

**C. ABDUL HAKEEM COLLEGE [AUTONOMOUS]**  
[Affiliated to Thiruvalluvar University, Vellore]  
**MELVISHARAM – 632509**



**Syllabus under CBCS**  
**Learning Outcome Based Curriculum Frame work**  
**[LOCF]**  
**with effect from 2018-2019 onwards**

**M.Sc. Zoology**

**Prepared By**  
**PG & Research Department of Zoology**

## **Introduction to LOCF [as per UGC OBE-LOCF Model]**

M.Sc Zoology deals with the study of animal kingdom specially the life and diversity of living forms, structural adaptation, their development, evolution, behavior habits and distribution of animals (both living and extinct), their conservation, genetics principles, biochemical aspects, biotechnology, immunology, data analysis etc. As it covers a fascinating range of topics from animal identification up to modern biology, students will have an insight into many disciplines. The learning outcomes-based curriculum framework for a M.Sc. degree in Zoology is designed to help the students in view of the evolving nature of animal science as an interdisciplinary subject. The framework is expected to assist the students at par with other institutions in maintenance of the standard of Zoology degrees/programmes across the country. The syllabus is revised based on a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes recommended by the UGC. This framework is intended for the academic flexibility and innovation in programme design and syllabi development, teaching-learning process, assessment of student learning levels etc.

### **Learning Outcomes based Curriculum Design**

The new curriculum design aims the following

- The courses should be delivered in terms of concepts, mechanisms, analysis and application, biological designs & functions and evolutionary significance cutting across organisms.
- The courses should be studied by students of all branches of biology. Both chalk and board, flipped classroom, blended learning, group discussion, field study and PowerPoint presentations can be used for teaching the course.
- The students should do the internship training/project/institutional visit/field visit under practical of different courses, wherever possible.
- The students are expected to learn the courses with excitements of biology with animal models along with the universal molecular mechanisms of biological designs and their functions.
- The students should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through computer and mobile graphic designs and quantitative parameters to realize how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of Zoology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology.
- The courses and their practical exercises will help the students to apply their knowledge in future course of their career development in higher studies and research.
- In addition, they may get interested to look for engagements/linkage in industry and commercial activities employing modern zoology, bioinstrumentation, Molecular Biology and Biotechnology.
- The students may also be interested in entrepreneurship and start some small business based on their interest and experience, after learning elective and skill based papers..

### **Scope of M.Sc Zoology**

The scope of Zoology as a subject is very broad. The intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The key areas of study within the disciplinary/subject area of Zoology comprise: animal diversity, cell and molecular biology, developmental biology and immunology, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, economic zoology, animal behaviour, bioinstrumentation, biotechnology, wildlife conservation, fisheries and aquaculture and insect, vectors and diseases. M.Sc. degree programme in Zoology also deals with skill enhancement courses such as apiculture, ornamental fish culture, medical lab technology, sericulture etc. The depth and breadth of study of individual topics dealt with would vary with the nature of specific Zoology programmes. As a part of the efforts to enhance the interest and employability of graduates of Zoology programmes, the curricula for these programmes are expected to include learning experiences and outcomes that offer opportunities for higher studies and research at reputed laboratories.

### **Aims of M.Sc Zoology**

The aims include

- To understand their behaviour, population dynamics, physiology and the way they interact with other species and their environments.
- To provide students with the knowledge and skill base that would enable them to undertake further studies in Zoology and related areas or in multidisciplinary areas that involve advanced or modern biology and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.
- To develop a classical zoologist with a modern approach to master many subjects of Zoology.
- To make students compete with the globe, therefore, the main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research.
- To enable students to focus on a “whole animal” or a “bits of animals” approach. The “whole animal” pathway makes the students proficient in the identification and study of animals while the latter approach provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc.

The curriculum can be modified to such extent that a student at M.Sc. level can be a specialist in immunology, entomology, animal behaviour etc. For such specializations, the curriculum needs to focus on special skills to maximise the students' employment probability; for example few skills needed by industry may include the species-specific monitoring for key species, handling of dangerous/ poisonous/ wild animals and the use of Geographic Information Systems (GIS) for data collection.

### Qualification Descriptors for M.Sc Zoology

The qualification descriptors for an M.Sc Zoology may include the following:

- Demonstrate
  - I. a fundamental/systematic or coherent understanding of the academic field of Zoology, its different learning areas and applications, and its linkages with related disciplinary areas/subjects;
  - II. procedural/practical knowledge that creates different types of professionals related to Zoology area of study, including research and development, teaching and government and public service;
  - III. (iii) Skills in areas related to specialization area relating the subfields and current developments in the academic field of Zoology.
- Use knowledge, understanding and skills required for identifying problems and issues relating to Zoology. A keen interest in research and the study of living organisms.
- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s);
- Meet one's own learning needs, drawing on a range of current research and development work and professional materials;
- Apply one's subject knowledge and transferable skills to new/unfamiliar contexts to identify and analyse problems and issues and solve complex problems with well-defined solutions.
- Demonstrate subject-related and transferable skills that are relevant to Zoology-related job trades and employment opportunities
- Good observation skills
- Able to work precisely
- A logical approach to problem-solving
- Good oral and written communication abilities
- Able to work independently or with team members

### Learning Outcomes in M.Sc Zoology

Knowledge and Understanding

- Demonstrate (i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields



(animal diversity, cell and molecular biology, developmental biology and immunology, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, entomology, animal behaviour, bioinstrumentation, biotechnology, biophysics, and sericulture) (ii) procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as, entomology, , apiculture, sericulture, aquaculture, etc.(iii) skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Biochemistry, Biophysics, Biostatistics, Bioinformatics etc).

- Over the years, Zoologists were able to find many differences within the same breed of an animal species. As a Zoology professional one can study extinct animals by specializing in Paleozoology, Animal Taxonomy, cell culture technique, aquatic animal health management etc
- Entomology, the branches dealing with the study of insects; environmental impact assessment, radiation ecology, marine biology and ecology or
- Appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
- Study concepts, principles and theories related with animal behaviour, ethics and welfare.
- Understand and interpret data to reach a conclusion
- Design and conduct experiments to test a hypothesis.
- Understand scientific principles underlying animal health, management and welfare.
- Accept the legal restrictions & ethical considerations placed for animal welfare.
- Understand fundamental aspects of animal science relating to management of animals.
- Assess problems and identify constraints in management of livestock.

### Graduate Attributes in Zoology

**Disciplinary knowledge and skills:** The student shall demonstrate (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Zoology and its different subfields like animal diversity, ecology, animal physiology, developmental biology, biophysics and biochemistry, genetics, evolutionary biology, biotechnology, immunology, sericulture and entomology, and other interdisciplinary subfields like bioinformatics, biostatistics etc; (ii) ability to use modern instrumentation for biotechnology and cell culture practices.

**Skilled communicator:** Ability to impart complex technical knowledge relating to Zoology in a clear and concise manner in oral communication and scientific writing.

**Critical thinker and problem solver:** Ability to have critical thinking and efficient problem solving skills in the basic areas of Zoology like animal diversity, ecology, animal physiology, developmental biology, biophysics and biochemistry, genetics, evolutionary biology, biotechnology, immunology, sericulture and entomology, and other interdisciplinary subfields like bioinformatics, biostatistics etc.

**Sense of inquiry:** Capability for asking relevant/appropriate questions relating to issues and problems in the field of Zoology, and planning, executing and reporting the results of an experiment or investigation. (ex. Environmental impact assessment, pollution control, animal conservation, disease diagnosis in aquaculture etc).

**Team player/worker:** Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.

**Skilled project manager/Supervisor:** Capable of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.

**Digitally literate:** Capable of using computers for Biostatistics, Bioinformatics and computation and appropriate software for analysis of genomics and proteomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.

**Ethical awareness/reasoning:** Capable of conducting their work with honesty and precision thus avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues. Research ethics committee expects them to declare any type of conflict of interest that may affect the research. Any plan to withhold information from researchers should be properly explained with justification in the application for ethical approval.

**Lifelong learners:** Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.

#### Programme Specific Objectives (PSO's)

- M.Sc. in Zoology is a 2 year post-graduate academic degree programme which mainly focuses on the studies related to animals. The teaching programme in the department is interdisciplinary and the course covers the new emerging areas of life sciences.
- Core Courses include Life and Diversity of Invertebrates and Chordates, Cell and molecular Biology, Genetics, Environmental Biology, Biotechnology, Animal Physiology, Developmental Biology, Immunology, Research Methodology, Evolution and Entomology.
- Elective Courses include Biostatistics & Bioinformatics, Biochemistry, Biophysics and Sericulture.
- The teaching involves theory and hands on practical training to students. The well-established state of the art laboratory funded by DBT and DST, Gol in the department provide student to utilize various instruments/equipment.
- The department houses a well-established library having the collection for all competitive examinations related with Zoology. In addition, the department have access to the internet facilities for academic and research purposes.
- In order to expose the students to research environment, every student is also required to take seminars, group discussion and paper presentation in seminars/conferences.
- Every year educational trip to reputed institutions is arranged to various places in India, as a part of M.Sc. curriculum.
- The research activities of the department was recognized nationally and internationally and cover areas such as Biodiversity, environmental monitoring, aquaculture and entomology with sharp focus on cell culture and aquatic animal health etc. The faculty members of this department received several research grants from various national and international agencies.

