



**Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon
National Education Policy - 2020**

**Proposed Curriculum for Post-graduate Programme in
Zoology**

In

All Universities affiliated Colleges under KBCNMU

With Effect From 2023-2024

Submitted by Zoology Subject Committee NEP 2020

INDEX

Sl. No.	Table of Content	Page. No.
1.	Introduction to Program in B.Sc. (Hons.) Zoology	3
2.	Learning Outcome-Based Curriculum Framework In Program	3
3.	Purpose of The Program	5
4.	Nature and Scopes of The Program	6
5.	Graduate Attributes of B.Sc. Honors in Zoology	7
6.	Qualification Descriptors for Zoology Graduation	8
7.	Subject Prerequisite	10
8.	Program Structure	11
9.	Program Objectives (POs) for Postgraduate Programme in Zoology	15
10.	Programme Outcomes for Postgraduate Programme in Zoology	16
11.	Assessment framework	17
12.	Course Content of B.Sc. (Hons.) Zoology	18
13.	Guidelines for Individual/ Team Projects and Field Reports and On-the-job training	48

1. Introduction to Program in B.Sc. (Hons.) Zoology

The Master of Science (Hons.) and Research in Zoology program is designed to provide students with a comprehensive understanding of the diverse aspects of zoology and develop their research skills in this field. This postgraduate program offers an opportunity for students to pursue advanced studies and engage in original research in various areas of zoology, including animal physiology, ecology, behavior, evolution, taxonomy, and conservation.

The program is structured to equip students with a strong foundation in zoological principles, theories, and methodologies. Through a combination of coursework, laboratory work, fieldwork, and research projects, students will develop a deep understanding of the intricate biological systems, ecological interactions, and evolutionary processes that shape the animal kingdom.

One of the key highlights of this program is the emphasis on research. Students will have the opportunity to work closely with experienced faculty members and engage in cutting-edge research projects that contribute to the advancement of zoological knowledge. They will learn to formulate research questions, design experiments, collect and analyze data, and communicate their findings effectively through scientific reports and presentations.

The program also places importance on critical thinking, problem-solving, and interdisciplinary approaches. Students will be encouraged to think critically, analyze complex scientific problems, and develop innovative solutions. They will explore the interconnectedness of zoology with other scientific disciplines, fostering collaborations and a broader perspective in addressing scientific challenges.

Ethical considerations in zoological research and conservation will be integrated into the program. Students will be encouraged to conduct their research in an ethical manner, ensuring the welfare and responsible treatment of animals. They will develop an understanding of conservation strategies and the importance of sustainability in preserving biodiversity and managing ecosystems.

Upon completion of the program, graduates will be well-prepared for a range of career opportunities in academia, research institutions, conservation organizations, zoos, museums, and government agencies. They will possess the necessary knowledge, research skills, and professional competence to pursue doctoral studies or embark on fulfilling careers in zoology.

The Master of Science (Hons.) and Research in Zoology program aims to nurture passionate and skilled zoologists who will contribute to scientific advancements, conservation efforts, and the sustainable management of our natural world. Graduates of this program will be at the forefront of research and innovation, making significant contributions to our understanding of animal life and its conservation.

2. Learning Outcome-Based Curriculum Framework In Program

The M.Sc. program in Zoology follows a learning outcome-based curriculum framework, ensuring that students acquire the necessary knowledge, skills, and competencies in the field of zoology. The curriculum is designed to align with the program objectives and equip students with a strong foundation in zoological sciences while promoting active learning,

critical thinking, and research skills. The following are the key components of the curriculum framework:

1. Foundation Courses:

Provide students with a comprehensive understanding of the core concepts, principles, and theories in zoology.

Develop a solid foundation in areas such as animal physiology, ecology, behavior, evolution, taxonomy, and conservation.

Introduce students to research methodologies, data analysis, and scientific writing.

2. Specialization Courses:

Offer advanced courses in specific areas of zoology, allowing students to deepen their knowledge and expertise in their chosen field of interest.

Explore specialized topics such as animal behavior, population dynamics, molecular genetics, evolutionary biology, and ecological conservation.

Foster critical thinking and problem-solving skills by analyzing and evaluating complex scientific problems within the chosen specialization.

3. Laboratory and Fieldwork:

Provide hands-on practical experiences through laboratory sessions, fieldwork, and data collection in natural habitats.

Develop practical skills in techniques such as specimen collection, taxonomic identification, data recording, and experimental methodologies.

Enhance observational and analytical skills by conducting field surveys, ecological studies, and animal behavior observations.

4. Research Projects:

Engage students in independent research projects, allowing them to apply their knowledge and skills to investigate scientific questions in zoology.

Develop research proposals, design experiments, collect and analyze data, and interpret and present research findings.

Enhance critical thinking, problem-solving, and scientific communication skills through research work.

5. Interdisciplinary Approach:

Encourage interdisciplinary perspectives by integrating concepts and methodologies from other related disciplines, such as ecology, genetics, conservation biology, and environmental sciences.

Foster collaborations and interdisciplinary research to address complex issues and challenges in zoology.

6. Ethical Considerations:

Promote ethical awareness and responsible conduct in zoological research and conservation. Address ethical considerations related to animal welfare, research ethics, and conservation practices.

Instill a sense of ethical responsibility in students towards the well-being and conservation of animal species.

7. Seminars and Presentations:

Enhance students' oral and written communication skills through seminars, presentations, and scientific writing assignments.

Develop the ability to effectively communicate scientific ideas, research findings, and complex concepts to both scientific and non-scientific audiences.

Encourage critical evaluation and constructive feedback through participation in seminars and scientific discussions.

8. Professional Development:

Equip students with professional skills necessary for their future careers in zoology.

Foster teamwork, leadership, time management, and organizational skills.

Promote lifelong learning, continuous professional development, and staying updated with advancements in the field.

The learning outcome-based curriculum framework ensures that students in the M.Sc. program in Zoology develop a broad knowledge base, research skills, critical thinking abilities, and ethical considerations necessary to contribute to scientific knowledge, conservation efforts, and the sustainable management of animal populations.

3. Purpose of The Program

The M.Sc. program in Zoology serves the following purposes:

- ❖ **Advanced Knowledge:** The program aims to provide students with advanced knowledge and understanding of the diverse aspects of zoology, including animal physiology, ecology, behavior, evolution, taxonomy, and conservation. It builds upon the foundational concepts introduced at the undergraduate level and delves deeper into specialized areas of study.
- ❖ **Research Skills Development:** The program seeks to develop students' research skills and abilities. Students will acquire the necessary skills to design and conduct independent research projects, apply scientific methodologies, collect and analyze data, and interpret research findings. This emphasis on research fosters critical thinking, problem-solving, and scientific inquiry.
- ❖ **Specialization and Expertise:** The program offers students the opportunity to specialize in specific areas of zoology based on their interests and career goals. By focusing on a particular field, students can develop specialized knowledge, expertise, and skills that will enhance their professional competitiveness and open doors to various career opportunities.
- ❖ **Professional Growth:** The program aims to facilitate the professional growth of students in the field of zoology. Through a combination of coursework, research projects, seminars, and presentations, students will enhance their oral and written communication skills, critical evaluation abilities, and scientific reasoning. They will develop professionalism, teamwork, leadership, and time management skills essential for successful careers in zoology.
- ❖ **Interdisciplinary Perspective:** The program encourages students to adopt an interdisciplinary approach to zoological research and study. It emphasizes the interconnectedness of zoology with other scientific disciplines, such as ecology, genetics, conservation biology, and environmental sciences. This interdisciplinary perspective enables students to address complex scientific problems and contribute to interdisciplinary research projects.

- ❖ **Ethical Considerations:** The program recognizes the importance of ethical considerations in zoological research and conservation. Students will develop an understanding of ethical guidelines and principles related to animal welfare, research ethics, and conservation practices. They will learn to conduct their research and conservation efforts in a responsible and ethical manner, considering the welfare and conservation of animal species.
- ❖ **Contribution to Science and Conservation:** The program aims to produce graduates who will contribute to the advancement of scientific knowledge and the conservation of animal species. Through their research projects and academic pursuits, students will make valuable contributions to the field of zoology by expanding our understanding of animal life, ecosystems, and conservation strategies.
- ❖ **Academic and Career Opportunities:** The program prepares students for further academic pursuits, including Ph.D. studies and research careers in academia and research institutions. It also equips students with the skills and knowledge required for diverse career opportunities in areas such as conservation organizations, environmental agencies, zoos, museums, and government bodies engaged in animal-related research and management.

Overall, the purpose of the M.Sc. program in Zoology is to provide students with advanced knowledge, research skills, and a strong foundation in zoological sciences. It aims to develop well-rounded professionals who can contribute to scientific knowledge, conservation efforts, and the sustainable management of animal populations.

4. Nature and Scopes of The Program

Nature:

The M.Sc. program in Zoology is a postgraduate academic program that focuses on the in-depth study of the animal kingdom and its various aspects. It combines theoretical knowledge, practical skills, and research opportunities to provide students with a comprehensive understanding of zoological sciences. The program emphasizes scientific inquiry, critical thinking, and research skills development, preparing students for careers in academia, research institutions, conservation organizations, and related fields.

Scope:

- **Broad Field of Study:** The program covers a wide range of topics within zoology, including animal physiology, ecology, behavior, evolution, taxonomy, conservation, and more. Students explore the diversity of animal life, understand the ecological interactions, and study the evolutionary processes that have shaped the animal kingdom.
- **Research-Oriented:** The program offers ample opportunities for students to engage in research. They undertake independent research projects, work closely with faculty mentors, and contribute to scientific knowledge by conducting original research in their chosen specialization. Students learn research methodologies, data analysis techniques, and scientific writing skills.
- **Interdisciplinary Connections:** The scope of the program extends beyond zoology as it encourages interdisciplinary connections. Students explore the interrelationships between zoology and other scientific disciplines, such as ecology, genetics, conservation biology, and environmental sciences. This interdisciplinary approach enhances their understanding of complex scientific problems and promotes collaborative research.

