. Dixit (Publication: Indus Publishing Company)
31. Conservation Education and Outreach Techniques by S. K. Sharma and R. K. Dixit (Publication: Indus Publishing Company)
32. Conservation Education for Sustainability by P.K. Mathur and R. Gopal (Publication: Indus Publishing Company)
33. Wildlife Conservation Awareness Techniques by P. K. Mathur and S. R. Gupta (Publication: Daya Publishing House)
34. Citizen Science in Wildlife Conservation by A. K. Sharma and S. Gupta (Publication: Daya Publishing House)
35. Volunteer Programs in Wildlife Conservation by S. R. Gupta and R. S. Negi (Publication: Indus Publishing Company)

UCN Red List of Threatened Species:
(Website: https://www.iucnredlist.org/)

Encyclopedia of Life (EOL):
(Website: https://eol.org/)

Food and Agriculture Organization (FAO) Fisheries and Aquaculture Department:
(Website: http://www.fao.org/fishery/)

Cornell Lab of Ornithology: (Website: https://www.allaboutbirds.org/)

National Center for Biotechnology Information (NCBI):
(Website: https://pubmed.ncbi.nlm.nih.gov/)

Smithsonian Conservation Commons:
(Website: https://www.si.edu/conservation)

Smithsonian Institution's Encyclopedia of Life Sciences:
(Website: https://www.smithsonianmag.com/science-nature/)

Biodiversity Heritage Library:
(Website: https://www.biodiversitylibrary.org/)

Conservation Commons:
(Website: https://www.conservationcommons.org/)

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Course: Pr- Major Laboratory 2. (DSC III.1- Developmental Biology + DSE- Wildlife Conservation and Management)		
Subject Code: 1 ZOO 6	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Developmental Biology :

1. Morphology and histology of non-chordate and chordate ovary and testis (insects, snails, frog and rat).
2. Study of mammalian/avian oogenesis and spermatogenesis through histological preparation.
3. Preparation and submission of permanent slide of testis, ovary, uterus, epididymis, prostate, and seminal vesicles.
4. Study of different types of eggs on the basis of their yolk content.
5. Collection and rearing of frog and toad spawn, embryos and larvae up to metamorphosis in the laboratory, preparation and study of developmental stages.
6. Study of cleavage in Lymnaea in laboratory.
7. Mounting of parasitic larvae in Lymnaea/Bellamya.
8. Study of development of Amphioxus, Frog, Chick and Pig through histological slides and whole mounts.
9. Whole mounting of chick embryo through window method.
10. Sperm counting.
11. Counting of abnormal sperm.
12. Semen analysis-Quantitative determination of fructose in semen.
13. Study of effect of antifertility drugs on various part of reproductive tract through estimation of Ascorbic acid.

B) **Practicals for Wildlife Conservation and Management**

1. Laboratory Demonstration of Local Diversity *Butterfly, Amphibian, Reptilian, Avian, Mammalian Diversity* (Models/Photograph/online Resources).
2. DNA extraction from scat/hair/saliva samples.
3. Biodiversity Assessment

   Objective: Students conduct field surveys to identify and document various species in a selected area, focusing on diversity, rarity, and endemism. (Non-invasive Method)

   Survey of Odonata, Butterflies, Birds, Larger Mammals, Amphibia, Reptilia etc.)
4. Field Trip to a Protected Area

   Objective: Students visit a nearby protected area to observe its management practices, biodiversity, and the role of local communities in conservation.
5. Field Practical (Any two) from the list provided

List of Field Practical

a) **Species Identification and Data Collection**
   Objective: Students practice species identification techniques, use field guides and identification keys, and collect data on species abundance and distribution.
b) **Habitat Suitability Assessment**
   Objective: Students assess habitat suitability for a selected species, considering factors such as food availability, shelter, and reproductive requirements.
c) **Diet Analysis**
   Objective: Students collect and analyse animal scat or stomach contents to determine the diet composition of a selected species.
d) **Observational Study of Social Behaviour**
   Objective: Students observe and record social interactions, mate selection behaviours, and communication signals among a group of animals in captivity or the wild.
e) **Keystone Species Monitoring**

Objective: Students select a keystone species and design a monitoring program to assess its population trends, habitat requirements, and conservation status.

f) **Ecotourism Site Assessment**
Objective: Students evaluate an ecotourism site for its ecological sustainability, socio-economic benefits to local communities, and potential impacts on wildlife.

g) **Conflict Hotspot Mapping**
Objective: Students identify and map areas prone to human-wildlife conflicts, analyse underlying causes, and propose mitigation measures.

h) **Conflict Resolution Workshop**
Objective: Students participate in role-playing exercises to simulate conflict scenarios and develop strategies for proactive and reactive conflict management.

i) **Legal Case Study Analysis**
Objective: Students analyse landmark wildlife legal cases, explore their implications for conservation, and propose amendments or improvements to existing laws.

j) **NGO Partnership Project**
Objective: Students collaborate with local NGOs on a conservation project, gaining first hand experience in NGO-government partnerships.

k) **Conservation Awareness Campaign**
Objective: Students design and implement a conservation awareness campaign targeting local communities, schools, or online platforms.

l) **Education Program Development**
Objective: Students develop lesson plans or educational materials for teaching wildlife conservation concepts to different target audiences.

m) **Citizen Science Project**
Objective: Students design and implement a citizen science project to involve volunteers in wildlife monitoring, data collection, or conservation research.