#### Programme Outcomes (PO) and Programme Specific Outcomes (PSO's)

PO's

PSO's

<b>PO1: Knowledge Empowerment</b> Empowered with Knowledge of basic concepts, principles, the scientific theories related to various scientific phenomena and their relevance in the day-to-day life with an interdisciplinary approach.	<b>PSO1:</b> Acquire knowledge on the various aspects of Zoology like Animal Diversity, Biochemistry, Cell Biology, Genetics, Animal Physiology, Developmental Biology, Ecology, Immunology, Biochemistry, Biostatistics, Bioinformatics, Biophysics, Evolution and Biotechnology.
<b>PO2: Skill Enhancement</b> Equipped with Skills of observations and logical inferences from the scientific experiments.	<b>PSO 2:</b> Independently assemble and understand facts from Practical experiments like genetics, molecular biology, environmental biology, Animal physiology and biochemistry and draw conclusions. <b>PSO 3:</b> Enhance independent study like internship training, project work and demonstrate awareness for higher studies, lifelong learning and professional development.
<b>PO3: Values Enrichment and Ethics</b> Enriched with Values to respect the diversity of life and practice limited use of Natural resources.	<b>PSO 4:</b> Acquire values in Zoology like animal ethics and minimization of animals for experiments, eugenics, understanding human genetic principles, blood grouping and blood donation, wild life conservation and environmental protection in a global, economic, environmental, and societal context. <b>PSO 5:</b> Acquire instrumental techniques, training skills, and modern technology like cell culture, aquatic animal disease diagnosis in an ethical sense and further training to the professionals.
<b>PO4: Social Responsibility and Extension</b> To be transformed to become Nurturers of Environment and Society.	<b>PSO 6:</b> Acquire proficiency in analysing and applying the techniques to help the farmers of Aquaculture, sericulture, Apiculture and Poultry farming <b>PSO 7:</b> Pursue M. Phil/ Ph. D, compete in national eligibility test (NET) of ICAR, UGC and State Government as well as other competitive exams of Forest service, fisheries, entomology etc. for an independent professional career.
<b>PO5: Experimental Learning</b> Recognize the scientific facts behind natural phenomena.	<b>PSO8:</b> Carry out experimental techniques in Biotechnology, Developmental Biology, Biophysics and methods of statistical analysis appropriate for Zoology.



## Learning Outcomes [LO's]

PO'S	C1	C2	C3	E1	C4	C5	C6	E2	P1	P2	EP1	C7	C8	C9	E3	C10	C11	C12	E4	P3	P4	EP2
Core competency	√	√	√	X	√	√	√	X	√	√	X	√	√	√	X	√	√	√	X	√	√	X
Critical thinking	√	√	√	X	√	√	√	X	√	√	X	√	√	√	X	√	√	√	X	√	√	X
Analytical reasoning	√	√	√	X	√	√	√	X	√	√	X	√	√	√	X	√	√	√	X	√	√	X
Research-skills	√	√	√	X	√	√	√	X	√	√	X	√	√	√	X	√	√	√	X	√	√	X
Teamwork	√	√	√	X	√	√	√	X	√	√	X	√	√	√	X	√	√	√	X	√	√	X
Additional Academic Knowledge	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Exposure beyond discipline	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Problem-solving	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Analytical reasoning	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Digital Literacy	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Moral and ethical awareness	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

C stands for Core Paper, E stands for Elective papers, P stands for Core Practical and EP for Elective Practical



## Assessment methods

The assessment of students' achievement in zoology will be aligned with the course/programme learning outcomes and the academic and professional skills that the programme is designed to develop. A variety of assessment methods that are appropriate within the disciplinary area of zoology will be used. The assessment strategy adopted within the M.Sc Zoology aims to test subject knowledge, independent thought and skills acquisition and to provide information about candidates that will be useful to employers. Learning outcomes will be assessed using the methods as given earlier.

Formative assessment is provided during practical classes where students can apply knowledge from lectures as well as seek guidance on practical skills. Students are also encouraged to ask questions during lectures to clarify issues, or even develop ideas derived from lecture material. Lecturer's will also set aside time for workshops and seminars focused on key subjects, where for example students can work in groups on one of a number of topics, present their conclusions for class based debate and receive feedback from lecturers as well as peers.

## Methods of assessment need to be implemented

- Thinking critically and making judgments by Essay, Report, Journal and Book review (or article) for a particular case/situation
- Identifying problems, posing problems, defining problems, analyzing data, reviewing, designing experiments, planning, applying information
- Computation, taking readings, using equipment, following laboratory procedures, following protocols, carrying out instructions
- Accessing and managing information (Researching, investigating, interpreting, organizing information, reviewing and paraphrasing information, collecting data, searching and managing information sources, observing and interpreting) by project, dissertation and applied problem.
- Demonstrating knowledge and understanding by written examination, oral examination, essay and report
- Communicating (One and two-way communication; communication within a group, verbal, written and non-verbal communication. Arguing, describing, advocating, interviewing, negotiating, presenting; using specific written forms) by written presentation (essay, report, reflective paper etc.), oral presentation, group work and discussion/debate/role play

## Suggested List of Supplementary Web Resources for Laboratory Exercises

1. Anatomy of Frog: Pro Dissector (CD) - [www.prodissector.com](http://www.prodissector.com)
2. Physiology of Frog: Physio Ex 4.0 (CD) - [www.physioex.com](http://www.physioex.com)
3. Anatomy of Chordates: The Vertebrate Dissection Guide Series (CD) –  
Learning Development Centre, University of Portsmouth
4. Anatomy of earthworm: The dissection works (CD); Source – [www.scienclass.com](http://www.scienclass.com);  
[www.neosci.com](http://www.neosci.com)
5. Anatomy of shark: Shark dissection and anatomy (video) - [www.neosci.com](http://www.neosci.com)
6. Cockroach dissection- [www.ento.vt.edu](http://www.ento.vt.edu)
7. Mammalian Physiology– [www.biopac.com](http://www.biopac.com)

## 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 or Internship is to be done by a group not exceeding 5 students or individually. 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 THREE research institute of National importance and one wild life sanctuary / museum / zoo and one field trip to Sericulture/Aquaculture farm. 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.

## Teaching-Learning Process

As programme of study in Zoology is designed to encourage the acquisition of disciplinary/subject knowledge, understanding and skills and academic and professional skills required for Zoology-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning.

Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning, practicum and project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, games, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

The syllabus aims to provide this knowledge, capitalizing upon the research activity and teaching expertise of the academic staff. The syllabus is also designed to develop the “analytical techniques and problem-solving skills” relevant to graduate-level employment. Students are encouraged to see themselves as producers of knowledge and collaborators in their learning experience. Lectures introduce key topics in the subject area and guide students 'independent study. Practical will allow students to develop laboratory skills and skills in fieldwork, surveying, data handling and processing, as well as to encounter at first hand the principles introduced in the lectures.

Students will also develop their own interests through self-guided research skills, as library based study and background research and project work. Seminars and small group tutorials will be used to facilitate class discussion. There have to be site visits and lectures by external specialists to provide opportunities to meet animal scientists employed in graduate roles and their employers. There will be an emphasis on the practical application of principles and the development of graduate skills will be included in subject specific units.

### Role of a Teacher

A teacher offer ways for the learners to take an active role, for at least a portion of the course, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate strategies and evaluating the outcomes both internal and external.

A teacher has not only to instruct but also to inspire the students; he or she has to influence the life and character of his or her students, and equip them with ideas and values which will enable them to enter the national stream as worthy citizens.

Teachers are supposed to do all these during the years as the students are under their contact and influence in the College. Learning technology is the broad range of communication, information and related technologies that can be used to support learning, teaching, and assessment.

Blended Learning is learning that is facilitated by the effective combination of different modes of delivery, models of teaching and styles of learning and applying them in an interactively meaningful learning environment.

E-Learning is the use of technology to enable people to learn anytime and anywhere. E-Learning can include training, the delivery of just-in-time information and guidance from experts. Video lectures recorded in segments, case studies, reading material, homework, and quizzes are designed in advance and made available for online streaming or download.

Students are expected to watch the videos, read the assigned material, and do homework before attending class, online or face-to-face, for discussions with the instructor or a teaching assistant.

Technology-enabled instructor engagement and robust learning cohorts give students the experience of learning with peers and from a teacher rather than in isolation from a book or content management system.

Importantly, these new technologies allow class enrolment to scale effectively from tens or hundreds of students to thousands of students per class.

Following Active Learning Methodologies may need to implement: –

- Learning by Doing
- Concept maps
- Brainstorming
- In class surprise quizzes and discussion
- Blended Learning with PPT/Videos
- Process Oriented Guided Inquiry Learning (POGIL) – Flipped Classroom

Using quality scalable online courses taught by other faculty is probably even more important to the long run economic health of most institutions, though this requires a substantial change in culture. Computer supported collaborative learning (CSCL) is a pedagogical approach wherein learning takes place via social interaction using a computer or through the Internet. This kind of learning is characterized by the sharing and construction of knowledge among participants using technology as their primary means of communication or as a common resource.

### **Question Paper Model**

#### **a) Theory Paper**

The following question paper patterns shall be followed for the candidates admitted from the academic year 2018-2019 wherever applicable.

External Maximum 75 Marks – wherever applicable (Ext.75 + Int.25 = Total. 100)

Section A Short answer questions of either / or type (like 1.a (or) b 5X6=30 5 questions – 1 from each unit

Section B Essay-type questions / Problem (Answer any 3 out of 5) 3X15=45

5 questions – 1 from each unit

NOTE: Each question should be taken according to the course outcome given for each subject.

#### **b) Practical paper**

The following question paper patterns shall be followed for the candidates admitted from the academic year 2018-2019 wherever applicable.

Section A: Major Practical's (Choose any one practical among each major/elective paper) – 30 marks

Section B: Minor Practical's (Choose any one practical among each major/elective paper) – 20 marks

Section C: Spotters/Specimens/Charts (Choose one from each major/elective paper) – 3 x 5 = 15 marks

Record Note: 10 Marks

Total: External 75 Marks + Internal 25 marks = Total 100 marks.