- **Practical Application:** The program provides hands-on experiences through laboratory work, fieldwork, and practical training. Students gain practical skills in techniques such as specimen collection, taxonomic identification, ecological surveys, behavioral observations, and experimental design. This practical application strengthens their ability to apply theoretical knowledge in real-world scenarios.
- **Ethical Considerations:** The program instills a sense of ethical responsibility in students by addressing ethical considerations in zoological research and conservation. Students learn about ethical guidelines, animal welfare, and responsible conduct in scientific research. They develop a deep understanding of the importance of conservation and sustainable practices in the management of animal populations.
- **Career Opportunities:** The program prepares students for diverse career opportunities in the field of zoology. Graduates can pursue academic positions as professors or researchers in universities and colleges. They can also work in research institutions, conservation organizations, zoos, museums, environmental agencies, and government bodies involved in animal-related research and management.
- **Contribution to Science and Conservation:** The scope of the program includes the contribution to scientific knowledge and conservation efforts. Through research projects, students make valuable contributions to the understanding of animal biology, behavior, ecology, and conservation strategies. They contribute to the preservation of biodiversity, sustainable management of ecosystems, and the protection of endangered species.

In summary, the M.Sc. program in Zoology provides a comprehensive and research-oriented study of the animal kingdom. It offers a broad scope of study, practical application, interdisciplinary connections, and ethical considerations. Graduates of this program are equipped with the knowledge, research skills, and practical experiences necessary to make significant contributions to scientific knowledge, conservation efforts, and the sustainable management of animal populations.

5. Graduate Attributes of B.Sc. Honors in Zoology:

- ❖ **Advanced Knowledge:** Graduates of the M.Sc. (Honors)/Research in Zoology program possess advanced knowledge and expertise in various aspects of zoology. They have a deep understanding of animal physiology, ecology, behavior, evolution, taxonomy, and conservation. They are equipped with the latest scientific knowledge and are familiar with current research trends in their chosen specialization.
- ❖ **Research Skills:** Graduates have developed strong research skills throughout the program. They can design and conduct independent research projects, formulate research questions, select appropriate methodologies, collect and analyze data, and interpret research findings. They are skilled in literature review, experimental design, statistical analysis, and scientific writing.
- ❖ **Critical Thinking:** Graduates have honed their critical thinking abilities through rigorous analysis of complex scientific problems in zoology. They can evaluate evidence, identify research gaps, and propose innovative solutions. They are adept at logical reasoning, problem-solving, and making evidence-based decisions in their field of expertise.
- ❖ **Scientific Communication:** Graduates possess excellent scientific communication skills, both orally and in writing. They can effectively present their research findings to scientific and non-scientific audiences through presentations, seminars, and publications. They can communicate complex scientific concepts in a clear and concise manner, demonstrating their ability to disseminate knowledge effectively.

- ❖ **Interdisciplinary Collaboration:** Graduates understand the interdisciplinary nature of zoology and can collaborate effectively with experts from diverse fields. They can contribute to interdisciplinary research projects, bridging the gap between zoology and related disciplines such as ecology, genetics, conservation biology, and environmental sciences. They have the ability to work in multidisciplinary teams to address complex scientific challenges.
- ❖ **Ethical Considerations:** Graduates are well-versed in ethical considerations related to zoological research and conservation. They have a strong understanding of ethical guidelines, animal welfare, and responsible conduct in scientific research. They prioritize the ethical treatment of animals and are committed to conservation and sustainability practices.
- ❖ **Professionalism and Leadership:** Graduates exhibit professionalism, integrity, and ethical behavior in their work. They have developed strong leadership qualities and are capable of leading research projects, managing teams, and effectively communicating with colleagues and stakeholders. They understand the importance of professional ethics and adhere to high standards of scientific integrity.
- ❖ **Lifelong Learning:** Graduates recognize the importance of lifelong learning and professional development. They have cultivated a commitment to staying updated with the latest advancements in zoology through continuous learning, attending conferences, workshops, and engaging in ongoing research. They are motivated to contribute to the field through teaching, mentoring, and further academic pursuits, such as pursuing Ph.D. studies.
- ❖ **Career Readiness:** Graduates are well-prepared for diverse career opportunities in academia, research institutions, conservation organizations, zoos, museums, and government agencies. They have acquired the necessary skills, knowledge, and practical experience to excel in their chosen careers in zoology. They are adaptable, resilient, and equipped with a strong foundation to thrive in a dynamic and evolving professional environment.

The M.Sc. (Honors)/Research in Zoology program develops graduates with advanced knowledge, research skills, critical thinking abilities, and ethical considerations necessary for successful careers in zoology. They possess the attributes required to contribute to scientific advancements, conservation efforts, and the sustainable management of animal populations.

On-the-job training in zoology provides practical skills, exposure to real-world scenarios, and networking opportunities within the field. It enhances participants' employability, allows them to explore specific areas of interest, and complements their academic knowledge with practical experience. It is important to note that the availability of on-the-job training programs may vary based on geographical location and the specific institutions and organizations within the field of zoology.

6. Qualification Descriptors for Zoology Graduation:

- Upon completion of a post-graduation degree in Zoology, graduates are expected to demonstrate the following qualification descriptors:
- **Advanced Knowledge:** Graduates possess a comprehensive and advanced understanding of the principles, theories, and concepts in the field of zoology. They have in-depth knowledge of animal physiology, ecology, behavior, evolution, taxonomy, and conservation. They are familiar with current research trends and advancements in their specialized area of study.

- **Research Skills:** Graduates have acquired advanced research skills and are capable of conducting independent research. They are proficient in research methodologies, experimental design, data collection, statistical analysis, and data interpretation. They can critically evaluate scientific literature, identify research gaps, and contribute to the development of new knowledge in zoology.
- **Critical Thinking and Problem-solving:** Graduates demonstrate strong critical thinking abilities and are skilled at analyzing complex scientific problems in zoology. They can apply logical reasoning, evaluate evidence, and propose innovative solutions. They have the ability to think critically and creatively, demonstrating adaptability and resourcefulness in addressing research and practical challenges.
- **Scientific Communication:** Graduates possess excellent scientific communication skills, both orally and in writing. They can effectively communicate their research findings, ideas, and scientific concepts to both scientific and non-scientific audiences. They are proficient in scientific writing, report preparation, and presenting research results through presentations, seminars, and publications.
- **Interdisciplinary Integration:** Graduates can integrate knowledge and collaborate effectively across interdisciplinary boundaries. They understand the interconnectedness of zoology with other scientific disciplines such as ecology, genetics, conservation biology, and environmental sciences. They can contribute to interdisciplinary research projects, bridging the gap between different fields and applying diverse perspectives to address complex scientific challenges.
- **Ethical Considerations:** Graduates possess a strong understanding of ethical considerations related to zoological research and conservation. They adhere to ethical guidelines and prioritize the welfare of animals. They conduct research and conservation efforts in a responsible and ethical manner, considering the ethical implications of their work and the broader impact on animal populations and ecosystems.
- **Professionalism and Leadership:** Graduates exhibit professionalism, integrity, and ethical behavior in their work. They demonstrate leadership qualities and can effectively manage research projects, lead teams, and collaborate with colleagues and stakeholders. They have developed strong teamwork, communication, and interpersonal skills necessary for successful careers in zoology.
- **Lifelong Learning:** Graduates have cultivated a commitment to lifelong learning and professional development. They recognize the importance of staying updated with the latest advancements in zoology through continuous learning, attending conferences, workshops, and engaging in ongoing research. They are motivated to contribute to the field through teaching, mentoring, and pursuing further academic pursuits, such as Ph.D. studies.
- **Career Readiness:** Graduates are well-prepared for diverse career opportunities in academia, research institutions, conservation organizations, zoos, museums, and government agencies. They have acquired the necessary skills, knowledge, and practical experience to excel in their chosen careers in zoology. They possess a strong foundation to contribute to scientific advancements, conservation efforts, and the sustainable management of animal populations.

These qualification descriptors reflect the skills, knowledge, and competencies that graduates of a post-graduation program in Zoology should possess. They provide a framework for assessing and evaluating the capabilities and readiness of graduates in the field of zoology.

➤ **Curriculum in subjects has to follow these Model Program Structures. The Terminology used in these Program Structures is as under;**

- ✓ Discipline Core (DSC) refers to Core Courses/Papers in a Core Discipline/ Subject
- ✓ Discipline Elective (DSE) refers to Elective Courses/Papers in the Core Subject or Discipline.
- ✓ Open Elective (OE) refers to Elective Courses/Papers in a non-core Subject across all disciplines.
- ✓ Program Structures also contain Ability Enhancement Compulsory Courses (AECC), Languages,
- ✓ Skill Enhancement Courses (SEC) (Both skills and value-based).

Pedagogy involves L+T+P model. Generally, subjects with practical involve L+P, while the subjects without practical involve L+T model. The numbers in parentheses indicate credits allotted to various courses/papers as per definitions of Choice Based Credit System (CBCS). Generally 1 hour of Lecture or 2 hours of practical per week in a semester is assigned one credit. Generally, core subject theory courses/papers will have 3 or 4 credits, while practical are assigned 2 or 3 credits

Subject prerequisite: To study ZOOLOGY at the Master's level, a student must pass out three year degree in Zoology (Hon.) / Research and earn the required credit points.

Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon
FACULTY OF SCIENCE AND TECHNOLOGY, B.Sc. (Honors) PROGRAMME

Credit distribution structure for Three/ Four year Honours/Honours with Research Degree Programme with Multiple Entry and Exit options
BoS: Zoology

Teaching and Examination scheme

Master of Science (Honors / Research), Four-Year (Eight Semester Degree Course)

M.Sc. (Level 6.0) Sem- I (Name of Courses for - Major, Minor, GE, VSEC, IKS courses)

Sr No	Course Category	Name of the course (Title of the Paper)		Total Credit	Hours/ Semester	Teaching Scheme (hrs/week)		Evaluation Scheme		
						Theory	Practical	Continuous Internal Evaluation (CIE) (CA)	End Semester Evaluation (ESE) (UA)	Duration of Examination (Hrs)
						T	P			
1	DSC	DSC-25	Comparative Anatomy of Invertebrates	4	60	4		40	60	
		DSC-26	Biochemistry	2	30	2		40	60	
		DSC-27	Biostatistics	4	60	4		40	60	
		DSC-28	Practicals based on Comparative Anatomy of Invertebrates	2	60		8	40	60	
		DSC-29	Practicals based on Biochemistry, and Biostatistics	2	60		8			
2	DSE	DSE-5	Wildlife Conservation and Management	4	60	4		40	60	
3	Research	RM	Research Methodology	4				40	60	
Total										

Master of Science (Honors / Research), Four-Year (Eight Semester Degree Course)
M.Sc. (Level 6.0) Sem- II (Name of Courses for - Major, Minor, GE, VSEC, IKS courses)

Sr No	Course Category	Name of the course (Title of the Paper)		Total Credit	Hours/ Semester	Teaching Scheme (hrs/week)		Evaluation Scheme		
						Theory	Practical	Continuous Internal Evaluation (CIE) (CA)	End Semester Evaluation (ESE) (UA)	Duration of Examination (Hrs)
						T	P			
1	DSC	DSC-30	Comparative Anatomy of Vertebrates	4	60	4		40	60	
		DSC-31	Immunology	2	30	2		40	60	
		DSC-32	Tools and Techniques in Life Sciences	4	60	4		40	60	
		DSC-33	Practicals based on Comparative Anatomy of Vertebrates	2	60		8	40	60	
		DSC-34	Practicals based on Immunology, and Tools and Techniques in Life Sciences	2	60		8			
2	DSE	DSE-6	Environmental Biology	4	60	4		40	60	
3	CC, FP, CEP, OJT/Int, RP	OJT /INT	Zoology-related industries, gardens, museums, zoos, etc., and prepare the report	4				40	60	
Total										

Master of Science (Honors / Research), Four-Year (Eight Semester Degree Course)
M.Sc. (Level 6.0) Sem- III (Name of Courses for - Major, Minor, GE, VSEC, IKS courses)

Sr No	Course Category	Name of the course (Title of the Paper)		Total Credit	Hours/ Semester	Teaching Scheme (hrs/week)		Evaluation Scheme		
						Theory	Practical	Continuous Internal Evaluation (CIE) (CA)	End Semester Evaluation (ESE) (UA)	Duration of Examination (Hrs)
						T	P			
1	DSC	DSC-35	Specialization* – 1. Animal Physiology -I 2. Entomology -I 3. Reproductive Physiology - I 4. Helminthology -I	4	60	4		40	60	
		DSC-36	Enzymology	2	30	2		40	60	
		DSC-37	Practicals based on Specialization	2	60		8	40	60	
		DSC-38	Practicals based on Enzymology	2	60		8	40	60	
		DSC-39	Bioeconomics	2	60		8			
2	DSE	DSE-7	Animal Husbandry	4	60	4		40	60	
3	RP	RP	Research project on any topic related to Zoology	4				40	60	
Total										

* Specialization, either anyone will be selected by the respective center / college

Master of Science (Honors / Research), Four-Year (Eight Semester Degree Course)

M.Sc. (Level 6.0) Sem- IV (Name of Courses for - Major, Minor, GE, VSEC, IKS courses)

Sr No	Course Category	Name of the course (Title of the Paper)		Total Credit	Hours/ Semester	Teaching Scheme (hrs/week)		Evaluation Scheme		
						Theory	Practical	Continuous Internal Evaluation (CIE) (CA)	End Semester Evaluation (ESE) (UA)	Duration of Examination (Hrs)
						T	P			
1	DSC	DSC-40	Specialization* – 1. Animal Physiology -II 2. Entomology -II 3. Reproductive Physiology - II 4. Helminthology -II	4	60	4		40	60	
		DSC-41	History of Indian Science	4	60	4		40	60	
		DSC-42	Practicals based on Specialization	2	60		8	40	60	
		DSC-43	Practicals based on the History of Indian Science	2	60		8	40	60	
2	DSE	DSE-8	Aquaculture	4	60	4		40	60	
3	RP	RP	Research project on any topic related to Zoology	6				40	60	
Total										

* Specialization, either anyone will be selected by the respective center/college

2 Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (44 credits) after Four Year UG Degree							
Exit option: PG Diploma (44 Credits) after Three Year UG Degree							
	8.0	---	Science, Arts and Commerce	Course Work (Total Cr.12) CW-1 (4) CW-2 (4) CW-3 (4)	Training in Teaching /Education/ Pedagogy (4)	16 + Ph. D. Work	Ph.D. in Subject

Curriculum Structure for Post Graduate Degree Program M. Sc., Hons in Zoology

- ❖ Name of the Degree Program: **M. Sc., Hons**
- ❖ Discipline Core: **Zoology**
- ❖ Total Credits for the Program: **44/88**
- ❖ Starting year of implementation: **2023-24**

Program Objectives (POs) for Postgraduate Programme in Zoology:

- **PO1: Advanced Knowledge:** To provide students with an in-depth understanding of the fundamental concepts, theories, and principles of zoology, encompassing areas such as animal physiology, ecology, behavior, evolution, and taxonomy.
- **PO2: Research Skills:** To develop students' research skills, enabling them to design and conduct independent research projects in zoology, including formulating research questions, selecting appropriate methodologies, collecting and analyzing data, and interpreting research findings.
- **PO3: Critical Thinking:** To cultivate critical thinking abilities in students, enabling them to evaluate and analyze complex scientific problems and challenges in zoology. Students will learn to apply logical reasoning, critical analysis, and problem-solving strategies to advance scientific knowledge in the field.
- **PO4: Communication Skills:** To enhance students' oral and written communication skills, enabling them to effectively present scientific ideas, research findings, and complex concepts to both scientific and non-scientific audiences. Students will learn to prepare scientific reports, research papers, and deliver engaging presentations.
- **PO5: Ethical Considerations:** To instill an understanding of ethical considerations in zoological research and its applications. Students will be aware of the ethical guidelines and principles in animal research and conservation, ensuring the welfare and responsible treatment of animals.
- **PO6: Interdisciplinary Approach:** To encourage students to adopt an interdisciplinary perspective, recognizing the interconnectedness between zoology and other scientific disciplines. Students will develop the ability to collaborate with experts from diverse fields to address complex research questions and contribute to interdisciplinary projects.
- **PO7: Professional Development:** To equip students with professional skills necessary for a successful career in zoology. This includes developing leadership qualities, teamwork abilities, time management skills, and an understanding of professional ethics in the field.
- **PO8: Conservation and Sustainability:** To foster an understanding of the importance of conservation and sustainability in zoology. Students will gain knowledge of conservation strategies, habitat management, and the implications of human activities on animal populations. They will develop skills to contribute to the preservation of biodiversity and the sustainable management of natural resources.
- **PO9: Career Readiness:** To prepare students for diverse career opportunities in academia, research institutions, conservation organizations, zoos, museums, and related fields. Students will acquire the necessary skills, knowledge, and practical experience to excel in their chosen careers in zoology.

- **PO10: Lifelong Learning:** To cultivate a commitment to lifelong learning and professional development in students. They will be encouraged to stay updated with the latest advancements in zoology, engage in continuous learning, and contribute to the field through ongoing research, teaching, and participation in scientific conferences and workshops.

These program objectives aim to guide the curriculum and learning outcomes of the postgraduate programme in Zoology, providing students with a comprehensive education and preparing them for successful careers in the field.

Programme Outcomes for Postgraduate Programme in Zoology:

- ❖ **Knowledge and Understanding:** Graduates of the postgraduate programme in Zoology will demonstrate advanced knowledge and understanding of the core concepts, theories, and principles of zoology. They will possess a comprehensive understanding of the diversity, structure, function, behavior, and evolution of animals across various taxonomic groups.
- ❖ **Research Skills:** Graduates will be equipped with the necessary skills to conduct independent and original research in the field of zoology. They will be able to design and execute research projects, collect and analyze data using appropriate methodologies, and interpret and present their findings effectively.
- ❖ **Critical Thinking and Problem-Solving:** Graduates will develop advanced critical thinking skills, enabling them to evaluate and analyze complex scientific problems related to zoology. They will be able to apply logical reasoning and scientific methodologies to identify and propose innovative solutions to zoological challenges.
- ❖ **Communication Skills:** Graduates will possess excellent oral and written communication skills, allowing them to effectively communicate scientific ideas and research findings to both scientific and non-scientific audiences. They will be able to prepare and deliver scientific presentations, write research papers, and effectively communicate their knowledge to a broader community.
- ❖ **Ethical Considerations:** Graduates will demonstrate a strong understanding of ethical considerations in zoological research and its applications. They will adhere to ethical principles and guidelines while conducting research involving animals, ensuring the welfare and conservation of animal species.
- ❖ **Interdisciplinary Perspective:** Graduates will develop an interdisciplinary perspective, recognizing the connections between zoology and other scientific disciplines. They will be able to collaborate with experts from various fields to address complex research questions and contribute to interdisciplinary research projects.
- ❖ **Professional Development:** Graduates will exhibit professional skills necessary for a successful career in zoology. They will have the ability to work both independently and as part of a team, demonstrating leadership qualities, time management, and organizational skills. They will also have a commitment to lifelong learning and staying updated with advancements in the field of zoology.
- ❖ **Conservation and Sustainability:** Graduates will understand the importance of conservation and sustainability in the context of zoology. They will possess knowledge of conservation strategies, habitat management, and the impacts of human activities on animal populations. They will contribute to the preservation of biodiversity and the sustainable management of natural resources.