6. One scientific project/Case Study from the list provided

List of Scientific Projects & Subjects for case studies

a) **Population Dynamics Study of a Local Species:**
Objective: To investigate the population dynamics of a selected species in a specific habitat over a period of time.
Methodology: Conduct field surveys to estimate population size, demographic parameters, and factors influencing population trends (e.g., birth and death rates, habitat changes, human activities).
Deliverables: Scientific report documenting population dynamics, including data analysis, interpretation of results, and recommendations for conservation management.

b) **Assessment of Habitat Suitability for Endangered Species:**
Objective: To assess the suitability of different habitats for an endangered species and identify key habitat requirements.
Methodology: Conduct habitat surveys, assess habitat quality and availability of resources (food, water, shelter), and analyze species-habitat relationships using GIS and remote sensing techniques.
Deliverables: Scientific project proposal outlining research objectives, methods, and expected outcomes; scientific report detailing habitat suitability assessment findings and conservation implications.

c) **Community-Based Conservation Initiative:**
Objective: To develop and implement a community-based conservation project in collaboration with local communities.
Methodology: Engage with stakeholders through participatory approaches (e.g., community meetings, workshops) to identify conservation priorities, design conservation actions, and monitor project outcomes.
Deliverables: Project proposal outlining objectives, activities, budget, and timeline; scientific report documenting project implementation, community involvement, and conservation outcomes.

d) **Evaluation of Ecotourism Impacts on Wildlife and Local Communities:**
Objective: To evaluate the ecological and socio-economic impacts of ecotourism on wildlife and local communities.
Methodology: Conduct surveys, interviews, and ecological assessments in ecotourism sites to assess changes in wildlife behaviour, habitat degradation, and community livelihoods.
Deliverables: Scientific project proposal outlining research objectives, methods, and expected outcomes; scientific report presenting findings and recommendations for sustainable ecotourism management.

e) **Development of Wildlife Corridors for Habitat Connectivity Enhancement:**
Objective: To design and implement wildlife corridors to enhance habitat connectivity and promote gene flow between fragmented habitats.

Methodology: Conduct landscape analysis, stakeholder consultations, and habitat restoration activities to establish wildlife corridors, monitor wildlife movements, and assess corridor effectiveness.
Deliverables: Project proposal outlining corridor design, implementation plan, and monitoring protocols; scientific report evaluating corridor effectiveness and conservation outcomes.

The examinee shall be required to produce at the practical examination the following:
Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a Bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Developmental Biology

1. Major Experiment ……..12 Marks
2. Minor Experiment…….. 08 Marks

Experiments from Section B) Wildlife Conservation and Management

3. DNA Extraction from scat, hairs, or saliva .....08 Marks
4. Spottings……..08 Marks
5. Project (case studies) report as per syllabus .....04 Marks
6. Viva Voce ……... 10 Marks

TOTAL **50 Marks**

Internal Marks

1. Certified Practical Record : 20 marks
2. Presentation on successful examples of sustainable Wildlife Conservation Initiatives : 10 marks
3. Submission of Permanent slides/Photographic collection : 10 marks
   Whole Mounts/Developmental Stages
4. Student Performance : 10 Marks

TOTAL **50 Marks**

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M. Sc. Zoology (NEPv23) Semester-II

Course: DSC I.2 Structure and Functions of Vertebrates Th- Major		
Subject Code: 2 ZOO 1	**No. of Credits: 4**	**No. of hours per week: 4**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 60**

COs: 2 ZOO1

Upon completion of this course successfully, students would be able to ---------

1. Describe merits and demerits of different types of taxonomic keys.
2. Differentiate between binomial and trinomial nomenclature.
3. Describe rules of International Code of Zoological Nomenclature (ICZN).
4. Identify various derivatives of integument in vertebrates.
5. Describe characteristic features of Agnatha.
6. Differentiate between different types of kidneys.
7. Justify position of protochordates among chordates

Unit	Contents	Hours
Unit-I	1.1 Types of Taxonomic keys, their merits and demerits. 1.2 Binomial and trinomial nomenclature 1.3 Principles and application of important rules of International Code of Zoological Nomenclature (ICZN) 1.4 Origin and classification of chordates	**10**
Unit-II	2.1 Characters, classification and evolutionary significance of Protochordata 2.2 Characteristic features of Agnatha and development of Ammocoete larva 2.3 General characters and affinities of Dipnoi. 2.4 Structure of integument in different classes of vertebrates, derivatives of integument: Glands, scales, horns, feathers, claws and hairs	**10**
Unit-III	3.1 Comparative account of Jaw suspension in vertebrates 3.2 Comparative account of girdle and limbs 3.3 Structure of tooth and dentition in Mammalia 3.4 Anatomy of gut in relation to feeding habits-herbivores, carnivores and omnivores	**10**
Unit-IV	4.1 Evolution of heart in vertebrates 4.2 Evolution of aortic arches and portal systems 4.3 Respiratory organs in fishes and amphibians 4.4 Air sacs in birds	**10**
Unit-V	5.1 Comparative anatomy of brain in relation to its function 5.2 Nerves: Cranial, peripheral and autonomous nervous system 5.3 Sense organs, simple receptors, organs of olfaction and taste, lateral line system and electric organs 5.4 Evolution of urinogenital system in vertebrates	**10**
Unit-VI	6.1 Origin of paired fins 6.2 Origin of Birds, Migration in Birds 6.3 Cetacea: General characters and adaptations 6.4 Evolution of Man: Primate ancestors of man from Oligocene, Miocene, Pliocene epochs. Pleistocene hominids.	**10**

Suggested Readings:

1. Carter, G.S. Structure and habit in vertebrate evolution-Sedgwick and jackson, London.
2. Eecles, J.C. The understanding of the brain. Mc Graw Hill co., New York and London.
3. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot, Allahabad.
4. Kent, C.G. Comparative Anatomy of Vertebrates.
5. Malcom Jollie, Chordata morphology. East-West Press Pvt. Ltd. New Delhi.
6. Milton Hilderbrand. Analysis of vertebrate structure. IVEd. John Wiley and Sons Inc., New York.
7. Monielli, A.R. The chordates, Cambridge University Press, London.
8. Smith, H.S. Evolution of chordata structure. Hold rinehart and Winstoin Inc., New York.
9. Sedgwick, a.A.Students Text Book of Zoology, Vol.II.
10. Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London.
11. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
12. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
13. Wolstenholnf,E.W.andKnight,J.(Ed).Tasteandsmellinvertebrates,J&AChurchill,London.
14. Romer,A.S.,VertebrateBody,IIIrdEd.W.B.Saundersco.,Philadelphia.
15. Young,J.Z.Lifeofvertebrates.TheOxfordUniversityPress,London.
16. Young,J.Z.Lifeofmammals,OxfordUniversityPress,London.
17. Colbert,E.H.Evolutionofthevertebrates,JohnWileyandSonsInc., NewYork.
18. Romer,A.S.VertebratePaleontology,3rdEdn.UniversityofChicago Press,Chicago.
19. Clark,W.E.Historyof the Primates IV Edn. University of Chicago Press,Chicago.
20. Weichert,C.K.andPresch,W.Elementsofchordateanatomy,4thEdn.McGrawHillBookCo,NewYork.
21. Messers, H.M. An introduction ofvertebratesanatomy
22. Montagna,W.Comparativeanatomy.Hohn.WileyandSonsInc.
23. De Deer,S.G.EmbryosandAncestors.ClarendonPress,Oxford.
24. Andrews, S.M. Problems in vertebrate evolution. Academic Press,NewYork.
25. Waterman.A.J.chordatastructureandfunction.Macmillanco.,New York.
26. Bhamrah and Juneja, Chordate Zoology,Anmol Publishers, N. Delhi Bhamarah and Juneja, Invertebrate Zoology,Anmol Publishers,N.Delhi.
27. Barbiur,T. Reptiles and Amphibians: Their habits and adaptations.HongtonMiffinCo.,NewYork.
28. KingsleyNoble,g.ThebiologyoftheAmphibia.DoverPublications,NewYork.
29. Smyth.Amphibiaandtheirways.TheMcMillanco..,NewYork.
30. Andrevos,S.M.,Miles, R..S.andWalker,A.D.Problemsinvertebrate evolution.AcademicPress, NewYork.
31. Boolotian and Stiles: College Zoology (Macmillan)
32. Campbell: Biology(Benjamin)
33. MarshallandWilliams:TextBookofZoology

34. Wolfe: Biology the Foundations(Wadsworth)
35. Wilson.Biodiversity,AcademicPress,Washington.
36. G.G. Simpson. Principleofanimaltaxonomy,Oxford IBHPublishing Company
37. E.Mayer.ElementsofTaxonomy.
38. E.O. Wilson. The Diversityof Life(TheCollege Edition),W.W.Northern &Co.
39. Tripathi,R.S.Biosystematicsandtaxonomy
40. Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.
41. Kardong, K. V. (2002). Vertebrates: Comparative anatomy,function evolution. Tata McGraw Hill.
42. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy ofthe Vertebrates. 9 th ed. Mc Graw Hill.
43. Hickman, C.P., Roberts, L.S., Larson, A., I'Anson, H., Eisenhour, D.J. (2006) Integrated Principles of Zoology, 13th Ed. McGraw Hill
44. Kardong, K. (2006). Vertebrates: comparative anatomy, function, evolution, 6th edition. Mc Graw Hill Publications
45. Kotpal, R. L. (2018). Modern Textbook of Zoology (11th Edition). Rastogi Publications

Weblink to Equivalent MOOC on SWAYAM if relevant:

https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA 32

Weblink to Equivalent Virtual Lab if relevant:

https://www.youtube.com/watch?v=PfWVMq4RDNw•https://www.youtube.com/watch?v=cCWHeq8H4TY•

https://youtu.be/uK6TAPBaBq0•https://www.youtube.com/watch?v=B4lyIDOXH3A

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Course: DSC II.2 Molecular Cell Biology Th- Major		
Subject Code: 2 ZOO 2	**No. of Credits: 4**	**No. of hours per week: 4**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 60**

COs: 2 ZOO 2

Upon completion of this course successfully, students would be able to ---------

1. At the end of the course, the student has a strong foundation on the functions of the cell.
2. This course imparts students the knowledge about how cell to cell communication occurs to carry out different functions of the cell.
3. The course will help to understand the basic principles of signal transduction mechanisms, In particular the concepts of response specificity, signal amplitude and duration, Signal integration and intracellular location
4. It will help the students to provide knowledge about cytoskeleton of the cells and how it gives Strength, shape and motility to the cell.
5. Have an overview of the different intracellular transport pathways in the eukaryotic cell, and understand how proteins and lipids affect these processes.

Unit	Contents	Hours
Unit-I	1.1 Biochemical composition of biomembranes. 1.2 Transport across cell membrane and Transporters. 1.3 Transport across epithelia 1.4 Basement membrane (basal lamina): structural and cross-linking components. 1.5 Collagens & other proteins of extracellular matrix. 1.6 Cell-cell adhesion and Cell-matrix adhesion. 1.7 Gap junctions and connexins.	**10**
Unit-II	2.1 Modes of cell signaling (autocrine, juxtacrine, paracrine and endocrine). 2.2 Signaling molecules. 2.3 G protein-coupled receptors that activate or inhibit adenylyl cyclase. 2.4 G protein-coupled receptors that regulate ion channels. 2.5 G protein-coupled receptors that activate phospholipase C. 2.6 Receptor protein-tyrosine kinases , Receptor protein-tyrosine phosphatases. 2.7 Receptor protein-guanylyl cyclases and Cytokine receptors. 2.8 Receptor blockers.	**10**
Unit-III	3.1 Second messengers. 3.2 Ion channels and electrical signaling. 3.3 Signal transduction by G protein-coupled receptors. 3.4 Signal transduction by receptor enzymes. 3.5 JAK-STAT pathway, Smad pathway, Wnt pathway, and hedgehog pathway. 3.6 Signal transduction in vision, gustation and olfaction.	**10**
Unit-IV	4.1 Phases of eukaryotic cell cycle. 4.2 Cyclins & cyclin-dependent kinases (CDKs). 4.3 DNA replication block & its removal. 4.4 Cell cycle checkpoints. 4.5 Regulation of CDK-Cyclin activity. 4.6 Programmed cell death (Apoptosis): Mechanism (intrinsic and extrinsic) & significance.	**10**
Unit-V	5.1 Structure of microfilaments.	**10**