### **Extra credit Courses:**

Every student is encouraged to register for Online Courses through SWAYAM platform and has to complete one course per year for the successful completion of their degree programme. The course should be of minimum 8 weeks duration and it can be of students own choice.

The following are the ICT initiatives of Govt of India.

1. SWAYAM Online courses: [www.swayam.gov.in](http://www.swayam.gov.in)
2. UG/PG Moocs: <http://ugcmoocs.inflibnet.ac.in>
3. ePG Pathasala: <http://epgp.inflibnet.ac.in>
4. e-content courseware in UG subjects: <http://cec.nic.in>
5. SWAYAMPBHA: <http://www.swayamprabha.gov.in>
6. CEC-UGC YouTube Channel: <http://www.youtube.com/user/cecedusat>
7. National Digital Library: <http://ndl.iitkgp.ac.in>
8. Shodhganga: <http://shodhganga.inflibnet.ac.in>
9. E-shodh Sindhu: <http://ess.inflibnet.ac.in>
10. Vidwan: <http://vidwan.inflibnet.ac.in>

### **Employments and higher studies opportunities for M.Sc. Zoology students**

1. The higher studies options after M.Sc. Zoology are: Master of Philosophy in Zoology, Master of Philosophy in Life Science, Ph. D. in Zoology,
2. A Master degree holder is eligible for writing competitive exams like NET, SET, placed as Project Assistantship, employability in Fishery Board of India, ZSI and Department of Sericulture and Department of Forests, Government of Tamil Nadu, Central Silk Board and Poultry Industry, Pest Control Supervisor etc.
3. P.G students are eligible for B.Ed., TNPSC, IAS, IPS, IFS (Group 1 exams), Biological laboratory Technician, Conservationist, Environmental Consultant, Herpetologist, Veterinary Technologist, Wildlife Educator, Wildlife Rehabilitator, Zoologist etc.



S.No	Part	Course	Type	Subject Codes	Subject Name	H/W	C	L-T-P	CIA	EXT	TOTAL
Semester 1		Subject Count 4									
1	III	Theory	Core 1	P18MZL101	Life and diversity of Invertebrates	5	4		25	75	100
2	III	Theory	Core 2	P18MZL102	Life and diversity of Chordates	5	4		25	75	100
3	III	Theory	Core 3	P18MZL103	Cell and Molecular Biology	5	4		25	75	100
4	III	Theory	DSE 1	P18EZL101/ P18EZL102/ P18EZL103	[Choose ANY 1 out of Three] Biostatistics and Bioinformatics/Basic Mathematics for Zoologists/Biosystematics & Biodiversity	3	3		25	75	100
	III	Practical 1	Core	P18MZLP21	Practical - I Life and Diversity of Invertebrates, Chordates, Cell and Molecular Biology	4	0		0	0	0
	III	Practical 2	Core	P18MZLP22	Practical - II Genetics, Environmental Biology and Biotechnology	4	0		0	0	0
	III	Practical 1	DSE 1	P18MZLP21	Practical – 1 Biochemistry	4	0		0	0	0
						30	15		100	300	400
Semester 2		Subject Count 8									
5	III	Theory	Core 4	P18MZL201	Genetics	4	4		25	75	100
6	III	Theory	Core 5	P18MZL202	Environmental Biology	4	4		25	75	100
7	III	Theory	Core 6	P18MZL203	Bio Technology	4	4		25	75	100
8	III	Theory	DSE 2	P18EZL201/ P18EZL202/ P18EZL203	[Choose ANY 1 out of Three] Biochemistry/Marine Biology/Ecotourism	4	3		25	75	100
9	III	Practical 1	Core	P18MZLP21	Practical - I Life and Diversity of Invertebrates, Chordates, Cell and Molecular Biology	4	5		25	75	100
10	III	Practical 2	Core	P18MZLP22	Practical - II Genetics, Environmental Biology and Biotechnology	4	5		25	75	100
11	III	Practical 1	DSE 1	P18EZLP21	Practical - I Biochemistry	4	3		25	75	100
12	III	Theory	Compulsory	P18CHR201	Human Rights	2	2		25	75	100
						30	30		200	600	800
Semester 3		Subject Count 4									
13	III	Theory	Core 7	P18MZL301	Animal Physiology	5	4		25	75	100
14	III	Theory	Core 8	P18MZL302	Developmental Biology	5	4		25	75	100
15	III	Theory	Core 9	P18MZL303	Immunology	5	4		25	75	100
16	III	Theory	DSE 3	P18EZL301/ P18EZL302/ P18EZL303	[Choose ANY 1 out of Three] Biophysics/History of Indian Science/Intellectual Property Rights	3	3		25	75	100
	III	Practical 3	Core	P18MZLP41	Practical - III Animal Physiology, Developmental Biology and Immunology	4	0		0	0	0
	III	Practical 4	Core	P18MZLP42	Practical - IV Research Methodology, Evolution and Entomology	4	0		0	0	0
	III	Practical 2	DSE 2	P18EZLP21	Practical – II Sericulture	4	0		0	0	0
						30	15		100	300	400
Semester 4		Subject Count 7									
17	III	Theory	Core 10	P18MZL401	Research Methodology	5	5		25	75	100
18	III	Theory	Core 11	P18MZL402	Evolution or Project	5	4		25	75	100
19	III	Theory	Core 12	P18MZL403	Entomology	5	5		25	75	100
20	III	Theory	DSE 4	P18EZL401/ P18EZL402/ P18EZL403	[Choose ANY 1 out of Three] Sericulture/Beekeeping/ Ornamental fish Culture	3	3		25	75	100
21	III	Practical 3	Core	P18MZLP41	Practical - III Animal Physiology, Developmental Biology and Immunology	4	5		25	75	100
22	III	Practical 4	Core	P18MZLP42	Practical - IV Research Methodology, Evolution and Entomology	4	5		25	75	100
23	III	Practical 2	DSE 2	P18EZLP41	Elective Practical - IV Sericulture	4	3		25	75	100
						30	30		175	525	700

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL101	<b>Semester :</b>	I
<b>Core - 1</b>	<b>Title: Life and Diversity of Invertebrates</b>				
<b>Credits:</b>	4			<b>Max. Marks.</b>	75

## OBJECTIVES

To comprehend the systematic position, functional morphology, mode of life, affinities and biodiversity of invertebrates.

<b>Course outcome:</b> At the end of course the students shall able to		CL	KC	PSO Addressed
CO1	Explain the Origin of Protozoa and Porifera	U	K1	
CO2	Organize the Origin of Bilateria, Platyhelminthes, Annelids and Arthropods	Ap	K2	
CO3	Compare the characters of Mollusca and Echinodermata	An	K2	
CO4	Classify and compare Minor Phyla and fossil evidences.	Ap	K4	

CL (Cognitive Level): R-Remembering, U-Understanding, Ap-Appling, An-Analysing, E-Evaluating, C-Creating  
Knowledge Level: K1-Factual, K2-Conceptual, K3-Procedural, K4-Metacognitive

## UNIT-I

Broad classification of the Animal Kingdom - Principles involved.

**Protozoa:** Feeding, locomotion and Reproduction. Parasitic protozoans.

Origin and evolution of Metazoa - theories. General organization and affinities of Mesozoa

### Porifera

Interrelationship between different classes

Marine sponges. Freshwater sponges. Skeleton in Sponges.

## UNIT-II

### Cnidaria

Origin and evolution, Polymorphism and Reproduction. Corals and Coral reefs

### Origin of Bilateria

Importance of Rhabdocoela as a stem group. Origin and evolutionary trends in coelom formation.

### Platyhelminthes

Functional morphology and adaptive biology for parasitic mode of life. Host response to parasitic infection

## UNIT-III

### Annelida

Phylogeny and general organization of Archiannelida. Interrelationship between different classes of Annelida. Adaptive radiation in Annelida.

### Arthropoda

Economic importance of Crustaceans

Phylogeny of Arthropods, Limulus-affinities, Xiphosuran-structure and affinities.

## UNIT-IV

### Mollusca

Origin of Mollusca, Theories of Molluscan ancestry, Molluscan phylogeny, Evolutionary importance of Monoplacophora, Adaptive radiation in Mollusca, Torsion in Gastropods. Cephalopods as highly evolved molluscs.

### Echinodermata

Origin of Echinodermata, Theories on ancestry of Echinodermata, Phylogeny of Echinodermata.

## UNIT-V

### Minor Phyla:

Systematic position, functional morphology, mode of life and affinities of Ctenophora, Nemertinea, Rotifera, Pogonophora and Phoronida

**Fossils:** Morphological and evolutionary significance of Invertebrate fossils such as Trilobites, Brachiopods, Cephalopods and Echinodermata.

## REFERENCE BOOKS

1. Barnes. R.D. 1974 Invertebrate Zoology. W.B. Saunders Co., Philadelphia.
2. Hyman L.H. 1951 The Invertebrata, Vol I to VI. McGraw – Hill Book Co., New York. University Press.
3. Barrington, E.J. W. 1969. Invertebrate Structure and Functions. English Language Book Society.
4. Moore, R.C. Lalicker, C.G. and Fisher, A.G. 1952 Invertebrate Fossils. McGraw Hill Book Co., New York.
5. Gardinar, M.S. 1972 Biology of the Invertebrates, McGraw - Hill Book Co., New York.

Syllabus for M.Sc., Zoology effective from the year 2018-2019				
<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL102	<b>Semester :</b> I
<b>Core - 2</b>	<b>Title: Life and Diversity Chordates</b>			
<b>Credits:</b>	4			<b>Max. Marks. 75</b>

**OBJECTIVES**

To comprehend the systematic position, functional morphology, mode of life, affinities and biodiversity of chordates.

**Course outcome:**

At the end of course the students shall able to

CO1. Describe the principles of Animal Taxonomy.