- ❖ **Career Readiness:** Graduates will be prepared for a wide range of career opportunities in academia, research institutions, conservation organizations, environmental agencies, zoos, museums, and other related fields. They will have the necessary skills and knowledge to pursue further academic research or professional careers in zoology.
- ❖ **Continuous Improvement:** Graduates will engage in continuous professional development, seeking opportunities to enhance their knowledge and skills in zoology. They will actively contribute to the advancement of the field through their research, teaching, and collaborations.

These programme outcomes reflect the expected knowledge, skills, and attributes that students will acquire upon completing a postgraduate programme in Zoology. They aim to prepare graduates for successful careers in the field of zoology, contributing to scientific knowledge and the conservation of animal species.

Credit distribution for the course

*In lieu of the Research Project, two additional elective papers/ Internship may be offered

Assessment framework:

Weightage for assessments (in percentage)

Type of Course	College Assessment Marks	University Assessment Marks
Theory	40	60
Practical	40	60
Projects	--	--
Experiential Learning (Internships etc.)	--	--

Semester I**Course Title:** Comparative Anatomy of Invertebrates

Course Title/Code: DSC-25 Comparative Anatomy of Invertebrates	Course Credits: 4
Course Code: DSC-25	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course specific objective

- To understand the structural and functional anatomy of Invertebrates.
- To acquire knowledge about locomotory, nutritional and organs of digestion and its mechanism
- To understand the respiratory, excretory and nervous coordinating organization
- To learn about the larval forms, colonial and social life of invertebrates.

Course specific outcomes**After successful completion of this course, students are expected to:**

- Enlighten themselves with knowledge related to structural & functional anatomy of invertebrate animals.
- Enrich themselves with understanding of organs and systems of locomotory, nutrition, digestion and other vital process.
- Know the larval forms found in invertebrates and their significance.
- Understand the social life in honey bees.

Semester I- Zoology DSC-25 Course Content:**F. Y. M. Sc (Zoology) Sem-I****ZOO ----- Comparative Anatomy of Invertebrates**

Unit	Topics	Lectures	Marks
1.	A. Structural organization of invertebrates B. Diversity and phylogeny of invertebrate C. Organization of Coelom: a. Acoelomates b. Pseudocoelomates c. Coelomates - Protostomia and Deuterostomia D. Invertebrate larvae: a. Larval forms of Platyhelminthes, Crustacea, Mollusca and Echinodermata b. Significance of larval forms.	15	25
2.	A. Locomotion: a. Locomotory organelles – Cilia, flagella b. Flagella, Ciliary and amoeboid movement in protozoa B. Nutrition and Digestion: a. Pattern of feeding and digestion in lower metazoan, b. Filter feeding in polychaeta, c. Filter feeding and digestion in mollusca and	15	25

	deuterostomes		
3.	A. Respiration: <ol style="list-style-type: none"> Organs of respiration- Gills and lophophores, Gills and lungs in Mollusca, Gills and trachea in Arthropoda, Respiratory pigments in invertebrates Mechanism of respiration in gastropods and Insecta B. Excretion and osmoregulation: <ol style="list-style-type: none"> Organs and Mechanism of excretion - Coelom, Coelomoducts, Nephridia and Malpighian tubules Osmoregulation in terrestrial and aquatic invertebrates. 	15	25
4.	A. Nervous system: <ol style="list-style-type: none"> Primitive nervous system- Coelenterates and Echinodermata, Advanced nervous system- Annelida, Arthropoda (Crustacea and Insecta), and Mollusca (Cephalopoda) Trends in neural evolution. B. Colonial and social life: <ol style="list-style-type: none"> Sponge and Coelenterate colonies Social life in the honey bee, Ants and Termites 	15	25
	Total	60	100

Suggested Readings:

- Barnes R. O.: The Invertebrates, W. B. Saunders and Co.
- Barrington E.J.W.: Invertebrates, Structure and function, homes Nelson and Sons, Ltd., London
- Hyman L.H.: The Invertebrate Volume 1 to 8, McGraw Hill Co. New York
- Jordan, E. L.: The Invertebrates, S. C. Chand, New Delhi.
- Kotpal R. L.: Modern Text book of Zoology: Invertebrates, Rastogi publications, Meerut
- Kotpal R.L.: Protozoa to Echinodermata Series,
- Marshall and William: A text book of Zoology: Invertebrate Vol. I, CBS publishers, New Delhi.
- Prasad S. N.: Life of Invertebrates, Vikas publishing house, New Delhi.
- Russel Hunter : A Biology of higher invertebrates, McMillon Co. Ltd. London

Semester I**Course Title: Biochemistry**

Course Title/Code: DSC-26 Biochemistry	Course Credits: 2
Course Code: DSC-26	L-T-P per week: 2-0-0
Total Contact Hours: 30	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- To acquire knowledge regarding biochemical aspects of life.
- To understand different type of metabolic process and energetics thereof.
- To make students familiar with details of enzymes, classes and factors influencing rate of enzymatic reactions.
- To learn about hormones, neurotransmitters and its mode of action.
- To gain the insight about Proteomics and Genomics with its applications.

Learning outcome:**After successful completion of this course, students are expected to:**

- Enlighten themselves with knowledge related to biochemical aspects of life.
- Enrich them with understanding of different type of metabolic process and energetics thereof.
- Know the details of enzymes, classes and factors influencing rate of enzymatic reactions.
- Understand different hormones, neurotransmitters and its mode of action.
- Gain insight about Proteomics and Genomics with its applications

Semester I- Zoology DSC-26 Course Content:**F. Y. M. Sc (Zoology) Sem-I****ZOO ----- Biochemistry**

Unit	Topics	Lectures	Marks
1.	Water, Acid, Base, Buffer, Buffers in Biological system Derivation of Henderson-Hasselbalch equation, Types of metabolism and energetics	07	25
2.	Enzymes: Definition, Different classes and Examples of enzymes, Factors affecting rate of enzyme reaction Isoenzyme: Lactate dehydrogenase Hormones, types and examples, mode of action of peptide and steroid hormones.	08	25
3.	Neurotransmitters: Types, Synthesis, storage, uptake, degradation and mechanism of action of acetyl choline, GABA, serotonin, dopamine, glutamate, aspartate, nitrous	07	25

	oxide and neuropeptides (Endorphins, enkephalins and substance P)		
4.	Proteomics and genomics: definition, scope and applications. Protein data bank and GenBank.	08	25
	Total	30	100

Suggested Readings:

- Lehninger, A.L.: Principles in Biochemistry, CBS publication, New Delhi
- Principles and techniques of practical Biochemistry, K. Wilson and J. Walkar, ISBN edition
- Biochemistry: Stryer
- Harper's Biochemistry: Robert Murray, D.K. Granner, Peter A. Mayer and Victor w.
- Rodwell. International 25th edition.
- Biochemistry: Zubay
- Biochemistry: Satyanarayan

Semester I**Course Title: Biostatistics**

Course Title/Code: DSC-27 Biostatistics	Course Credits: 4
Course Code: DSC-27	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- Understand the Fundamentals of Biostatistics: The first objective of the Biostatistics course in Zoology is to provide students with a solid understanding of the fundamental concepts and principles of biostatistics.
- Apply Statistical Methods to Biological Data: The second objective is to enable students to apply statistical methods to analyze and interpret biological data effectively.
- Interpret and Critically Evaluate Research Findings: The Biostatistics course aims to develop students' ability to interpret and critically evaluate research findings in zoology.
- Apply Biostatistics to Experimental Design: The fourth objective is to equip students with the knowledge and skills to apply biostatistics in designing scientific experiments in zoology.

Learning outcome:

- Knowledge and Understanding: Upon completion of the Biostatistics course in zoology, students will demonstrate a solid knowledge and understanding of the fundamental concepts, principles, and techniques of biostatistics.
- Data Analysis Skills: Students will develop the skills to analyze and interpret biological data using appropriate statistical methods.
- Critical Thinking and Interpretation: Students will develop critical thinking skills and the ability to interpret research findings in the context of biostatistics.
- Experimental Design and Statistical Decision-making: Students will learn how to apply biostatistics in experimental design.

Semester I- Zoology DSC-26 Course Content:

**F. Y. M. Sc (Zoology) Sem-I
ZOO ----- Biostatistics**

Unit No.	Content	Lectures	Marks
1.	Introduction, Sampling and Data Classification <ul style="list-style-type: none"> • Applications and uses of statistics. • Meaning of Population, Sample, random sampling. • Methods of collection of Data:- SRSWR, SRAWOR, Systematic random sampling, Stratified random Sampling. • Meaning of variable, discrete variable, continuous 	15	25

	<p>variable.</p> <ul style="list-style-type: none"> Some important terms: frequency, relative frequency, class limits, class width, inclusive and exclusive method of classification. Frequency distribution, relative frequency distribution, and cumulative frequency distribution. 		
2.	<p>Graphical representation of grouped data</p> <ul style="list-style-type: none"> Histogram, frequency polygon, Ogive curves. Exercise and problems. <p>Measures of central tendency and dispersion:</p> <ul style="list-style-type: none"> Computation of mean, mode and median (for raw data and grouped data) Computation of variance, SD, coefficient of variation (for raw data and grouped data) Exercise and problems. 	15	25
3.	<p>Correlation and Regression</p> <ul style="list-style-type: none"> Concept of Correlation, types of correlation, scatter diagram. Karl-Pearsons's coefficient of correlation (ungrouped data) and its properties. Concept of Regression, linear regression, regression coefficients and its properties. Exercise and problems. <p>Analysis of variance:</p> <ul style="list-style-type: none"> Meaning of ANOVA, one-way and two-way classification. Linear model of one-way and two-way classification. Exercise and problems 	15	25
4.	<p>Testing of hypothesis:</p> <ul style="list-style-type: none"> Statistical Hypothesis, Null hypothesis, Alternative hypothesis, critical region, acceptance region, Type I error, Type II error, Level of significance, one tailed and two tailed tests. Tests Based on large samples: - test of significances of mean, test of significance of difference of means. Tests based on small samples: - t- test: Testing single population mean, two population means, paired t-test. χ^2 – test for testing independence of attributes, single population variance. F- Test for testing two population variances. Exercise and problems. 	15	25
	Total	60	100

Suggested Readings:

- N. Gurumani :- An introduction to biostatistics, 2nd revised edition, MJP publishers, Chennai 600 005

- Irfan Ali Khan and Atiya Khanum:- Fundamentals of biostatistics, 3rd edition, Ukaaz publication, Hyderabad
- Dr. Satguru Prasad:- Fundamentals of biostatistics [Biometry], Emkay publications, Delhi 110051
- B.K.Mahajan:- Methods in Biostatistics, Jaypee Brothers, Medical publishers (p) ltd. New Delhi, 110 002
- Principles and practice of Biostatistics :- J.V.Dixit

Zoology Core Lab Course Content

Semester I

Course Title: DCS-28 : Practical	Course Credits: 2
Course Code: DSC-28	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of Practical: 4 Hours
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objectives

- To acquire the practical skill about dissection of Grasshopper or Cockroach related to their digestive, nervous and reproductive system.
- To perform mountings of various significant parts of Grasshopper/Cockroach
- Understand the concept of systematics or taxonomic features of invertebrate animals.