	5.2 Dynamics and functions of microfilaments. 5.3 Microfilament membrane-binding proteins & their functions. 5.4 Structure, dynamics and functions of microtubules. 5.5 Structure and functions of intermediate filaments	
Unit-VI	6.1 Protein synthesis in eukaryotes 6.2 Protein uptake into ER. 6.3 Co- & Post-translational modifications of proteins in ER. 6.4 Protein sorting in Golgi apparatus. 6.5 Vesicle formation and fusion. 6.6 Transport of proteins across nuclear membrane.	**10**

Suggested Readings:

1. 1.Molecular cell Biology, J. Darnell , H. Lodish & D. Baltimore , Scientific American Book , Inc. USA.
2. Molecular cell Biology of the cell , B Alberts , D Bray , J. Lewis , M. Raff , K. Roberts and J. D. Watson Garland Publishing Inc. New York.
3. The cell a molecular approach: Cooper
4. Molecular cell biology: Gerald Karp
5. Animal Cell Culture – A practical approach, Ed. John R.W.Masters. IRL Press. 35
6. Introduction to instrumental analysis, Robert Braun. McGraw Hill International Editions
7. A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
8. Foundation in microbiology : Talaro
9. Microbiology: Pelczar
10. De Robertis- E. D. P., - Cell and Molecular Biology , I. S. E. publication.
11. Turner P. C. and Mc Lennan - Molecular Biology ; Viva Books Pvt. Ltd.
12. Benjamin Lewis - Gene VIII , Oxford press.
13. Watson J. D. - Molecular biology of Gene ., Benjamin publication.
14. Darnell J. - Molecular cell Biology ; Scientific American Books USA.
15. Alberts B., Bray D. Lewis J.- Molecular Biology of the Cell , garland publishing Inc.

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Course: Pr- Major Laboratory 3. (DSC I.2- Structure and Functions of Vertebrates + DSC II.2 –Molecular Cell Biology)		
Subject Code: 2 ZOO 5	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Structure and Functions of Vertebrates:

1. Anatomy of Any Two Systems by demonstration and labelling with available resources like C.D./chart/ models/ Video clippings/ PPT/ Preserved dissected specimens etc. from a major carp fish / Rat / mouse / rabbit or similar available chordate animals (Any one animal)
2. Study of stained permanent slides by ICT based sources: Mammalian Histology: Skin, bone, regions of alimentary canal, digestive glands, lung, kidney, gonads, liver, pancreas.
   - Protochordates: Salpa (Whole mount); Doliolum (Whole mount); Amphioxus (Whole mount), Oral hood of Amphioxus, Pharynx of Amphioxus,
   - Fishes: Ampulla of Lorenzini, Types of scales
   - Amphibia: Ciliated epithelium, Striated muscles, Unstriated muscles,
   - Aves: Pecten of Pigeon,
   - Mammals: Blood Smear
3. Photographic collection and Comments on campus / local faunal diversity with reference to their ecology.
   a. Any 05 local Freshwater fish species with fin formulae
   b. Any three snake species
   d. Any three migratory birds 30
4. Preparation of Slides
   a. Hair impressions of cat, dog, rabbit, buffalo, human beings etc.
   b. Mounting of fish scales
5. Museum Study:-
   Taxonomy of animal specimens / charts / photographs / models / video clipping available in the laboratory representing major orders of Protochordata and Chordata, other than studied during previous courses.

B) Practicals for Molecular Cell Biology

1. Determination of molecular weights of proteins by SDS-PAGE
2. Light microscopic demonstration of Plasma membrane. (Oil red O, Sudan black B)
3. Demonstration of mitochondria by vital staining.
4. Histochemical demonstration of extracellular matrix. (Glycoproteins-Alcian blue pH 12.5, PAS)
5. Histochemical demonstration of Lysosomes by demonstrating acid phosphatase activity.
6. Histochemical demonstration of DNA & RNA by Feulgen & MGPY technique. (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
7. Study of bone marrow cells.
8. Culturing of protozoans (Paramecium, Amoeba and Volvox).

The examinee shall be required to produce at the practical examination the following:

Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a Bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Structure and Functions of Vertebrates

1. Anatomical labelling ……..04 Marks
2. Experiment from Section 4…… 04 Marks
3. Identify given Spots 3 slides & 3 specimens …….12 Marks

Experiments from Section B) Practicals for Molecular Cell Biology

4. Major experiment..... 12 Marks
5. Minor experiment..... 08 Marks
6. Viva Voce …….. 10 Marks

TOTAL **50 Marks**

Internal Marks

1. Certified Practical Record : 20 marks
2. Submission of Permanent slides/Photographic collection : 10 marks
3. Photographic collection based on Practicals : 10 Marks
4. Student Performance : 10 Marks

TOTAL **50 Marks**

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Course: DSC III.2 Ecology and Environment Th- Major		
Subject Code: 2 ZOO 3	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 2 ZOO 3

Upon completion of this course successfully, students would be able to ---------

1. Understand the concepts and principles of ecology.
2. Understand the structural and functional aspects of biodiversity and the need for its conservation.
3. Be aware of the suitable use of field techniques, data collection, mapping, analysis and interpretation.
4. Be able to take up interdisciplinary research and teaching in ecology and environment.
5. Making the people and the society aware towards better understandings of the environmental ethics, issues and challenges before the vast growing population of the state and the country as well.