CO2. Define the phylogeny of prochordates

CO3. Describe the comparative anatomy of fishes, amphibians and reptiles.

CO4. Distinguish the origin and evolutionary adaptation of aves and mammals.

**UNIT-I: TAXONOMY****Principles of taxonomy**

Nomenclature- Binomial, Trinomial nomenclature.

Suffix as for super family name-(oidea), familyname (idea), use of suffixes 'i', 'orum', 'ae', 'arum', 'ensis' and 'iensis'.

Tautonyms, Synonyms and Homonyms

**New trends in taxonomy:** Ecological approach, Ethological approach, Cytological approach, Biochemical approach and Numerical taxonomy, Bar coding.

**Taxonomic key:** Indented, Simple non-Bracketed, Grouped type, Combination key, Pictorial key, Branching type, Circular and Box-type.

**UNIT-II**

**Prochordate phylogeny** - systematic position of Prochordates –Cephalochordata, Urochordata and hemichordata.

**Ostracoderms:** Silurian and Devonian Ostracoderms. Evolutionary position of the Ostracoderms.

**Placoderms:** Origin of Jaws- Placoderms as ancient "experiment" in the evolution of the jawed vertebrates. Structural peculiarities of Cyclostomata.

**UNIT-III**

**Chondrichthyes:** Fossil history of chondrichthyes, tendencies in Elasmobranch evolution.

**Actinopterygii:** Origin and evolution, Adaptive radiation of bony fishes.

Accessory respiratory organs in fishes, Parental care of fishes.

**Amphibia:** Origin and evolution of Amphibia.

**UNIT-IV**

**Reptilia:** Evolution of Reptilia. Saurischian and Ornithischian Dinosaurs -Rhynchocephalia - Adaptive radiation of Reptiles.

**Aves:** Birds as glorified reptiles. Fossil history of birds, Palate in Birds. Adaptive radiation in birds, Ratidae

**Mammal:** Evolution of Mammals, Structural peculiarities of Prototheria, Metatheria and Eutheria. Adaptive radiation of mammals.

**UNIT-V**

**Comparative anatomy:** Origin and evolution of the vertebrate integumentary system. Paired fins and limbs, heart and aortic arches and brain of vertebrates.

**REFERENCE BOOKS**

1. Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
2. Jolie, M. 1968. Chordate Morphology. East West Press. Pvt, Ltd,
3. Romer, A.S. and Parson, T.S. 1978 Vertebrate Body. W.B. Saunders Co., Philadelphia.
4. Young, J.2.1969. Life of Vertebrates. Clarendon Press, Oxford.
5. Colbert, E.H. 1969. Evolution of Vertebrates. John Wiley and Sons Inc, New York.
6. Holstead. 1969 The Pattern of Vertebrate Evolution. Freeman and Co. San Francisco. U.S.A.
7. Hobart M. Smith, 1960 Evolution of Chordate Structure, Holt, Rinehart and Winston. Inc. New York.
8. Kapoor, V.C. 1998 Theory and Practice of Animal Taxonomy. Oxford and IBH Publishing Co., Pvt, Ltd. New Delhi.
9. Hyman, L.H. 1966. Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago.



## Syllabus for M.Sc., Zoology effective from the year 2018-2019

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL103	<b>Semester :</b>	I
<b>Core - 3</b>	Title: <b>Cell and Molecular Biology</b>				
<b>Credits:</b>	4	Max. Marks. 75			

**OBJECTIVES**

To understand the structure and molecular basis of cellular interactions, energy transformation, regulation and control of genes, cell cycle and information transfer.

**Course outcome:**

At the end of course the students shall able to

CO1. Describe the cellular membrane transport and energetics of cellular respiration.

CO2. Appraise the role of nucleus and chromatin

CO3. Explain the cell division and its control.

CO4. Elaborate the functions of Nucleic acids and gene transfer mechanisms.

**UNIT-I:**

Plasma membrane: Membrane associated receptors, Membrane transport - Membrane Potentials - Extracellular space - cell adhesion, intercellular recognition - Intercellular junctions.

Mitochondria - energetics - Control of cellular respiration - Biogenesis and mitochondrial replication.

**UNIT-II:**

Nuclear - cytoplasmic interactions. Nuclear receptors, Nuclear transplantation - Cell fusion: homokaryons, heterokaryons. Cytoplasts and karyoplasts.

Structure and function of Chromatin - Organisation of nucleosomes - Euchromatin and heterochromatin - Polytene and lambrush Chromosomes

**UNIT-III:**

Cell cycles - its components  $G_0$ - $G_1$  transition - Spindle organization - Chromosome movements - Regulation and synchronization of cell division.

Cancer cell: Differences between normal and cancer cell- structural and functional characteristics -Tumour Viruses- Oncogenes - Environmental factors inducing cancer. Hormones in relation to cancer-Theories of carcinogenesis.

**UNIT-IV:**

Chemistry of DNA - Polymorphism of DNA – C value paradox-Mechanism and enzymology of DNA replication - DNA repair mechanisms.

Chemistry of RNA - Different types of RNA and their functions.

**UNIT-V:**

Information transfer in Prokaryotes; information transfer in Eukaryotes. Transcription - Promoters - Initiators and terminators - Transduction. RNA processing - Trimming of introns and splicing of exons.

**REFERENCE BOOKS**

1. De Robertis. E.D.F. and De Robertis.E.M.F. 2001. Cells and Molecular Biology, B.I Publications Pvt Ltd, India.
2. Lewin, B.2000 Genes VII. Oxford University Press, New York.
3. Howland J.L. 1973. Cell Physiology, McMillan Publishing Co., New York.
4. De Witt, 1977. Biology of the cell.An evolutionary approach. Saunders Company.
5. Karp, G. 1979. Cell Biology. McGraw Hill Ltd., Japan.
6. Avers. C.J., 1976.CellBiology. Van Nostrand Company, New York.
7. Korenberg. A. 1974. DNA Replication. Dorothy- W.H. Freeman and Company, San Francisco.
8. Hawkins, J.D.1996. Gene Structure and Expression, Cambridge University Press, London.
9. Shanmugam, G., 1988. A laboratory manipulation in fish.MaduraiKamaraj University.
10. Albert, B and Watson. J.D. 1990.Molecular Biology of the cell. Garland Publishing, London.
11. Malacinski, G.M. 2005. Essentials of molecular biology.Narosa Publish House, Chennai.
12. Lodish, H., BerkA .,Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, S.L.and Darnell, J. 2004. Molecular Cell Biology. W.H. Freeman & Co., New York.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZL101	<b>Semester :</b>	I
<b>DSE-1</b>	<b>Title: Biostatistics and Bioinformatics (Elective)</b>				
<b>Credits:</b>	3			<b>Max. Marks. 75</b>	

**OBJECTIVES**

To understand the basic concepts of biostatistics and bioinformatics in order to analyze and solve biological problems in a more systematic way through computational management

**Course outcome:**

At the end of course the students shall able to

CO1. Describe the variables in biology and principles of statistical distributions.

CO2. Apply statistical significance test in various biological problems

CO3. Explain the relationship between various biological variables.

CO4. Elaborate the application of bioinformatics in future research.

**UNIT-I:**

**Introduction:** Definition and characteristics of statistical population and sample. Variables in biology and its types. Probability: Types and Theories. Theoretical distribution: Properties and application of normal, binomial and Poisson distribution.

**UNIT-II**

Hypothesis testing: Null and alternative hypothesis - levels of significance - degrees of freedom - type I and type II errors. Test of significance: Chi-square test, types-test for goodness of fit, test of independence and test of homogeneity (computation required), properties and application.

Student 'T' Distribution: types-unpaired and paired (computation required), properties and application

**UNIT-III:**

Correlation: Types, properties and application.

Uses of scatter diagram-Computation of Karl Pearson's co-efficient of correlation - testing its significance and Interpretation.

Regression analysis - properties – application (computation required). ANOVA - Applications.

Population Statistics -Vital statistics - natality and morality rates. Population estimation and population growth.

**UNIT-IV:**

Bioinformatics - Biological Database - Servers for Bioinformatics (NCBI, EBI, Genoment) Virtual Library - Data mining - Data Warehousing - Searching techniques - Genomics - Proteomics.

**UNIT-V:**

Algorithm and tools sequence analysis - Similarity Search - Biomolecular visualization - Drug designing-Molecular docking and dynamics. FASTA and BLAST.

**REFERENCE BOOKS**

1. Milton, J.S 1992 Statistical Methods in Biological and Health Science. McGraw-Hill Inc, New York.
2. Scheffler, W.C. 1963 Statistics for biological sciences. Addition - Wesley Publication Co., London.
3. Snedecor, G. Wand Cochran, W. G. 1967 Statistical Methods. Oxford Publication Co., New Delhi.
4. Arthur, M.L. 2003. Introduction to Bioinformatics Oxford University Press, New Delhi.
5. Higgins D. and Taylor, W. 2000 Bioinformatics: Sequence, Structure and Databanks. Oxford University Press, New Delhi.
6. Durbin, R., Eddy, S.R., Krogh, A. and Mitchison, G. 1998. Biological sequence Analysis. Cambridge University Press, Cambridge, U.K.
7. Baxevanis, A. and Ouellette, B.F. 1998. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley Interscience, Hoboken, New Jersey, USA.

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZL102	<b>Semester :</b>	I
<b>DSE-1</b>	<b>Title: Basic Mathematics for Zoologists (Elective)</b>				
<b>Credits:</b>	3	<b>Max. Marks. 75</b>			

## OBJECTIVES

The course offers the zoology student an opportunity to learn basic mathematical principles for their effective use in solving biological problems and in data interpretation.

### Course outcome:

At the end of course the students shall able to

CO1. Understand the different Graphs and Functions of Basic Mathematics.