Course Outcomes (COs):

After successful completion of this course, students are expected to:

- perform dissection of Grasshopper or Cockroach related to their digestive, nervous and reproductive system.
- acquire practical skills for mountings of various significant parts of Grasshopper/Cockroach
- Classify the invertebrate animals belonging to phylum Porifera to Hemichordata

Lab Course Content

Comparative Anatomy of Invertebrates

List of experiments/practicals to be conducted	60 Hrs.
<ol style="list-style-type: none"> 1. Dissection of Grasshopper/Cockroach so as to expose its – (E) <ol style="list-style-type: none"> a. Digestive system b. Nervous System c. Reproductive system (Male and Female) 2. Mounting of following – (E) <ol style="list-style-type: none"> a. Nephridia and Spermatheca of earthworm, b. Mouthparts of Grasshopper/Cockroach, c. Cornea and Wings of Grasshopper/Cockroach d. Tracheal and spiracles of Grasshopper/Cockroach e. Ommatidium of Cockroach 3. Classification of Invertebrates - Porifera to Annelida up to order (one example from each order) 4. Classification of Invertebrates -Arthropoda to Hemichordata up to order (one example from each order) 	

Zoology Core Lab Course Content

Semester I

Course Title: DCS-29 : Practical	Course Credits: 2
Course Code: DSC-29	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of Practical: 4 Hours
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objectives

- Application of Statistical Software: The first objective of the Biostatistics Practicals is to provide students with hands-on experience in applying statistical software for data analysis.
- Practical Application of Biostatistical Techniques: The second objective is to allow students to apply biostatistical techniques learned in theory to real-world biological datasets through practical exercises, students will have the opportunity to analyze and interpret actual data sets from zoological studies.

Course Outcomes (COs):

- Data Analysis Proficiency: Upon completion of the Biostatistics Practicals, students will demonstrate proficiency in analyzing biological data using appropriate statistical techniques.
- Statistical Software Skills: Students will develop skills in using statistical software for data analysis.
- By the end of the course, students will have the ability to use statistical software effectively to analyze biological data and present their findings visually.

Lab Course Content

Biochemistry

List of experiments/practicals to be conducted	30 Hours
<ol style="list-style-type: none"> 1. Preparation of buffer of known molarity and pH 2. Estimation of Glycogen from liver of rat/goat/suitable animal 3. Estimation of protein by Lowry method 4. Estimation of crud fat content in food by soxhlet method 5. Study of enzyme inhibition using suitable inhibitor, substrate and enzyme 6. Estimation of sex hormones in blood samples using suitable method 7. Study of Protein structure using PDB file and Ramachandran plot 8. Study of genomic database of human being using GenBank 	

Biostatistics

List of experiments/practicals to be conducted	30 Hours
<ol style="list-style-type: none"> 1. Construction of frequency distribution and its graphical representation. (frequency curve, frequency polygon, ogives) 2. Computation of mean, mode, and median. (ungrouped and grouped data) 	

<ol style="list-style-type: none"> 3. Computation of variance, Sd, and coefficient of variation (ungrouped and grouped data) 4. Correlation and regression (ungrouped data) 5. Large sample tests 6. Small sample tests (Chi-square test, t-test, and F-test) 7. ANOVA (Based on one-way and two-way classification) 	
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Suggested Readings:**Biochemistry**

- Lehninger, A.L.: Principles in Biochemistry, CBS publication, New Delhi
- Principles and techniques of practical Biochemistry, K. Wilson and J. Walkar, ISBN edition
- Biochemistry: Stryer
- Harper's Biochemistry: Robert Murray, D.K. Granner, Peter A. Mayer and Victor w.
- Rodwell. International 25th edition.
- Biochemistry: Zubay
- Biochemistry: Satyanarayan

Biostatistics

- N. Gurumani :- An introduction to biostatistics, 2nd revised edition, MJP publishers, Chennai 600 005
- Irfan Ali Khan and Atiya Khanum:- Fundamentals of biostatistics, 3rd edition, Ukaaz publication, Hyderabad
- Dr. Satguru Prasad:- Fundamentals of biostatistics [Biometry], Emkay publications, Delhi 110051
- B.K.Mahajan:- Methods in Biostatistics, Jaypee Brothers, Medical publishers (p) ltd. New Delhi, 110 002
- Principles and practice of Biostatistics :- J.V.Dixit

Semester I**Course Title: Wildlife Conservation and Management**

Course Title/Code: DSE-5 Wildlife Conservation and Management	Course Credits: 4
Course Code: DSE-5	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course objectives:

- To provide graduates in Biology a specialization in the field of Biodiversity, Conservation and Wildlife Management
- To generate qualified students who can directly get jobs in the allied fields of Biodiversity, Conservation and Wildlife Management;
- To generate qualified postgraduates who can be part professional organizations working in the field of conservation and environment protection.
- To generate a team of post graduates who can take up jobs related to the environment in educational institutions.

Course Outcomes (COs):

- Skilled post graduates who can undertake research in the field of Biodiversity, Wildlife biology and Nature conservation.
- An alternate avenue to Biology graduates to specialize as “environmental entrepreneurs” in areas such as Environmental audits, Environmental education, Ecotourism etc.
- Awareness about Biodiversity and Nature Conservation.

Semester I- Zoology DSE-5 Course Content:

F. Y. B. Sc (Zoology) Sem-I
ZOO --- Wildlife Conservation and Management

Unit	Topics	Lectures	Marks
1.	A. Concept of Biodiversity. a. What is biodiversity b. Types of Biodiversity c. Climatic Zones and Biodiversity d. Biodiversity as a natural resource B. Wildlife Management a. Principles of wildlife management b. Wildlife management techniques c. Prey-predator ratio d. Improving carrying capacity Water holes, salt licks, stall feeding, e. Controlled grazing, controlled fire Culling & translocation	15	25
2.	A. Species Conservation Techniques a. In situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries, Conservation Reserves,	15	25

	<p>Community reserves).</p> <p>b. Ex-situ conservation (Botanical & Zoological Gardens, Gene Banks, Seed and Seedling Banks, Pollen Culture, Tissue Culture and DNA banks, Butterfly Gardening)</p> <p>c. Concept of Biodiversity Hotspots and Mega-diversity Country; Role of captivity In wildlife management.</p> <p>B. Habitat Conservation Techniques</p> <p>a. Concept of Habitat</p> <p>b. Habitat Management</p> <p>c. Habitat Edge improvement</p> <p>d. Role of Corridor in Wildlife Management</p> <p>e. Ecological Restoration Programme; Social Forestry; Agro Forestry; Joint Forest.</p>		
3.	<p>A. Wildlife conflicts</p> <p>a. Dealing with Human–Wildlife conflicts Compensating losses</p> <p>b. Regulating forest usage (e.g. grazing at Keoladeo / Gir, Fishing in Sunderbans, Mahua collection in Kanha)</p> <p>B. People’s participation in managing protected areas</p> <p>a. Integrating Local Community in conservation (e.g. Kaziranga, Eagle’s Nest)</p> <p>b. Training & skill development of local human resource</p> <p>c. Interpretation Centers & Interpretation to visitors</p> <p>d. Case studies of success stories: (e.g. Ranthambor, Periyar, Lakswadweep, Van samitis).</p>	15	25
4.	<p>A. Threats to Biodiversity.</p> <p>a. Biodiversity of Indian subcontinent</p> <p>b. India as a mega diversity nation</p> <p>c. Factors causing biodiversity degradation</p> <p>d. Concept of species extinction.</p> <p>B. Wildlife Trade and Laws</p> <p>a. Wildlife protection Act of India</p> <p>b. CITES</p> <p>c. TRAFFIC</p> <p>d. RED Data Book</p> <p>e. Measures to control poaching & wildlife trad</p>	15	25
	Total	60	100

Suggested Readings

- Fundamentals of Wildlife Management, Gopal, Rajesh Justice Home, Allahabad, India.
- Wildlife Ecology, Conservation and Management, Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Blackwell Publishing, U.S.A.
- Wild Animals in Central India, Brander, A.A, Natraj Publisher, Dehradun.
- Wild Animals, Their Minds and Manners, Hornaday, W.T. IBD, Dehradun.
- Concepts in Wildlife Management, Hosetti, B.B. Daya Publishing House, Delhi.

- Handbook of Environment, Forest and Wildlife Protection Laws in India, Justice Kuldip Singh, Natraj Publishers, Dehradun.
- Biodiversity conservation in managed and protected areas, Katwal/Banerjee, Agrobios, India.
- Wildlife Issues in a Changing World, Moulton, M. P. & J. Sanderson, St. Lucie Press
- Biodiversity and its conservation in India, Negi, S.S. International Book Distributor, Dehradun.
- Manual for Wildlife Management in India, Negi, S.S. International Book Distributor, Dehradun.
- Fundamentals of Ecology, Odum, Eugene P, Natraj Publishers, Dehradun.
- Essentials of Conservation Biology, Primack, R.B.,
- Sinauer Associates, Inc. Nederland, MA
- Wildlife management, Robert, G.H, W.H. Freeman and Co., San Francisco, U.S.A.