Unit	Contents	Hours
Unit-I	1.1 Structure of Ecosystems- Abiotic and Biotic components. 1.2 Types of Ecosystems: Terrestrial ecosystem, fresh water ecosystem. (Lentic and lotic) 1.3 Marine ecosystem. 1.4 Ecological pyramids: - Types, limitations and importance. 1.5 Cycling of materials; water, carbon, nitrogen and phosphorus. 1.6 Food chain and food web in different ecosystem.	**07**
Unit-II	2.1 Ecological niche. 2.2 Biodiversity Conservation Strategies and Conservation Tool (In-situ and Ex-situ Methods of Conservation). 2.3 IUCN, IUCN Red Lists. 2.4 Major Sanctuaries, National Parks, Tiger Reserves in India and Maharashtra. 2.5 State Wildlife Board: Functions and Working. 2.6 Biodiversity hot spots in India.	**07**
Unit-III	3.1 Interspecific interactions; Commensalism, mutualism, competition and predation. 3.2 Intraspecific interactions and density dependence. 3.3 Ecological succession (Hydrosere, Xerosere and Lithosere). 3.4 Invasive species and control. 3.5 Types Extinction of Species (Natural, Mass, Anthropogenic) 3.6 Consequences of Extinction of Species	**08**
Unit-IV	4.1 Air pollution: Sources and harmful effects. 4.2 Water pollution: Sources and harmful effects 4.3 Land pollution: Sources and harmful effects 4.4 Alterations of ecosystem function: acid rain, nuclear winter. 4.5 Global warming and ozone hole. 4.6 Effects of Mining on Environment.	**08**
Unit-V	5.1 Salient feature of Waste management. 5.2 E-Waste management. 5.3 Bio-medical waste management. 5.4 Maharashtra State Pollution Control Board-Working and Functions. 5.5 Hazardous and Other Wastes (Management & Trans boundary Movement) Rules, 2016. 5.6 Biosafety programs.	**08**

Unit-VI	6.1 Impact of Agriculture on Environment. 6.2 Sustainable Agriculture: Rain water harvesting. 6.3 Eco-tourism – Advantages & Disadvantages of Eco-tourism 6.4 Man-Animal Conflicts in India. 6.5 Poaching activities in India. 6.6 International treaties for wildlife conservation	**07**

Suggested Readings:

1. Smith, T.M. and Smith R.L. 2022. Elements of Ecology, Pearson Education, India.
2. Cain, ML, Bowman, WD and Hacker SD 2022. Ecology, 2nd Edition, Sinauer Associates Inc.
3. Odum, E. P. (2010). Fundamentals of Ecology, Oxford and IBH Publishing Co. Pvt. Ltd.
4. Environmental Impact Assessment- G.N.Vankhede Biotech Publishers, Delhi
5. Ecology and Biogeography of India- Mani, M.S. : 1974. Junk. Publ. The Hague.
6. Singh, J.S., S.P and Gupta, S.R. 2022. Ecology, Environment and Resource Conservation, Anamaya Publ., New Delhi.
7. Miller. G.T. 2004. Environmental Science. Thomson, California.
8. Chapman, J.L.and M.J. Reiss. 2019. Ecology: Principles and Applications. Cambridge Univ. Press.
9. Krebs, C.J. 2008. Ecology: The experimental Analysis of Distribution and Abundance (6th Edition), Benjamin Cummings Publ.
10. Toxicology - A Sood , Sarup and Sons, New Delhi.
11. 11 Environmental biodegradation, Ramkumar, Sarup and Sons , New Delhi.
12. Toxicology by Parikh.
13. Poisoning by Drugs and Chemicals – Cooper.
14. 14 Environmental Management of Toxic and Hazardous Chemical – Madhuraj.
15. 15 Environmental Biology - J. L. Blish.
16. Environmental Physiology - Philips G.
17. Toxicology Mechanism and Analytical Methods - Stewarts and Stratman.
18. Ecology and Biodiversity By P.C.Joshi;Today’s and Tomorrow’s Publishers and Printers, Ansari Road New Delhi.

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Course: DSE- Advance Tools and techniques in Biology Th- Major Elective		
Subject Code: 2 ZOO 4 (TB)	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 2 ZOO 4

Upon completion of this course successfully, students would be able to ---------

1. Here students are taught to deal with different tools and techniques applicable in biological
2. Research including various types of microscopes, spectrophotometer and bioinformatics software. etc.
3. The theory session mainly focuses on understanding the principles and working mechanisms of different instruments.
4. Learning of Principle and applications of different radioactive material.
5. Learning phylogeny construction by using bioinformatics software.
6. Develop skills of advanced instrumentation.

Unit	Contents	Hours
Unit-I	1.1 Scanning electron microscopy. 1.2 Transmission electron microscopy. 1.3 Atomic Force microscopy. 1.4 Chemical analyzer and its uses.	**07**
Unit-II	2.1 Radioisotope and their biological applications 2.2 Sample preparation for radioactive counting of biological samples. 2.3 Metabolic labeling 2.4 Autoradiography. 2.5 Liquid scintillation.	**07**
Unit-III	3.1 ESR. 3.2 NMR spectrometers. 3.3 Flame photometer. 3.4 Plasma emission spectroscopy. 3.5 Principle and uses of X- ray crystallography	**08**
Unit-IV	4.1 Sequence databases: Gene Bank, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ). 4.2 Sequence alignment: Local and global sequence alignment, Homology algorithms (BLAST, FASTA). 4.3 Methods of phylogenetic tree construction: UPGMA, Neighbor joining. 4.4 Maximum parsimony, Maximum likelihood methods.	**08**
Unit-V	5.1 RIA and its and applications. 5.2 ELISA, types and applications. 5.3 PCR, Principle, methods, types and applications. 5.4 Gel documentation and its uses.	**08**
Unit-VI	6.1 Documentation for Instrumentation systems and procurement procedures. 6.2 Design of typical research laboratory. 6.3 Methods of sterilization. 6.4 Bio-safety measurement and IPR's.	**07**