CO2. Recognize simple functions of basic mathematics

CO3. Evaluate slope of curves and derivatives of different functions.

CO4. Apply various types of mathematical models.

### UNIT-I:

Mathematics as a language, Need of learning mathematics, Applications of mathematics in Biology. Graphs and functions: Linear function, Quadratic function, Exponential function, Periodic functions, Combination of simple functions, Examples from Biology, Logarithmic function, Slope of curves, Idea of derivatives.

### UNIT-II

Calculus: Differentiation and its applications to biology, Integration and its applications to biology. Indefinite integrals, integration of simple functions, Integral as "anti-derivative" Definite integrals, Integral as area under a curve, Integration by parts, finding derivative and integral given a set of data points.

### UNIT-III:

Algebra: Basics of algebra, Linear algebra, Eigenvalues, Differential equations, Simple differential equations, First order differential equations, Examples: Polymerizing and depolymerizing filaments, Partial differential equations, Vector algebra..

### UNIT-IV:

Fourier Series: Introduction to Fourier series, Fourier coefficients, Calculation of Fourier series for simple functions, Sum of periodic functions. Plotting functions using computer, gun plot demonstration, numerical calculations, Interpolation

### UNIT-V:

Mathematical models: Master equation-Simple model for polymerization & depolymerization dynamics, Simple model for molecular motor motion, biased walk, Growth velocity of polymerizing filaments, Master equation, Solving master equation. Evolutionary model: Wright-Fisher model, Simplest model in population genetics/evolution, Binomial distribution, Evolution

## REFERENCE BOOKS

1. NPTEL Course on Biomathematics accessible at <https://nptel.ac.in/syllabus/102101003/>
2. Cann, J.A. (2002). Maths from Scratch for Biologists. Wiley
3. D'Arcy Wentworth Thompson (1992). On Growth and Form: The Complete Revised Edition, Dover Books on Biology.
4. Ahmad, V.U., and Basha, A. (2010). Spectroscopic Data of Steroid Glycosides: Volume 1. Springer; Softcover reprint of hardcover 1st ed. 2007 edition.
5. Aitken, M.; Broadhursts, B. and Haldky, S. (2009). Mathematics for Biological Scientists, Garland Science.
6. Batschelet, E. (2003). Introduction to Mathematics for Life Scientists (3rd edition) Springer Verlag
7. Murray, J.D. (1989). Mathematical Biology, Springer.
8. Sneyd, J. and Keener, J. (2000). Mathematical Physiology, Springer.
9. Fall, C.P. *et al.* (2002) Computational Cell Biology, Springer.



<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZL103	<b>Semester :</b>	I
<b>DSE-1</b>	Title: Biosystematics and Biodiversity				
<b>Credits:</b>	3	Max. Marks. 75			

## Objectives

To understand the nomenclature and classification of animals

### Course outcome:

At the end of course the students shall able to

CO1. Identify the nomenclature and classification of important biodiversity.

CO2. Analyze how animal species are named and placed in a systematic classification.

CO3. Understand the importance of biodiversity and techniques used to conserve them.

CO4. Explain how ecosystem disruption can affect animal diversity and cause loss at global level and its conservation.

### UNIT-I:

Taxonomy: Introduction to Taxonomy –importance of taxonomy – Aims and tasks of a Taxonomist. Zoological Nomenclature: History of Nomenclature. Zoological classification: kinds of classification – Phyletic lineages, components of classification – Linnean Hierarchy. Concepts of species: typological species concept, nominalistic species concept, biological species concept, evolutionary species concept, recognition species concepts, other kinds of species – polytypic species – subspecies – super species. Newer Trends in Taxonomy: morphological approach - immature stages and embryological approach - ecological approach, behavioural approach, cytological, biochemical and molecular approaches.

### UNIT-II

Biosystematics: Definition and basic concepts - Importance and applications of biosystematics in biology. Trends in biosystematics - concepts – structural, biochemical and molecular systematics. Numerical taxonomy and Differential systematics. Species registry, collection, data collection, preservation, curating, storing and cataloguing, maintaining quality of collection, methods of identification using taxonomic keys, description of taxonomic characters. International code of Zoological Nomenclature (ICZN) and its operative principles - Formation of scientific names of various taxa. Nature of scientific names – Synonyms and Homonyms \_ Meanings of Authors in Brackets. Types: Holotypes, Paratype, Lectotype, Syntype, Neotype and Allotype; Ethics and publications in Taxonomy Research. International code of Zoological Nomenclature (ICZN) and its operative principles - Formation of scientific names of various taxa. Nature of scientific names – Synonyms and Homonyms \_ Meanings of Authors in Brackets. Types: Holotypes, Paratype, Lectotype, Syntype, Neotype and Allotype; Ethics and publications in Taxonomy Research.

### UNIT-III:

Biodiversity: Definition – Types: genetic, species and ecosystem diversity. Values and uses of biodiversity. Mega diversity centres. Hotspots – significance of Western Ghats and Indo-Burma region. Biosphere reserves of India. Rare endemic and endangered species – IUCN Red list category – CITES. Diversity indices – Shannon-Wiener index, Dominance index. Conservation of biodiversity: In situ - afforestation, social forestry, agro forestry, Biosphere reserves, national parks and sanctuaries; Ex situ - Cryopreservation, gene banks, sperm banks, DNA banks, tissue culture and biotechnological strategies. Loss of biodiversity. Biodiversity laws of India. Wildlife Protection Acts.

### UNIT-IV:

Wildlife Biodiversity: Definition of wildlife: Causes of wildlife depletion, Economic importance of wildlife and need for wildlife conservation. Wildlife of India and the World. India as a wildlife diverse country. Endangered species - concepts and management. Extinction - threats to terrestrial, wetland and aquatic biodiversity loss of genetic diversity - effects of fragments, edges and corridors. Loss of global biodiversity – causes - pollution, global warming, urbanization, exotic species, over exploitation.

### UNIT-V:

Modern concepts in wildlife conservation: Wildlife Crimes: Wildlife forensics and its applications in deducting wildlife crimes. Wildlife toxicology: Types of contaminants, methods of toxicity evaluation, bioconcentration bioaccumulation and bio magnifications. Impacts of pesticides and heavy metals on Amphibia, Reptila, Aves and mammals. Conservation of terrestrial and aquatic ecosystems and their diversity. Modes of wildlife conservation: Protected species of Indian wildlife. Biodiversity protection laws - other conservation measures. Conservation Assessment and Management Plan (CAMP) and Population and Habitat Viability Assessment (PHVA) - Analysis and reports. Identification and prioritization of Ecologically Sensitive Areas (ESA). Environmental Impact Assessment (EIA) Methods and their role in wildlife conservation.

## Reference Books

1. Traffic India, The Wildlife protection Act, 1972, 154pp, 1990.
2. Swaminathan, M.S. and Jana, S. Biodiversity Mac Millian, Chennai, 326pp, 1992.
3. Negi, S.S. Biosphere reserves in India: Land use, Biodiversity and conservation, Indus, New Delhi, 1996.
4. Kapoor, V.C. Theory and practice of animal taxonomy, Oxford and IBH, New Delhi, 247pp, 1998.
5. Sivramiah Shantharam and Jane F. Montgomery, Biotechnology, Biosafety and Biodiversity, Oxford IBH, 237pp, 1999.
6. Krishnamurthy, K. V., Textbook of Biodiversity, Science Publishers, 2003.
7. Agarwal and Gupta, U. Animal Taxonomy, S.Chand, New Delhi. 86pp, 2004.
8. Singh, B.K. Biodiversity: Conservation and management, Mangal Deep publication, 58pp, 2004.
9. Tripathi, R. C., Biosystematics and Taxonomy, University Book House, Jaipur 2005.
10. Sharma, A. K., Ray, D., Ghosh, S. N., Biological diversity: Origin, evolution and conservation, Motilal Banarsidass, 2012.
11. Pullaiah, T., Textbook of Biosystematics Theory and Practicals, Regency Publications, 2013.
12. Ashok Verma, Principles of Animal Taxonomy, Narosa Publishing house, 2015.
13. Asad, R. R., Magical biodiversity of India, Oxford UP, 2016.
14. George Gaylord Simpson, Principles of animal taxonomy, Columbia University Press, New York, 247pp, 1990.
15. M. Kato. The Biology of Biodiversity, Springer – Verlag, New York, 2000.
16. John Milton, M.C. (ed). Training Manual on GIS and Marine Biodiversity, 320pp, 2008.



<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL201	<b>Semester :</b>	II
<b>Core - 4</b>	Title: <b>Genetics</b>				
<b>Credits:</b>	4	Max. Marks. 75			

## Objectives

To understand the fine structure of gene and its development, expression and regulation in prokaryotes and eukaryotes.

### Course outcome:

At the end of course the students shall able to

- CO1. Describe the molecular basis of gene and mapping chromosomes.
- CO2. Explain gene regulation mechanisms
- CO3. Analyze human genetics and gene disorders.
- CO4. Elaborate the application of genetics in population studies and animal breeding.

### UNIT-I:

Molecular structure of DNA and RNA - Replication, theories, Gene concept - One gene one polypeptide concept. Identification of DNA and RNA as the genetic material. Microbial Genetics - Conjugation, transformation and transduction and Sexduction. Packaging DNA molecules into chromosomes. Chromosome mapping in prokaryotes (Virus, Bacteria) and eukaryotes (*Neurospora* and Man)

### UNIT-II:

Enzyme regulation of gene action. Gene regulation of gene action - Operon concept - GAL and LAC Operon system. Evidence of regulation of gene action. Hormonal control of gene action. Genes and metabolism. Inborn errors of metabolism in Man. Regulation of gene expression in prokaryotes (*E.coli*) and eukaryotes (*Drosophila*).