Semester I**Course Title: Research Methodology**

Course Title/Code: RM - Research Methodology	Course Credits: 4
Course Code: RM	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- **Understanding Research Design and Methodology:** The first objective of the Research Methodology course in zoology is to provide students with a comprehensive understanding of research design and methodology.
- Students will learn about the various research designs used in zoological studies, such as observational studies, experimental designs, field surveys, and meta-analyses.
- **Developing Research Skills and Ethical Considerations:** The second objective is to develop students' research skills and instill ethical considerations in zoological research.
- Students will learn how to formulate research hypotheses, design research projects, and develop research proposals.

Learning outcome:

- **Research Design and Methodology:** Upon completion of the Research Methodology course in zoology, students will demonstrate a comprehensive understanding of research design and methodology.
- They will be able to critically evaluate and select appropriate research designs and methods based on the research question and objectives.
- **Ethical Research Practices:** Students will develop a strong awareness of ethical considerations in zoological research.
- They will understand the ethical guidelines, regulations, and principles governing research involving animals.

Semester I- Zoology RM - Course Content:

F. Y. M. Sc (Zoology) Sem-I
ZOO ----- Research Methodology

Unit	Topics	Lectures	Marks
1.	Definition, introduction, and scientific approach of research <ul style="list-style-type: none"> • Meaning of research-Research, methodology and important characters • Objectives of research • Motivation in research • Types of research • Significance of research • Research methods versus methodology 	15	25

	<ul style="list-style-type: none"> • Research and scientific methods • Research methods in flow charts • Various steps of research process • Criterion of good research • Need of research in developing countries 		
2.	Research design <ul style="list-style-type: none"> • Selection of problems, suitable approaches and methods • Meaning of research design • Need of research design • Features of good design • Importance concepts of research design • Basic principle of experimental design 	15	25
3.	Component of research report/paper/project <ul style="list-style-type: none"> • Prepare Title, Author and Addresses, key words and Abstract (summary and synopsis) Writing of research paper and project <ul style="list-style-type: none"> • IMMRAD system (Introduction, Material methods, Result and Discussion), Acknowledgement, Summary, Conclusion and references. • concept of scientific writing • Meaning of scientific paper • Write a letter to Editor of scientific journal for publishing a research paper. 	15	25
4.	Parameters of research <ul style="list-style-type: none"> • Writing review of literature (book and paper) • Advantages of scientific photographs • Sources of literature • Preparation of Cue cards/index card/reference card • Search engine – Google, Yahoo, Bing, etc • How search engine works Ethical Issues <ul style="list-style-type: none"> • intellectual property rights, • Commercialization, • Copy Right, • Royalty, • Patent law, • Plagiarism, • Citation, • Impact factor • h-index 	15	25
	Total	60	100

Suggested Readings:

- Dr. Nageshwar Rao and Dr. Rajendra P. Das: Communication Skills, Himalaya Publishing House 2005
- Margerson, J.E.: The Art of effective communication, Excel Books New Delhi.

- Research methodology, for biological science, N. Gurumani, MJP publisher
- Chennai
- Research Methodology, Methods and Techniques. C. R. Kothari
- Hand book of Research methodology, modern methods and New Techniques. M. N. Borase
- Research Methodology A Handbook. Prof. R. P. Misra
- Writing good reports. John Bowden
- How to write and publish a Scientific papers (4th edition). Robert A. Day.
- Statistical methods for Research workers. M. L. Bansal



SEMESTER II

Semester II**Course Title:** Comparative Anatomy of Vertebrates

Course Title/Code: DSC-30 Comparative Anatomy of Vertebrates	Course Credits: 4
Course Code: DSC-30	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- Understand the basic principles of comparative anatomy: The primary objective of this course is to provide students with a comprehensive understanding of the fundamental principles of comparative anatomy.
- Develop skills in anatomical observation and comparison: Another key objective of the course is to develop students' skills in anatomical observation and comparison.
- Explore the evolutionary relationships among vertebrate groups: Comparative anatomy provides valuable insights into the evolutionary relationships among different vertebrate groups.
- Apply comparative anatomy to broader scientific contexts: The final objective of the course is to enable students to apply their knowledge of comparative anatomy to broader scientific contexts.

Learning outcome:

- Demonstrate a thorough understanding of vertebrate anatomy: Upon completing the course, students will be able to demonstrate a comprehensive understanding of the anatomical structures and systems found in different vertebrate groups.
- Apply comparative approaches to analyze anatomical variations: Students will develop the ability to apply comparative approaches to analyze and interpret anatomical variations among vertebrate organisms.
- Evaluate and interpret phylogenetic relationships: Students will gain the skills to evaluate and interpret the phylogenetic relationships among vertebrate groups based on anatomical evidence.
- Apply knowledge of comparative anatomy to scientific research and applications: The course will equip students with the ability to apply their knowledge of comparative anatomy to broader scientific contexts and practical applications.

Semester II- Zoology DSC-26 Course Content:**F. Y. M. Sc (Zoology) Sem-I****ZOO ----- Comparative Anatomy of Vertebrates**

Unit	Topics	Lectures	Marks
1.	A. Comparative study of Integumentary system a. Introduction of comparative study b. Comparative study of structure of integuments of Petromyzon, Amphioxus,	15	25

	<p>Scoliodon, Frog, Calotes, Pigeon and Rat.</p> <p>B. Comparative study of Integumentary derivatives</p> <p>a. Epidermal derivatives of Vertebrates.</p> <p>b. Epidermal glands –various types of glands of vertebrates and their functions (e.g. mucous, serous, ceruminous, poison, uropygial, sweat, sebaceous, mammary glands, etc.).</p> <p>c. Epidermal derivatives -types of scales, feathers, beaks, hair, hoof, horns and antlers, claws, teeth, nails, hooves, and baleen. Functions of integument.</p>		
2.	<p>A. Notochord and Cartilage-</p> <p>a. Types and origin of cartilage and Bones –</p> <p>b. Development of bones and types of joints.</p> <p>c. Comparative study of skull of Shark, frog, Calotes, pigeon and human. Study of Vertebrae of shark, frog, Calotes, pigeon and human.</p> <p>d. Sternum- origin and comparative study of Tetrapoda Girdles and appendicular bones of frog, Calotes, pigeon and human.</p> <p>B. Comparative anatomy of Digestion –</p> <p>a. Digestive system- Origin and development of Alimentary canal.</p> <p>b. Parts and modification of oral cavity of vertebrates.</p>	15	25
3.	<p>A. Comparative anatomy of Respiration and circulation</p> <p>a. Respiratory system-</p> <p>b. Types of various respiratory organs and sound production in vertebrates.</p> <p>B. Circulatory system</p> <p>a. Hemopoiesis and Development of heart.</p> <p>b. Comparative study of heart of shark, frog, Calotes, pigeon and rat. Evolution of Aortic arches.</p> <p>C. Comparative anatomy of Excretory systems –</p> <p>a. Development of kidney.</p> <p>b. Evolution of kidneys in vertebrates.</p>	15	25
4.	<p>A. Comparative anatomy of Nervous systems-</p> <p>a. Meninges, Development and differentiations of various parts of brain.</p> <p>b. Comparative anatomy of brain of shark, frog, calotes, bird and rat.</p> <p>B. Comparative anatomy of Reproductive systems-</p> <p>a. Development of gonads.</p> <p>b. Genital ducts in vertebrates.</p>	15	25
	Total	60	100

Suggested Readings

- Young, J.Z.: Life of Vertebrates. The Oxford University Press, London.
- Parker and Haswell: Text book of Zoology vol. II
- Goodrich. Structure and Development of Vertebrates Vol.I and II.
- Watermann, A.J.: Chordate Structure and Function, Mac Millan Co. New York.
- Weichert C.K.: Anatomy of Chordates 4th edn. MC Graw Hill Books Co. New York.
- Comparative Anatomy of Vertebrates- R.K. Saxena and Sumitra Saxena, Viva Books.
- Comparative Anatomy and Developmental Biology R.L. Kotpal, Sastry & Shukla-Rastogi publication
- Kardong K, Vertebrates: Comparative Anatomy, Function and Evolution, McGraw-Hill Companies, USA.
- Kent CG and Carr R, Comparative Anatomy of Vertebrates, McGraw-Hill Companies, USA.
- Liem KF and Franklin W, Functional Anatomy of the Vertebrates: an Evolutionary Perspective, Harcourt College Publishers, California.
- Wolff RG, Functional Chordate Anatomy, Amazon Publication, UK.
- Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.

Semester II**Course Title: Immunology**

Course Title /Code: DSC- 31: Immunology	CourseCredits: 2
Course Code: DSC- 31	L-T-P per week: 2-0-0
Total Contact Hours: 30	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course objectives:

Upon successful completion students will –

- Understand all basics components of the immune system.
- get knowledge of how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology;
- understand the role of cytokines in immunity and immune cell activation; and be able to identify and characterize cytokines of particular immune importance;
- understand the significance the Major Histocompatibility Complex in terms of immune response and transplantation;

Course Outcomes (COs):

- Healthy immunity accomplishes four essential principles:
 - ability to detect and fight off infection;
 - ability to recognize a host's own cells as "self," thereby protecting them from attack;
 - a memory from previous foreign infections; and
 - ability to limit the response after the pathogen has been removed.
- This subject will describe the development, function and regulation of cells of the immune system; immunoglobulins; cytokines; immunological mechanisms operating in immunity to infectious disease; autoimmunity; hypersensitivity; and transplantation and tumour immunology.
- Immunology study helps to explain how the body's defense system (the immune system) functions and treat patients with immune system disorders.
- One can provide support for the diagnosis and management of conditions such as HIV, multiple sclerosis and tuberculosis.