Suggested Readings:

1. Braun, R.(1988)Introduction to instrumental analysis, J. Chem. Educ., 65 (12), pp A336.
2. Boyer, R.F. (1993) Modern Experimental Biochemistry, 2nd edition, BenjaminCummings.
3. Clark, J.M. and Swizer R.L. (2000) Experimental Biochemistry, 3rd edition, W.H. Freeman & Co Ltd.
4. Cooper, G.M. (1997) The Cell-A Molecular Approach. ASM press.
5. Freifelder, D.M. (1982) Physical Biochemistry, W.H. Freeman and Co.
6. Masters, J. R.W. (2000) Animal Cell culture- A practical approach. 3 edition, OUP Oxford.
7. Locquin, M. and Langeron M. (1983) Handbook of Microscopy, Butterwaths – Heinemann. 42
8. Wilson, K. and Goulding K.H.(1986) A biologist Guide to principles and Techniques of Practical Biochemistry London.
9. Wilson ,K.and Walker J.(2000) Practical Biochemistry, 5th edition, Cambridge University Press.
10. Foundations of Bioinformatics and Systems Biology by University of Michigan
11. Structural Bioinformatics by Graham Kemp and Per-Georg Nyholm

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Course: Pr- Major Laboratory 4. (DSC III.2- Ecology and Environment + DSE- Advance Tools and techniques in Biology)		
Subject Code: 2 ZOO 6	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Ecology and Environment:

1. Water quality analysis: B.O.D., C.O.D. and Hardness.
2. Collection of fauna from wetland and diversity analysis.
3. Photographic collection and preparation of checklist of birds from local wetland.
4. Analysis of waste water for heavy metals.
5. Visit to local polluted site, observations and remedial measures.
6. Construction of Food chain/food web of the visited area.
7. To identify the sources of air/water/soil/noise pollution of your area.
8. Prepare a chart of biodegradable and non-biodegradable pollutants generated in your locality.
9. Identification of important food plants of mammals in a given area.
10. Study of strategy for preventing and managing human-wildlife conflicts.
11. To prepare a checklist of invasive species.
12. To study the Zooplankton communities in a fresh water ecosystem.

B) **Practicals for Advance Tools and techniques in Biology**

1. Detection of Na+ and K+ by Chemical analyzer.
2. Detection of serum Bilirubin by Chemical analyzer.
3. Sub cellular fractionation of chicken liver.
4. Amplification of any gene by using PCR (thermal cycler).
5. Understanding PubMed database.
6. Multiple sequence alignment by using Crustal.
7. Perform a BLAST of given protein / nucleic acid sequence and interpretation of the results.
8. Construction of phylogenetic tree using bioinformatics software.
9. Perform a primer designing by using bioinformatics tools.
10. Detection of target protein by using antibodies: ELISA method

The examinee shall be required to produce at the practical examination the following:

Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a Bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Ecology and Environment

1. Major Experiment ……..12 Marks

2. Minor Experiment…….…… 08 Marks

Experiments from Section B) Practicals for Advance Tools and techniques in Biology

3. Major Experiment ……..12 Marks

4. Minor Experiment…….…… 08 Marks

5. Viva Voce …….. 10 Marks

TOTAL 50 Marks

Internal Marks

1. Certified Practical Record : 20 marks
2. Submission of Check list of invasive species : 10 marks
3. Submission of Phylogenetic tree by using software : 10 Marks
4. Student Performance : 10 Marks

TOTAL 50 Marks

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Course: DSE- Advance Wildlife Conservation and Management Th- Major Elective		
Subject Code: 2 ZOO 4 (WCM)	**No. of Credits: 3**	**No. of hours per week: 3**
Exam duration: 3 Hrs	**Maximum Marks: 100 (External:60 Internal:40)**	**Total No. of contact hours: 45**

COs: 2 ZOO 4

Upon completion of this course successfully, students would be able to ---------

1. Students will demonstrate a comprehensive understanding of population dynamics and conservation principles, including factors influencing population growth, decline, and management strategies.
2. Students will develop a deep understanding of Metapopulation dynamics and connectivity's role in maintaining population viability across fragmented landscapes.
3. They will acquire proficiency in applying genetic principles to wildlife conservation, including assessing genetic diversity, monitoring techniques, and developing genetic management strategies.
4. Proficiency in utilising techniques for wildlife research and monitoring, such as mark-recapture methods, remote sensing, and AI/machine learning applications, will be demonstrated.
5. Students will critically evaluate interdisciplinary knowledge to design evidence-based conservation strategies for wildlife populations and habitats' sustainable management.
6. Students will develop leadership skills essential for effective engagement in wildlife conservation, including effective communication and collaboration with diverse stakeholders.
7. They will enhance employability in local, national & international wildlife conservation & ecotourism landscapes by acquiring practical skills