### UNIT-III:

Evolution of sex chromosomes. Dosage compensation - X inactivation. Geneomic imprinting. Human Genetics. Normal human karyotype - Variations in karyotypes (autosomal and sex chromosomal, structural and numerical) with special reference to classical syndromes in man (Down, Turner's and Klinefelter's syndrome). Principles and methods of pedigree analysis - statistical evaluation. Genetic counseling - Objectives, ethics and principles. Methods of counselling for point mutation, disorders, structural and chromosomal disorders. Variation in chromosome numbers-ploidy in animals, euploidy and aneuploidy.

### UNIT-IV:

Genes in development and differentiation Mechanism of chromosomal breakage - physical chemical and biological factors or agents. Mutagens and mutagenesis and carcinogenesis - genetic changes in Neoplasia in man. Radiation induced mutations. Population genetics: Population and gene pool. Hardy Weinberg Law-Genetic equilibrium. Calculation of gene frequencies for Autosomal (Complete dominance, codominance and multiple alleles) and sex linked genes. Factors affecting Hardy Weinberg equilibrium.

### UNIT-V:

Applied Genetics - Application of genetics in animal and plant breeding. Retroviral vectors-transgenic genes-transgenic animals. Application of genetics in Crime and Law - DNA fingerprinting, Genetic basis of intelligence. Studies on Twins. Genetic counselling-eugenics and eugenics.

### Reference Books

1. Watson. J.D. Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. 1987 Molecular Biology of the Gene. W.A. Benjamin/Cummings Co., New York.
2. Sinnot. E.W., Dunn. L.C., Dobzhansky, T.H. 1973. Principles of Genetics. McGraw Hill Co., New Delhi.
3. Daniel L. Hartl. 1994. Genetics. Jones and Barflaff Publishing, Boston.
4. Lewin, B. 2000. Genes VII. Oxford university Press, New York.
5. Stickberger, M.W. 1985. Genetics. Printice - Hall of India, Pvt. Ltd., New Delhi.
6. Pandian, T.J. and Muthukrishnan, J. 1988. Workshop on Research Methods for Chromosomal Manipulation in Fish. Department of Biotechnology Govt. of India, New Delhi.
7. Pandian, T.J. and Muthukrishnan, J. 1990. Research Methods for Gene and Chromosome Manipulation in Fish. Department of Biotechnology, Govt. of India, New Delhi.

### Syllabus for M.Sc., Zoology effective from the year 2018-2019

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL202	<b>Semester :</b>	II
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<b>Core - 5</b>	<b>Title: Environmental Biology</b>	
<b>Credits:</b>	4	<b>Max. Marks. 75</b>

**Objectives**

To generate up-to-date knowledge on environmental conservation and management through a comprehensive understanding of the components of ecosystem, biological cycles, habitat ecology, resource ecology, pollution and its management.

**Course outcome:**

At the end of course the students shall able to

- CO1. Describe the structure of various ecosystems.
- CO2. Explain population regulation and biogeochemical cycles
- CO3. Analyze environmental adaptation and conservation strategies.
- CO4. Discuss various types of pollution and control measures.

**UNIT-I:**

Review of concept of ecosystem - Natural and Man-made ecosystem, with examples. Energy flow - Trophic structure and levels - Pyramids, food chain and web - ecological efficiencies, and productivity and its measurement. Definition, nature and flux of energy through communities. Influence of competition, predation and disturbances - Community succession - homeostasis.

**UNIT-II:**

Structure and distribution - Growth curves and pyramids - Groups, natality, Mortality - Density indices, Life study tables - factors affecting population growth - Carrying capacity. Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle - Recycle pathway of elements –Bio-geo Chemical Cycles – Carbon, Phosphate & Nitrogen.

**UNIT-III:**

Major Biomass, Adaptations with reference to physico - chemical features of environment of coastal ecosystems. Renewable and non - renewable resources - animal resources. Conventional and non - conventional energy sources.

**UNIT-IV:**

Principles of conservation - Rain water harvesting - Soil health and fauna inputs in agricultural Biosphere reserves - wildlife conservation and management. Biodiversity - Germplasm conservation and cryopreservation. Social forestry - tribal welfare.

**UNIT-V:**

Environmental pollution and its biological effects. Air, water, soil and noise pollution. Biological indicators and their role in environmental monitoring.

**Reference Books**

1. Odum. E.P. 1996 Fundamentals of Ecology. Nataraj Publishers, Dehra Dun.
2. Trivedi, P.R. and Gurdeepraj, K. 1992. Environmental Biology. Akashdeep Publishing House New Delhi
3. Berwer. A. 1988. The Science of ecology. Saunder's college publishing.
4. Bandopadhyay, J. 1985. India's Environment Crisis and response. Nataraj Publishers, Dehra Dun.
5. Smith, R.L. 1986. Elements of Ecology. Harper and Row Publishers, New York.
6. Ismail, S.A. 1997. Vermicology, Biology of Earthworms. Orient Longman, Chennai.
7. Alpha Soli, I. Arceivala. 1998. Wastewater treatment for pollution control - Second Ed. Tata McGraw Hill Publication Company Ltd., New Delhi.
8. Asthana, D.K. and Asthana, M. 2001. Environmental Problems and Solutions. S. Chand and Co., New Delhi.

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<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZL203	<b>Semester :</b>	II
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<b>Major - 6</b>	Title: <b>Bio Technology</b>		
<b>Credits:</b>	4		Max. Marks. 75

**Objectives**

To familiarize the application of engineering and technology in biology and to find solutions to problem concerning human activities including agriculture, medical treatment, industry and environment.

**Course outcome:**

At the end of course the students shall able to

CO1. Describe the basic steps in gene cloning and associated techniques.

CO2. Explain gene transfer through artificial plasmids and associated techniques

CO3. Elaborate cell culture techniques.

CO4. Design experiments on fermentation and bioremediation.

**UNIT-I:**

Basic steps in Gene cloning - various types of restriction enzymes - ligase linkers and adaptors - c DNA - transformation - Selection of recombinants. Hybridization techniques chemical synthesis of oligonucleotides.

Gene probe - Molecular finger printing (DNA finger printing) - RFLP - the PCR techniques - Genomic library - Blotting techniques - Southern blotting - Northern blotting - Western blotting

**UNIT-II:**

Plasmid biology - cloning vector based on E. coli PBR 322 and bacteriophage. Cloning vector for yeast. Cloning vector for *Agro bacterium tumefaciens*. Cloning vector for mammalian cells - Simian virus 40 - Gene transfer technology - Particle bombardment - Micro injection techniques.

**UNIT-III:**

Cell culture - Organ culture - whole embryo culture - Embryo transfer - In vitro fertilization (IVF) technology - Dolly - in vitro fertilization and embryo transfer in human. Transgenic animal. Human gene therapy. Cryobiology.

**UNIT-IV:**

Fermentation - bioreactor - Microbial products - Primary & Secondary Metabolites - enzymes technology - single cell protein (SCP). Biopolymers, Biopesticides and Biofertilizers.

**UNIT-V:**

Bioremediation - bioremediation of hydrocarbons - Industrial wastes - Heavy metals - Xenobiotics - bioleaching - biomining - biofuels. Applications of biotechnology in agriculture, medicine and food science. Genetically modified organism (GMO'S) - GM foods. Biotechnology & biosafety - IPR.

**Reference Books**

1. Purohit, S.S. and S.K.Mathur. 1999. Biotechnology Fundamentals and Application. Agro Botanica, New Delhi.
2. Alan Scragg. 1999. Environmental Biotechnology, Longman Publication.
3. R.C.Dubey 2001 A text book of biotechnology. Rajendra Ravindra Printer. New Delhi.
4. T.A. Brown 2004 Gene cloning and DNA analysis. Blackwell Science, Osney Mead, Oxford.
5. Dawson, M.T., Powell .R, and Gannon, F. 1996. Gene Technology. Bios Scientific Publishers.
6. Chopra, V.L. and Nanin, A.1992. Genetic Engineering and Biotechnology. Oxford and I BH Publishing Co., New Delhi.
7. Marx, J.L.1989 A Revolution in Biotechnology. Cambridge University, Press, Oxford.
8. Old, R.W.and Primrose, S.B.1985 Principles of Gene Manipulations. An introduction to Genetic Engineering. Oxford Blackwell Publishers, London.

**Syllabus for M.Sc., Zoology effective from the year 2018-2019**

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZL201	<b>Semester :</b>	II
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<b>DSE - 2</b>	Title: <b>Biochemistry</b>	
<b>Credits:</b>	3	Max. Marks. 75

**Objectives**

To comprehend the chemical constituents of living matter, chemistry of food stuffs and their transformation in animal systems, the energy changes associated with these transformation and hormonal regulation.

**Course outcome:**

At the end of course the students shall able to

CO1. Describe the importance of water and ionic balance in animal body.

CO2. Explain the significance of amino acids and enzymes

CO3. Elaborate various metabolic principles of a cell.

CO4. Explain the importance of hormones and vitamins.

**UNIT-I:**

Water - Biological importance, pH and Acid - Base balance. Henderson Hasselbach equation. Buffers - Biological importance. Acidosis, Alkalosis. Electrolyte and water balance.

**UNIT-II:** Amino acids - structure, classification and function. Peptide bonds. Essential and non - essential amino acids, isoelectric point, zwitter ions. Protein - structure, classification, Properties of protein - Deamination, transamination, transmethylation.

Enzymes - general properties, function, classification, nomenclature. Enzyme kinetics - Factors affecting enzyme action, Mechanism of enzyme action, Enzyme regulation.

**UNIT-III:**

Carbohydrate - structure, classification and biological significance.