Semester II- Zoology DSC-31 Course Content:

F. Y. M. Sc (Zoology) Sem-II
ZOO----Immunology

Unit	Content	Lectures	Marks
1	A. INTRODUCTION a. Introduction- immunity- types-innate, acquired. b. Primary and Secondary lymphoid organs, lymphoid tissues. c. Immunoreactive cells- structure and functions-macrophages, granulocytes, NK cells, d. T and B lymphocytes – origin, development, differentiation, lymphocyte e. Sub-population in humans.	7	20
2	A. ANTIGENS & IMMUNOGLOBULINS	8	30

	<p>a. Antigens and immunogenicity- terminologies and definition- antigen, immunogen, haptens, super antigen, tolerates, epitope, paratope.</p> <p>b. Features associated with antigenicity and immunogenicity.</p> <p>c. Basis of antigen specificity. MHC – types and importance- distribution and function.</p> <p>d. Antigen processing and presentation to T- lymphocytes.</p> <p>e. Immunoglobulin- structure, types, distribution, biological and chemical properties .</p> <p>f. Theories of antibody production- its regulation and diversity.</p> <p>g. Monoclonal and polyclonal antibodies.</p> <p>h. Complement system – mode of activation- Classical, Alternate and Lectin</p> <p>i. Pathways, biological functions.</p>		
3	<p>A. IMMUNE RESPONSE</p> <p>a. Antigen recognition – TCR, BCR, MHC restriction,</p> <p>b. Lymphocyte activation,</p> <p>c. Clonal proliferation and differentiation.</p> <p>d. Physiology of acquired immune response – various phases of HI,</p> <p>e. CMI – cell mediated cytotoxicity,</p> <p>f. DTH response.</p>	7	20
4	<p>A. HYPERSENSITIVITY</p> <p>a. Hypersensitivity – types and mechanisms,</p> <ul style="list-style-type: none"> • Type I: reaction mediated by IgE antibodies. • Type II: cytotoxic reaction mediated by IgG or IgM antibodies. • Type III: reaction mediated by immune complexes. • Type IV: delayed reaction mediated by cellular response. <p>b. Autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections,</p> <p>c. Detection of molecules using ELISA, RIA, western blot, detection of molecules in living cells, immunoprecipitation, flow cytometry, immunofluorescence microscopy, in situ localization by techniques such as FISH and GISH</p> <p>d. Immune regulation mechanisms – brief account on immuno-induction, immunosuppression, immuno-tolerance, immuno-potential.</p> <p>e. Role of cytokines, lymphokines and chemokines</p>	8	30
	Total	30	100

Suggested readings-

- Kuby J. (1996) Immunology. 3rd Ed. W. H. Freeman and Co, New York
- Pancer Z. and Cooper M. D. (2006). The Evolution of Adaptive Immunity, Ann. Rev. Immunol., 24: 497–518
- Pathak S. S. and Palan V. (1997) Immunology - Essential and Fundamental. Preen Publications Bombay.
- Roitt E., Brostoff J. and Male D. (1993) Immunology. 6th Ed. Mosby and Co. London.
- Roitt I. M. (1988). Essentials of Immunology. ELBS, London.
- Roitt M. (1984). Essentials of Immunology. P. G. Publishers Pvt. Ltd., New Delhi.
- Stites D. P., Stobo J. D., Fudenberg H. H. and Wells J. V. (1982). Basic and Clinical Immunology. 1 4th Ed. Lange Medical Publications. Maruzen Asia Pvt. Ltd., Singapore
- Talwar G. P. (1983) Handbook of Immunology, Vikas Publishing Pvt. Ltd. New Delhi.

Semester II**Course Title:** Tools and Techniques in Life Sciences

Course Title/Code: DSC-32 Immunology	Course Credits: 4
Course Code: DSC-32	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- Introduction to Essential Tools and Techniques: The first objective of the course is to introduce students to a range of essential tools and techniques used in life sciences research in the field of zoology.
- Hands-on Experience with Laboratory Techniques: The second objective is to provide students with hands-on experience in using various laboratory techniques relevant to zoology.
- Field Sampling and Data Collection Methods: Students will learn about field sampling techniques and data collection methods specific to zoology.
- Data Analysis and Interpretation: Students will learn how to analyze and interpret data collected using tools and techniques in life sciences.

Learning outcome:

- Proficiency in Laboratory Techniques: Upon completion of the course on Tools and Techniques in Life Sciences in Zoology, students will demonstrate proficiency in performing various laboratory techniques.
- Familiarity with Advanced Research Tools and Instruments: Students will develop a strong familiarity with advanced research tools and instruments used in zoological research.
- Competence in Field Sampling and Data Collection: Students will acquire competence in field sampling techniques and data collection methods specific to zoology.
- Data Analysis and Interpretation Skills: Students will develop data analysis and interpretation skills related to tools and techniques in life sciences.

Semester II- Zoology DSC-26 Course Content:**F. Y. M. Sc (Zoology) Sem-II****ZOO ----- Tools and Techniques in Life Sciences**

Unit No.	Name of Topic	Lectures	Marks
1.	Principle, parts and its applications of Microscopic techniques: a) Microscope: Light, phase contrast, interference, fluorescence, polarization. b) Inverted and electron microscopy. Principles and Uses of analytical instruments- a) Balances, pH meter, colorimeter, spectrophotometer. b) Densitometric scanner, spectrofluorometer, chemiluminometer.	15	25

	c) Radioactivity counter, Differential scanning calorimeter. d) ESR and NMR spectrometers.		
2.	Principle, instrumentation and application of - a) UV-Vis spectrophotometer, b) Colorimeter c) Fluorimeter a) Electrophoresis: Principle, types and applications of agrose gel electrophoresis, starch, SDS and PAGE electrophoresis. b) Radioactivity: Radioisotopes, half life units, Geiger Muller counter, gamma counter and scintillation, safety guidelines.	15	25
3.	Principle, instrumentation and application of - a) Centrifuge: Basic principle, type analytical and preparative centrifuges, different density gradient centrifuge and analytical with its application b) Incubator, hot air oven and autoclave: Principle, instrument and its application. c) pH meter: Principle types, types of electrodes and application. d) Freezers, coolers, platelet agitators, cryo thawing baths. Cell culture techniques a) Design and functioning of tissue culture laboratory b) Cell proliferation measurement c) Cell viability testing d) Culture media preparation and cell harvesting methods	15	25
4.	Separation techniques in biology a) Molecular separation by chromatography, Precipitation. b) Organelles separation by centrifugation etc. c) Cell separation by flowcytometry, density gradient centrifugation, unit gravity centrifugation, affinity adsorption, anchorage base techniques. a) Immunological techniques based on antigen-antibody interaction – Principle and applications. b) Biosensors.	15	25
	Total	60	100

Suggested Readings:

- Plummer, L: Practical Biochemistry Tata McGraw-Hill.
- Bullock, J. D., Kristiansen, B.- Basic Biotechnology, 1987, academic press, New York.
- Prave, P. Faust, V., Sitting, W & Sukatsch, D.A.- Fundamental of Biotechnology, VCL Publishers, New York. 1987.
- Spier, R. E. and Griffins, J.B.- Animal Cell Biotechnology, Vol. I&II, Academic Press, Orlande, 1985.
- Keshav Trehan- Biotechnology. Wiley Estern Limited, Bangalore, 1990.
- D. B. Tembhare- Techniques in Life Sciences, Himalaya Publishing House.
- T. Poddar, S. Mukhopadhyay, S. K. Das- An Advanced Laboratory Manual Of Zoology, MACMILLAN.
- Keith Wilson, John Walker Principles and Techniques of Practical Biochemistry (Wilson, Principles and Techniques of Practical Biochemistry)

Zoology Core Lab Course Content

Semester II

Course Title: DSC-33 : Practical	Course Credits: 2
Course Code: DSC-33	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of Practical: 4 Hours
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Outcomes (COs):

- Develop proficiency in anatomical specimen preparation: The primary objective of the practical component of this course is to develop students' practical skills in anatomical dissections and specimen preparation.
- Identify and describe anatomical structures through hands-on observation: The practical sessions will enable students to identify and describe anatomical structures of vertebrates through hands-on observation.
- Apply comparative approaches to analyze anatomical variations: Students will learn to apply comparative approaches during practical sessions to analyze and interpret anatomical variations among vertebrate organisms.
- Acquire data collection and analysis skills for anatomical research: The practical component will provide students with valuable skills in data collection and analysis for anatomical research.

Learning outcomes

- Demonstrate proficiency in anatomical dissections and specimen preparation: Upon completion of the practical component, students will be able to demonstrate proficiency in anatomical dissections and specimen preparation.
- Apply comparative approaches to analyze and interpret anatomical variations: Students will develop the ability to apply comparative approaches during practical sessions to analyze and interpret anatomical variations among vertebrate organisms.
- Acquire data collection and analysis skills for anatomical research: Through practical sessions, students will acquire data collection and analysis skills for anatomical research.
- Demonstrate effective communication of anatomical findings: Students will develop effective communication skills for presenting and communicating their anatomical findings.