Unit	Contents	Hours
Unit-I	**Population Dynamics & Conservation** 1.1 Population in Wildlife Conservation 1.2 Biological Attributes of Community 1.3 Metapopulation & Metapopulation Dynamics 1.4 Fragmented Population Gene flow & Connectivity	**07**
Unit-II	**Migration, Dispersal, and Landscape Conservation** 2.1 Migration and Dispersal 2.2 Concept of Landscape Conservation 2.3 Management of Protected Areas & Landscape Conservation 2.4 Identifying Key Conservation Areas and Enhancing Connectivity	**07**
Unit-III	**Wildlife Conservation Genetics** 3.1 Basics of Genetics and Their Application 3.2 Genetic Diversity 3.3 Genetic Monitoring Techniques 3.4 Genetic Management Strategies	**08**
Unit-IV	**Techniques in Wildlife Research and Monitoring** 4.1 Mark-Recapture, Transect Surveys, Camera Trapping, Acoustic monitoring 4.2 Application of drones, Remote Sensing and geospatial analysis. 4.3 Molecular tools in conservation genetics: DNA barcoding, microsatellite analysis,eDNA 4.4 AI and machine learning: Applications of artificial intelligence and machine learning in wildlife monitoring and data analysis.	**08**
Unit-V	**Wildlife Habitat Management** 5.1 Principles of Habitat Management 5.2 Techniques for Habitat Restoration and Enhancement 5.3 In-situ & Ex-situ Conservation	**08**

	5.4 Socio-Economic Considerations	
Unit-VI	**Wildlife Disease Ecology and Management** 6.1 Types of Wildlife Diseases 6.2 Disease Ecology 6.3 Disease Surveillance and Monitoring Techniques 6.4 Disease Management Strategies	**07**

Suggested Readings:

1. "Principles of Conservation Biology" by Martha J. Groom, Gary K. Meffe, and C. Ronald Carroll (Sinauer Associates, Inc.)
2. "Wildlife Conservation by Sustainable Use" by J. Michael Lockwood and Graeme Caughley (Blackwell Science)
3. "Community Ecology" by Gary G. Mittelbach and Thomas W. Schoener (Sinauer Associates, Inc.)
4. "Metapopulation Biology: Ecology, Genetics, and Evolution" by Ilkka Hanski and Oscar E. Gaggiotti (Elsevier Academic Press)
5. "Connectivity Conservation" edited by Kevin R. Crooks and M. Sanjayan (Cambridge University Press)
6. "Animal Migration: A Synthesis" by E.J. Milner-Gulland, John M. Fryxell, and Anthony R.E. Sinclair (Oxford University Press)
7. "Landscape Ecology Principles in Landscape Architecture and Land-Use Planning" by Wenche Dramstad, James D. Olson, and Richard T.T. Forman (Island Press)
8. "Protected Area Management: Principles and Practice" edited by Graeme L. Worboys, Michael Lockwood, and Ashish Kothari (Oxford University Press)
9. "Protected Areas of India: A Guide to Wildlife Reserves" by Ramesh Bedi (Niyogi Books)
10. "Designing Wildlife Corridors: An Introduction for Practitioners" by Jonathan L. Gelbard and Kevin R. Crooks (Island Press)
11. "Principles of Genetics" by D. Peter Snustad and Michael J. Simmons (Wiley)
12. "Conservation Genetics: Principles and Practice" by Andrew Frankham (Wiley-Blackwell)
13. "Wildlife DNA Analysis: Applications in Forensic Science" by Adrian Linacre and Shanan Tobe (CRC Press)
14. "Genetic Management of Fragmented Animal and Plant Populations" by Richard Frankham, Jonathan D. Ballou, and Katherine Ralls (Cambridge University Press)
15. "Ecological Census Techniques: A Handbook" by William J. Sutherland, Ian Newton, and Rhys E. Green (Cambridge University Press)
16. "Remote Sensing and GIS for Ecologists: Using Open Source Software" by Martin Wegmann, Benjamin Leutner, and Stefan Dech (Pelagic Publishing)
17. "Molecular Ecology" by Joanna R. Freeland, Peter D. Nichols, and David W. Slobodkin (Wiley)
18. "Machine Learning for Dummies" by John Paul Mueller and Luca Massaron (Wiley)
19. "Wildlife Habitat Management: Concepts and Applications in Forestry" by Brenda C. McComb, Roger N. Timm, and Catherine J. Alverson (CRC Press)
20. "Restoration Ecology: The New Frontier" by Jelte van Andel and James Aronson (Wiley-Blackwell)
21. "Ex Situ Plant Conservation: Supporting Species Survival in the Wild" by Edward O. Guerrant Jr., Kayri Havens, and Mike Maunder (Island Press)
22. "Socio-Economic Considerations in Biotechnology Regulation" edited by Maurice J. H. M. Merkx and Francisco J. Andrade (Springer)
23. "Infectious Diseases of Wild Mammals" edited by Elizabeth S. Williams and Ian K. Barker (Wiley-Blackwell)
24. "Disease Ecology: Community Structure and Pathogen Dynamics" by Sharon K. Collinge and Chris Ray (Oxford University Press)
25. "Veterinary Epidemiology: Principles and Methods" by Michael Thrusfield (Wiley-Blackwell)

26. "Wildlife Diseases: Landscape Epidemiology, Spatial Distribution and Utilization of Remote Sensing and Geographic Information Systems" by Milton Friend and J. Christian Franson (CRC Press)

Online Resource:

1. **Population in Wildlife Conservation**: Population Reference Bureau
2. **Biological Attributes of Community**: Encyclopedia of Life
3. **Metapopulation & Metapopulation Dynamics**: Metapopulation Ecology
4. **Fragmented Population Geneflow & Connectivity**: Connectivity Conservation
5. **Migration and Dispersal**: Animal Migration
6. **Concept of Landscape Conservation**: IUCN Protected Areas Categories System
7. **Management of Protected Areas & Landscape Conservation**: Protected Planet
8. **Identifying Key Conservation Areas and Enhancing Connectivity**: Connectivity Conservation
9. **Basics of Genetics and Their Application**: Genetics Home Reference
10. **Genetic Diversity**: Conservation Genetics
11. **Genetic Monitoring Techniques**: Wildlife Genetics International
12. **Genetic Management Strategies**: Conservation Genetics
13. **Mark-Recapture, Transect Surveys, Camera Trapping, Acoustic monitoring**: Wildlife Insights
14. **Application of drones, Remote Sensing and geospatial analysis**: Earth Observing System Data and Information System
15. **Molecular tools in conservation genetics**: eDNA Laboratory Protocols
16. **AI and machine learning**: Wildbook
17. **Principles of Habitat Management**: Habitat Management Guidelines
18. **Techniques for Habitat Restoration and Enhancement**: Habitat Restoration
19. **In-situ & Ex-situ Conservation**: IUCN Conservation Tools
20. **Socio-Economic Considerations**: UNEP-WCMC Socio-Economic Data
21. **Types of Wildlife Diseases**: Wildlife Disease Association
22. **Disease Ecology**: One Health Initiative
23. **Disease Surveillance and Monitoring Techniques**: Global Wildlife Disease News Map
24. **Disease Management Strategies**: USGS National Wildlife Health Center