**METABOLISM**

1. Glycogenesis, 2. Glycogenolysis, 3. Gluconeogenesis, 4. Glycolysis, 5. Hexose mono phosphate shunt. Lipids - structure and classification, Lipids of biological significance, Biosynthesis and Oxidation of Fatty Acids. Energetics.

**UNIT-IV:**

General function, Classification - Steroid Hormones, Protein Hormones, Tissue Hormones.

Vasoactive Peptide Synthetic Hormones. Mechanism of Hormone action.

**UNIT-V:**

Water and Lipid soluble Vitamins - structure, classification, sources and deficiencies in man. Metabolism of Xenobiotics - Detoxification and Biotransformation.

**Reference Books**

1. Murray, R. K, Granner, D.K. Maynes, P.A and Rodwell, V. W. 1998. Harper's Biochemistry. 25th Edition. McGraw Hill, New York.
2. Hames, B. D., Hoopa, N.M and Houghton, J.D. 1998. Instant notes in Biochemistry. Viva Books Pvt. Ltd. New Delhi.
3. Jain, J. L. Jain, S. and Jain N. 2005. Fundamental of Biochemistry, S. Chandra & Co. Ltd. New Delhi..
4. Vasudevan, D.M. and Sreekumar. S. 2000. Text of Biochemistry for Medical students. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi.
5. Rama Rao, A.V.S.S. 1986. Text Book of Biochemistry. L.K. & S Publishers. A.P.
6. Ambika, S. 1990. Fundamentals of Biochemistry for Medical Students, Published by the author.
7. Lehninger, A.L. 2004. Principles of Biochemistry. CBS Publishers, New Delhi.
8. Zubay, G. 1989. Biochemistry. McMillan Publishing Co., New York.
9. Voet, D and Voet, J.G. 2004. Biochemistry. John Wiley and Sons, Inc.



<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZL202	<b>Semester :</b>	II
<b>DSE - 2</b>	<b>Title: Marine Biology</b>				
<b>Credits:</b>	3			<b>Max. Marks. 75</b>	

**Objectives**

To understand and generate awareness of the marine ecosystem.

**Course outcome:**

At the end of course the students shall able to

CO1 Understand the topographical, physical, chemical and biological characteristics of the marine environment.

CO2 Collect and identify plankton and fauna of various marine zones and measure the primary productivity.

CO3 Create awareness on the wealth such as biodiversity and minerals available from the marine zone.

CO4 Generate awareness to sustainably utilize the available resources and pollution free ecosystem.

**UNIT-I:**

Marine environment: Classification of pelagic and benthic divisions. Bottom topography – submarine, canyons and ridges. Estuaries - Classification, characteristic feature and types. Animal adaptations. World Oceans. Coastal lagoons - coral reefs. Mangrove environment and community.

**UNIT-II:** Physical Oceanography: Characteristics of Seawater: salinity, temperature and density, T/ S diagram, dissolved gases. Waves: gravity, wind waves, waves in the shallow waters - internal waves, standing waves, tsunamis. Tides: tide generating forces, theories on tides, semi -diurnal, diurnal, tidal waves, tidal effect on organisms. Currents: Forces causing currents -surface currents, deep ocean circulation and thermohaline circulation.

**UNIT-III:**

Chemical Oceanography: Plant nutrients: inorganic plant nutrients, origin, distribution and important role in the fertility of the sea. Nitrate, phosphate and silicate as nutrients - phosphorus and nitrogen cycles. Marine pollution: Definition - pollutant sources and composition and biological effects -biodegradation and treatment methods. Pollutants: heavy metals, oil, pesticides, sewage, thermal and radioactive. Wealth of the Sea: Minerals of the sea - Mn nodules - formation, distribution, importance and exploitation -other important minerals, glauconite, petroleum and phosphorita.

**UNIT-IV:**

Biological Oceanography I: Plankton: classification of plankton, phyto - and zooplankton. Collection of plankton - Adaptations of plankton – structural, physiological and defensive mechanisms. Primary Production: Definition – Measurement. Methods of estimation, factors affecting primary production. Indicator organisms, plankton and fisheries- Red tide.

**UNIT-V:**

Biological Oceanography II: Benthos: Nature of benthic substratum. Life habits and feeding adaptations of benthic organisms- Epibenthos, swimmers, in fauna, suspension feeding, herbivores, browsers, carnivores and scavengers. Deep sea: Characteristic features of pelagic and benthic fauna - adaptations. Intertidal: Definition, classification, zonation -general characteristic features. Rocky shore: environmental factors, zonation and its pattern, fauna, adaptations of rocky shore. Sandy shore: Environmental factors, zonation, fauna and its adaptations. Muddy shore: Environmental factors, zonation, fauna and its adaptations. Mud banks- formation, structure, importance in marine fishery.

**Reference Books**

1. Seshappa, S., Indian Marine Biology, Daya Publishing House, 1992.
2. Marine biological station, marine faunal diversity of India, Zoological Survey of India, 130 Santhome High Road, Chennai – 600028, 2003.
3. Chhappgar, B. F., Marine life in India, Oxford University Press, 2006.
4. Morre, H.B., Marine ecology, John Wiley & Sons, Inc., 1958.
5. Sverdrup, H.U., M.W. Johnson, and R.H. Fleming., The oceans their physics, chemistry and general biology, (Asian Students Edition), Asia Publishing house, New Delhi, 1961.

6. Odum, E.P., Fundamentals of ecology, 3/ e 1971.
7. James, P.S.B.R. Recent advances in marine biology, Today and Tomorrow publishers, New Delhi, 1986.
8. Raffaelli, D. and Hawkins, S., Intertidal ecology, Chapman and Hall, 1/ e, 1996.
9. Chapman, J.L. and M.J. Reiss., Ecology: Principles & applications, Cambridge University Press, 1997.



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Year:	I Year	Subject Code :	P18EZL203	Semester :	II
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<b>Elective - 2</b>	<b>Title: Ecotourism</b>		
<b>Credits:</b>	3		<b>Max. Marks. 75</b>

**Objectives**

This course is designed to provide students with an understanding of the management and planning of ecotourism opportunities. The course will give students to the concept of ecotourism and its economic, cultural and environmental impacts at different scales. Students will learn the methods through which ecotourism can be marketed and managed, together with its potential adverse impacts.

**Course outcome:**

At the end of course the students shall able to

- CO1. Identify and manage for ecological impacts to soil, water, vegetation, and wildlife resulting from recreation and tourism development;
- CO2. Understand ecological impacts and ecotourism management approaches in a variety of ecosystems under diverse landowners;
- CO3. Analyse the environmental and social consequences of ecotourism management strategies and decisions;
- CO4. Understand management tools to reduce visitor related impacts that occur in ecotourism areas (impacts of outdoor recreation include impacts to soil, vegetation, water, wildlife, air, soundscape, night sky, historical/cultural resources, visitor experiences, and facilities/services).

**UNIT-I:**

History of ecotourism and its definitions. Types of Tourism: Extreme tourism Mass tourism. Why is mass tourism NOT eco-friendly? Evolution and characteristics of ecotourism, relevance of responsible tourism. World Ecotourism Summit-policies and formulations. How an ecotourism development can benefit future generations. Ecotourism as a tool of capacity building and conservation.

**UNIT-II:** Ecotourism as a growth sector within the tourism industry. Tourist resorts. Environmental, socio-cultural and economic impacts of ecotourism. Viewpoints on tourism industry and major constituents, Tourism organizations – international, national, state level and private sector, Importance of tourism statistics. Tourism industry in India, Ecotourism in Kerala- possibilities and problems.

**UNIT-III:**

Tourism policies and planning, Involvement of local bodies and officials in tourism, Coordination between tourists and hosts, Tourism products and operation, Tourist sites and attractions. Managing personnel in tourism, Managerial practices in tourism, Tourism services and management, Seasonality and destination in tourism, Preparation of maps and charts.

**UNIT-IV:**

Tourism marketing- definition, concepts and features Advertising and publicity in tourism Role of media in tourism, Tourism writing. Communication skills and tourism Ecotourism and competing resource users.

**UNIT-V:**

International and domestic tourism markets, Marketing research and analysis, Tourism forecasting and use of technology in tourism marketing, Airlines, Travel Agency, hotel accommodation, tour packages marketing etc.

**Reference Books**

1. Mowforth, M., & Munt, I. (2009). Tourism and sustainability (3rd Edition). London, UK: Routledge.
2. Newsome, D., Moore, S.A., & Dowling, R.K (2002). Natural area tourism. Bristol, UK: Channel View. (Publications.
3. Weaver, D. (2008). Ecotourism (2nd Edition). Hoboken, NJ: JS Wiley. Staff : Dr Julian Clifton

**Syllabus for all PG Courses effective from the year 2018-2019**

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18CHR201	<b>Semester :</b>	II
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<b>Compulsory</b>	<b>Title: Human Rights</b>	
<b>Credits:</b>	2	<b>Max. Marks. 75</b>

**UNIT-I**

Definition of Human Rights - Nature, Content, Legitimacy and Priority - Theories on Human Rights - Historical Development of Human Rights.

**UNIT-II**

International Human Rights - Prescription and Enforcement up to World War II - Human Rights and the U.N.O. - Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Convention on Economic, Social and Cultural Rights and Optional Protocol.

**UNIT-III**

Human Rights Declarations - U.N. Human Rights Declarations - U.N. Human Commissioner.

**UNIT-IV**

Amnesty International - Human Rights and Helsinki Process - Regional Developments - European Human Rights System - African Human Rights System - International Human Rights in Domestic courts.

**UNIT-V**

Contemporary Issues on Human Rights: Children's Rights - Women's Rights - Dalit's Rights - Bonded Labour and Wages - Refugees - Capital Punishment.

Fundamental Rights in the Indian Constitution - Directive Principles of State Policy - Fundamental Duties - National Human Rights Commission.