Lab Course Content

Comparative Anatomy of Vertebrates

Sr. No.	Title of Practical
1	Study of skin of Scoliodon, Frog, any one Reptile, Bird and Mammalian skin with the help of slides
2	Study of any ten integumentary glands of vertebrates with the help of specimen / model / charts / pictogram.
3	Study of any ten integumentary hard derivatives of vertebrates with the help of specimen / model / charts / pictogram.
4	Comparative study of skull of Scoliodon, Frog, Calotes, Gallus and Human

5	Comparative study of Vertebrae of Frog and Human
6	Comparative study of pectoral of Scoliodon, Frog, Calotes, Gallus and Human
7	Comparative study of pelvic girdles of Scoliodon, Frog, Calotes, Gallus and Human
8	Comparative study of limbs bones of Frog and Human
9	Comparative study of heart of Scoliodon, Frog, Calotes, Gallus and Rat.
10	Comparative study of urinogenital system of Scoliodon, Frog, Calotes, Gallus and Rat.
11	Comparative study of brain of Scoliodon, Frog, Calotes, Gallus and Human
12	Comparative study of Genital ducts of Scoliodon, Frog, Calotes, Gallus and Human

Suggested Readings:

- Alexander, R. M.: The chordate. Cambridge University press London.
- Ballairs- Reptiles (Hutchinson)
- Bourne, G. M.: The structure and function of nervous tissue. Academic Press, Newyork.
- Carter, G. S.: Structure and Habit in vertebrate evolutions. Sedgwich and Jackson London.
- Eccles, J. C.: The understanding of the brain. McGraw hill Co., Newyork.
- Hyman : Comparative vertebrate Anatomy, University of Chicago Perss.
- Green : Anatomy of Rat (Hafner)
- Kingsley J.S. : outlines of comparative Anatomy of Vertebrates (Central book Depot, Allahabad)

Zoology Core Lab Course Content**Semester II**

Course Title: DSC-34 : Practical	Course Credits: 2
Course Code: DSC-33	L-T-P per week: 0-0-4
Total Contact Hours: 60	Duration of Practical: 4 Hours
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objectives:

- Develop proficiency in essential immunological laboratory techniques: The primary objective of the practical component in immunology is to develop students' proficiency in essential immunological laboratory techniques.
- Apply immunological techniques to investigate immune responses and diseases: The practical sessions will provide students with the opportunity to apply immunological techniques to investigate immune responses and diseases.
- Develop proficiency in essential laboratory tools and techniques: The primary objective of the practical component in Tools and Techniques in Life Sciences is to develop students' proficiency in essential laboratory tools and techniques.
- Apply laboratory tools and techniques to solve research questions: The practical sessions will provide students with opportunities to apply laboratory tools and techniques to solve research questions in the life sciences.

Course Outcomes (COs):

The student will

- Demonstrate proficiency in immunological laboratory techniques: Upon completion of the practical component, students will demonstrate proficiency in a variety of immunological laboratory techniques.
- Apply immunological techniques to investigate immune responses and diseases: The practical sessions will enable students to apply immunological techniques to investigate immune responses and diseases.
- Demonstrate proficiency in a range of laboratory tools and techniques: Upon completion of the practical component, students will demonstrate proficiency in a range of laboratory tools and techniques commonly used in life sciences.
- Apply laboratory tools and techniques to investigate biological phenomena: The practical sessions will enable students to apply laboratory tools and techniques to investigate and analyze biological phenomena.

Lab Course Content**Immunology**

List of experiments / practicals to be conducted	30 Hours
1) Blood Grouping 2) Chemistry of immunoglobulin molecules, classes and physiological importance. 3) Use of ELISA technique (HIV) or any suitable method 4) Isolation and purification Bovine serum immunoglobulin G (IgG) fraction by suitable method 5) Study of agglutination reaction and its significance performing WIDAL test. 6) Determination of Antigen and Antibody reaction by using any suitable method 7) Demonstrations of:	

a. Serum protein separation by electrophoresis b. ELISA (Antigen/ Antibody detection) c. Egg inoculation technique	
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Tools and Techniques in Life Sciences

List of experiments / practicals to be conducted	30 Hours
1. Calibration of pH meter. 2. Study of Compound and Phase Contrast microscopy. 3. To verify Beer-Lamberts Law. 4. Cell fractionation by using density gradient centrifuge (any suitable gradient) 5. Test Cell viability and counting. 6. Determination of Molecular Weight of DNA by electrophoresis 7. Study of agglutination reaction and its significance performing WIDAL test.	

Suggested Readings:

- Pravash Sen. Gupta, Clinical Immunology; Oxford University Press. 2003.
- Noel R. Rose, Herman Friedman, John L. Fahey, Manual of Clinical Laboratory Immunology. ASM. III edition; 1986.
- Frank C. Hay, Olwyn M. R. Westwood, Practical Immunology, 4th Edition ISBN: 978-1-405-14673-9 April 2008 Wiley-Blackwell
- Leslie Hudson and Frank C. Hay, Practical Immunology, Blackwell Scientific Publication. Ed.3; 1989.
- Goding J.W., Monoclonal Antibodies: Principle and Practice; Academic Press. 2001.
- Carl A. K. Borreback, Antibody Engineering, Oxford University Press. Ed.2; 1995.
- Leonore A. Herzenberg, Donald M. Weir, Leonard A. Herzenberg, Caroline Blackwell, Weir's Handbook of Experimental Immunology, Vol. I – IV; Blackwell Science. 1996.
- Stefan H.E. Kaufmann and Dieter Kabelitz, Immunology of Infection. Methods in Microbiology. Vol. 25; Academic Press. 1998.
- Sringer, T.A, Hybridoma Technology in the Biosciences and Medicine; Plenum Press. New York. 2004.
- Garrison Fathman. C., Fitch, F.W., Isolation, Characterization and Utilization of T lymphocyte clones; Academic Press. 2003.
- G.P.Talwar and S.K.Gupta., A Handbook of Practical and Clinical Immunology, Vol.I-II; CBS Publishers and Distributors. Delhi. 1993

Semester II**Course Title:** Environmental Biology

Course Title/Code: DSE-6 Environmental Biology	Course Credits: 4
Course Code: DSC-6	L-T-P per week: 4-0-0
Total Contact Hours: 60	Duration of Lecture: 1 Hour
College Assessment (CA) Marks: 40	University Assessment (UA) Marks: 60

Course Objective:

- To understand the Population and age structure of Population
- To understand Growth of organism and models of population growth
- To acquire knowledge of prey-predator system
- To know Competition in Nature and concept of niche
- To understand Community, Diversity and Ecological Succession
- To Understanding the need of conservation

Learning outcome:

After successful completion of this course, students are expected to:

- Enrich with the knowledge of Population and its structure
- Know the Growth of organism and models of population growth
- Understand the prey-predator system
- Understand Meaning of Competition in Nature and how the concept of niche evolved
- Know the community structure, significance of species diversity and Concept of Ecological Succession
- Elucidate the how conservation is important for species diversity and ultimately humans

Semester II- Zoology DSC-31 Course Content:

F. Y. M. Sc (Zoology) Sem-II
ZOO----DSE-6 Environmental Biology

Unit	Topics	Lectures	
1.	A. Ecology Of Population <ul style="list-style-type: none"> • Population Ecology, Characteristic of population (Population density, Methods of measuring population Density), Population growth curve (Exponential growth, Logistic growth), Population regulation, Life history strategies (R & K selection), Age structure Population 	15	25
2.	A. Population Growth <ul style="list-style-type: none"> • Population Growth, Growth of organism with non-overlapping generation, Effect of Overlapping Generations, Stochastic and time lag model of population growth, Exponential growth, Verhulst–Pearl logistic growth model, Semelparous and Iteroparous Reproductive strategies, Stable age distribution B. Predation	15	25

	<ul style="list-style-type: none"> • Predation, Patterns of abundance Models of • Prey-Predation dynamics (discrete generation and continuous generation Systems), Optimal foraging theory, Patch choice, Diet Prey Selectivity Foraging time, Role of predation in nature 		
3.	A. Competition And Niche Theory <ul style="list-style-type: none"> • Species competition, Intra-specific competition, Inter-specific competition, History of niche concepts (Grinnellian and Eltonian Niche; Hutchinsonian niche and Modern Niche Theory), Symbiosis and its classification 	15	25
4.	A. Community Ecology And Ecological Succession <ul style="list-style-type: none"> • Nature of Community, Community Structure (Factors to shape community, Shannon Wiener Diversity Index and Simpson index), Keystone species, Level of species diversity, Measurement of Biological Diversity, Factors affecting species diversity, Edges & Ecotones, Succession & Type of Ecological Succession, Concept of Climax B. Conservation Biology <ul style="list-style-type: none"> • Principle of Conservation, Goal of Conservation biology, Need of conservation Biology, Major drivers of diversity changes-Direct and indirect Drivers. 	15	25
	Total	60	100

Suggested Readings

- M Ausloos and M Dirickx (eds.), The logistic map and the route to chaos: From the beginnings to modern applications, Understanding Complex Systems (Springer, Berlin, 2006).
- J R Miner, Pierre-François Verhulst, the discoverer of the logistic curve, Human Biology 5 (1933), 673-689.
- Fundamental Of Ecology by Dash Madhab Chandra, Dash Satya Prakash The Mc Graw Hill Edition 3rd Edition 2009.
- Environmental biology (principle of ecology) by Verma P.S, Agarwal V.K S.Chand publication second edition reprint 2013.
- Sharma, P.D. (2003) Ecology and Environment. 7th Edition, Rastogi Publication, Meerut.
- General book of Ecology by P.D. Sharma

Guidelines for Individual/ Team Projects and Field Reports

The aim of the individual/ team project/s is to develop an aptitude for research in Zoology and to inculcate proficiency to identify appropriate research topic and presentation.

The topics of biological interest and significance can be selected for the project. Project is to be done by a group not exceeding 5 students. The project report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally bound form and duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for End Semester. The viva-voce based on the project is conducted individually. Project topic once chosen shall not be repeated by any later batches of students.

The project report may have the following sections:

1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.)
2. Introduction with relevant literature review and objective
3. Materials and Methods
4. Result
5. Discussion
6. Conclusion / Summary
7. References.

Field Study/ Study tour

Students have to visit one research institute and one wild life sanctuary / museum / zoo. Scientifically prepared hand-written study tour report along with photographs of candidate at the places of visit must be submitted by each student for End Semester on the day of the examination of project.

On-the-job training in zoology provides practical skills, exposure to real-world scenarios, and networking opportunities within the field. It enhances participants' employability, allows them to explore specific areas of interest, and complements their academic knowledge with practical experience. It is important to note that the availability of on-the-job training programs may vary based on geographical location and the specific institutions and organizations within the field of zoology.