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Course: Pr- Major Laboratory 4. (DSC III.2- Ecology and Environment + DSE- Advance Wildlife Conservation and Management)		
Subject Code: 2 ZOO 6	**No. of Credits: 2**	**No. of hours per week: 4**
Exam duration: 6 Hrs	**Maximum Marks: 100 (External:50 Internal:50)**	**Total No. of contact hours: 60**

A) Practicals for Ecology and Environment:

1. Water quality analysis: B.O.D., C.O.D. and Hardness.
2. Collection of fauna from wetland and diversity analysis.
3. Photographic collection and preparation of checklist of birds from local wetland.
4. Analysis of waste water for heavy metals.
5. Visit to local polluted site, observations and remedial measures.
6. Construction of Food chain/food web of the visited area.
7. To identify the sources of air/water/soil/noise pollution of your area.
8. Prepare a chart of biodegradable and non-biodegradable pollutants generated in your locality.
9. Identification of important food plants of mammals in a given area.
10. Study of strategy for preventing and managing human-wildlife conflicts.
11. To prepare a checklist of invasive species.
12. To study the Zooplankton communities in a fresh water ecosystem.

B) **Practicals for Advance Wildlife Conservation and Management**

Part A: Practical (Any four)

1. Camera Trapping & Data Analysis

Student analyse camera trap images to identify and count individual animals, estimate population density, and assess species richness

2. e - DNA sampling & extraction

Collect environmental DNA (eDNA) samples from water bodies to detect the presence of elusive or endangered species. Extract DNA from water samples and use molecular techniques to identify target species.

3. Genetic diversity of a wildlife species in a local population

Students extract DNA from biological samples (e.g., saliva, scat, feathers & Hairs) and perform polymerase chain reaction (PCR) to amplify genetic markers, providing hands-on experience with molecular biology techniques.

4. Assesment of disease risks to wildlife populations: Disease Pathogen Identification

Students isolate and identify pathogens from wildlife samples using microbiological techniques such as culturing, microscopy, and biochemical tests, gaining practical skills in disease diagnosis.

5. Ex-situ Conservation Techniques

Students visit a captive breeding facility or botanical garden to learn about ex-situ conservation methods, participating in activities such as seed banking, captive breeding, and reintroduction planning.

6. Migration Route Analysis

Students analyse GPS tracking data or historical migration records to map migration routes of a selected species, identifying stopover sites and migration barriers.

7. Genetic Diversity Analysis

Students analyse genetic data using software tools to calculate genetic diversity indices such as allele frequencies, heterozygosity, and F-statistics, interpreting results to assess population genetic structure.

Part B: Field Survey (Any one)

1, Field Survey: Population Estimation

Students learn and practice various methods for estimating wildlife population size, such as mark-recapture, line transects, point count, pollard walk method (Modified line transect)

2. Field Survey: Community Structure Analysis

Students analyse ecological data to assess species richness, diversity, and evenness in a simulated community dataset, using statistical tools like Simpson's Diversity Index and Shannon-Wiener Index.

Part C: Projects (Any one)

1. Project: Habitat Restoration Experiment

Students design and implement a habitat restoration experiment, testing different restoration techniques (e.g., planting native species, controlling invasive species) and monitoring their effectiveness in improving habitat quality.

2. Project: Socio-Economic Survey

Students conduct surveys or interviews with local communities to assess the socio-economic impacts of conservation initiatives, collecting data on livelihoods, attitudes towards conservation, and perceptions of benefits and costs.

3. Project: Investigate metapopulation dynamics of a species occupying fragmented habitats. Assess patch occupancy, colonisation-extinction dynamics, and connectivity between habitat patches using field surveys and GIS analysis.

4. Project: Study the migratory behaviour of a bird species in a local ecosystem. Track individual migration routes using satellite telemetry or bird banding techniques and analyse movement patterns.

5. Project: Habitat Mapping

Students use GIS software to create habitat maps and assess landscape connectivity, identifying key conservation areas and potential habitat corridors.

6. Project: Habitat Assessment and Monitoring

Students conduct field surveys to assess habitat characteristics such as vegetation structure, food availability, and shelter resources, using standardized protocols to collect data for habitat quality assessment.

The examinee shall be required to produce at the practical examination the following:

Practical record book duly signed by teacher in-charge and certified by the Head of the Department as a Bonafide work of the examinees.

DISTRIBUTION OF PRACTICAL MARKS

External Practical Marks

Experiments from Section A) Practicals for Ecology and Environment

1. Major Experiment ……..12 Marks
2. Minor Experiment…….…… 08 Marks

Experiments from Section B) Advance Wildlife Conservation and Management

3. Practical (Any one from Part A) …… …..10 Marks
4. Field survey (Any one from Part B).....06 Marks
5. Record Submission…… ……....04 Marks
6. Viva Voce ……..…….…….. 10 Marks

TOTAL **50 Marks**

Internal Marks

1. Certified Practical Record	: 20 marks
2. Scientific Project and Report writing	: 20 Marks
3. Student Performance	: 10 Marks

TOTAL **50 Marks**

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