**Reference Books:**

1. International Bill of Human Rights, Amnesty International Publication, 1988.
2. Human Rights, Questions and Answers, UNESCO, 1982
3. Maurice Cranston - What is Human Rights
4. Desai, A.R. - Violation of Democratic Rights in India
5. Pandey - Constitutional Law.
6. Timm. R.W. - Working for Justice and Human Rights
7. Human Rights, A Selected Bibliography, USIS.
8. J.C.Johari - Human Rights and New World Order.
9. G.S. Bajwa - Human Rights in India.
10. Amnesty International, Human Rights in India.
11. P.C.Sinha & - International Encyclopedia of Peace, Security
12. K. Cheous (Ed) Social Justice and Human Rights (Vols 1-7).
13. Devasia, V.V. - Human Rights and Victimology.



<b>Practical – 1 (Core)</b>	<b>Title:</b>	<b>Life and Diversity of Invertebrates, Chordates and Cell and Molecular Biology</b>
<b>Credits:</b>	<b>5</b>	<b>Max. Marks. 75</b>

**Objectives**

To demonstrate practically the various organ systems of animals, techniques in cell and molecular biology

**Course outcome:**

At the end of course the students shall able to

CO1. Demonstrate practically the various systems of invertebrates.

CO2. Explain cell and molecular biology techniques

CO4. Design experiments on Cell biology.

**INVERTEBRATA AND CHORDATA****Invertebrata**

- Digestive system- Prawn/Cockroach/Loligo/Sepia
- Nervous system- Prawn/Cockroach/Loligo/Sepia

**Chordata**

- 9<sup>th</sup> and 10<sup>th</sup> Cranial Nerves of teleost fish
- Aortic arches of Teleosts

**Minor-Mounting**

- Appendages of Prawn
- Mouthparts-Cockroach, mosquito, housefly, honeybee
- Sting of honeybee

**Study of museum specimens and charts relevant to-**

- Structural modifications of chordates – Hippocampus, Acipensar, Ambystoma
- Adaptive features for their mode of life-Echeneis, Hyla and Draco

**CELL AND MOLECULAR BIOLOGY****CYTOLOGICAL TECHNIQUES**

Micrometry - measurements using ocular and stage micrometers - measurements of cell from any prepared slide (any prepared slide).

Vital staining - Buccal smear stained with Methylene blue.

**CHROMOSOME**

Chromosome preparation - Preparation of meiotic chromosomes from grasshopper - (demonstration only)

**MOLECULAR BIOLOGY TECHNIQUES (demonstration only)**

Laboratory Centrifuge –principle and application

Subcellular fractionation of fish liver tissue

Isolation of DNA from goat Liver tissue

Isolation of RNA from human blood

Spectrometric measurement of denatured DNA

Isolation and analysis of proteins using SDS.

<b>Year:</b>	I Year	<b>Subject Code :</b>	P18MZLP22	<b>Semester :</b>	II
<b>Practical – 2 (Core)</b>	<b>Title:</b>	<b>Genetics, Environmental Biology and Biotechnology</b>			
<b>Credits:</b>	5	<b>Max. Marks. 75</b>			

**Objectives**

To demonstrate practically the genetic observations, Volumetric analysis of water pollution parameters and application of biotechnology.

**Course outcome:**

At the end of course the students shall able to

CO1. Demonstrate and identify practically the various genetic disorders.

CO2. Analyze environmental pollutions through titrations

CO4. Design experiments on Biotechnology.

**GENETICS**

1. Preparation of Drosophila culture
2. Sex identification of Drosophila.
3. Identification of four mutants of Drosophila.
4. Identification of A,B, ABO blood groups and Rh in Man
5. Mounting of salivary glands of Chironomous larva and analysis of banding pattern
6. Karyotyping using normal human metaphase chromosomes (Charts) and Identification of syndromes (Down, Klinefelter and Turner's)
7. Problems relating to the application of binominal theorem in population genetics with reference to P.T.C., Earlobe attachment etc.

**ENVIRONMENTAL BIOLOGY**

1. Estimation of Aquatic Primary productivity – Dark and Light bottle method (demonstration only)
2. Estimation of Dissolved Oxygen in water samples
3. Estimation of Dissolved CO<sub>2</sub> in water samples
4. Estimation of Salinity in water samples
5. Estimation of Calcium in water samples
6. Estimation of Alkalinity in water samples
7. Analysis of TDS and TSS in industrial effluent
8. Demonstration of BOD and COD
9. Estimation of earthworm population (Demonstration)
10. Collection, isolation and identification of planktons
11. Study of fauna in different environments and their adaption
  - a. Sandy shore
  - b. Muddy shore
  - c. Rocky shore
12. Animal Associations – parasitism, mutualism and commensalism
13. Educational Visit to a marine research institute and a field visit to a coastal and marine ecosystem to study the adaptation of fauna inhabiting a Sandy, Muddy and Rocky shore.

**BIOTECHNOLOGY**

Visit to Biotechnology Laboratory to observe the demonstration of

1. Cell culture techniques – primary cell culture, sub-culturing and cryopreservation.
2. Agarose and SDS Gel electrophoresis
3. Isolation of plasmid DNA
4. DNA digestion by restriction enzymes.
5. PCR analysis
6. Western, southern and Northern blot analysis

Necessary books may be referred to learn the techniques and to be recorded in the record Note books. Observation of photographs of different instruments should be used.



<b>Year:</b>	I Year	<b>Subject Code :</b>	P18EZLP21	<b>Semester :</b>	II
<b>Elective Practical - I</b>	<b>Title: Elective Practical - Biochemistry</b>				
<b>Credits:</b>	3			<b>Max. Marks. 75</b>	

**Objectives**

To demonstrate practically the biochemical tests and experiments.

**Course outcome:**

At the end of course the students shall able to

CO1. Demonstrate practically the biochemical quantification procedures.

CO2. Explain and estimate serum biomolecules

CO4. Design experiments on biochemical instruments.

**BIOCHEMISTRY**

1. Buffer preparation and determination of  $p^H$  - Demonstration
2. Enzyme kinetics of Salivary amylase with reference to pH, Temperature and Substrate concentration
3. Qualitative analysis of urine: protein, glucose and Ketone bodies.
4. Paper Chromatography: Determination of amino acids in body fluids and tissues of animal/insect.
5. Quantitative estimation of glucose, protein, cholesterol, urea and creatinine in the serum of goat (Kit-method).
6. Principles and application of spectrophotometry or colorimetry, electrophoresis, centrifuge, Chromatography.

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<b>Year:</b>	II Year	<b>Subject Code :</b>	P18MZL301	<b>Semester :</b>	III
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Major - 7	Title: <b>Animal Physiology</b>		
Credits:	4		Max. Marks. 75

**Objectives**

To derive an unified knowledge of the functions of animals organs and their adaptation

**Course outcomes**

After completion of this course, students will be able to

CO1: Demonstrate the physiological mechanisms of nutrition

CO2: Describe the physiology of digestive and respiratory system of human beings.

CO3: Explain the blood composition, types, groups and circulatory system.

CO4: Interpret the physiology of excretory system, nervous system & receptors.

**UNIT I:**

Nutrition - nutrients - digestion and adsorption of proteins, carbohydrates and lipids. Role of gastrointestinal hormones in digestion.

**UNIT II:**

Comparison of respiration in different invertebrates and vertebrates- Physiology of respiration in Man-mechanism, role of pigments and control, BMR and its significance.

Circulation - physiology of cardiac muscle - blood coagulation and theories-cardio-vascular diseases and its prevention.

**UNIT III:**

Excretion – excretion of metabolic waste products in relation to the environment – physiology of excretion in Man. Iono – osmoregulation in Invertebrates (crustaceans), fishes, birds and terrestrial animals –hormonal control.

**UNIT IV:**

Structure and Types of neurons. Molecular structure and chemical composition of muscle fiber and physiology of muscle contraction. Myoneural Junction. Physiology of endocrine glands-Hormones secreted. Physiology of mammalian reproduction - reproductive cycle - hormonal control of reproduction.

**UNIT V:**

Bioluminescence - chemistry and functional significance. Photo and phonoreceptors. Temperature regulation in poikilotherms, homeotherms and heterotherms - hibernation, aestivation - diapause. Biological clock and Rhythms.

**REFERENCE BOOKS**

1. Hoar, W.S.1991. General and Comparative Physiology. Prentice Hall of India, NewDelhi.
2. Prosser, C.L. 1973. Comparative Animal Physiology,3rd edn. W.B. Saunders & Co., Philadelphia.
3. Barrington, E.J.W.1975 . An Introduction to General and Comparative Endocrinology. Clarendon Press, Oxford
4. Bentley,P.J.1971. Endocrine and osmoregulation, Springer Verlag, New York.
5. Palmen,J.D. Brown, I.R and Hastings, J.W.1970. Biological clocks, Academic Press, London.
6. Welson, A. 1979. Principles of Animal Physiology.McMillan Publishing Co. Inc. New York.
7. Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London.

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Year:	II Year	Subject Code :	P18MZL302	Semester :	III
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<b>Major - 8</b>	<b>Title: Developmental Biology</b>		
<b>Credits:</b>	4		<b>Max. Marks. 75</b>

**Objectives**

To imbibe the current knowledge pertaining to the development of animal embryos of diverse taxonomic groups through analyses based on modern biological tools.

**Course outcomes**

After completion of this course, students will be able to

CO1: Describe the basic concepts of developmental biology.

CO2: Model the process of fertilization, cleavage and gastrulation.

CO3: Categorize the basic concepts of organogenesis.

CO4: Compare the basic concepts of growth, regeneration and ageing and analyze medical aspects

**UNIT I:**

Early Embryonic Development:

- The beginning of Organisms-the structure and role of Sperm and egg
- Fertilization and its mechanism in Sea urchin and mammals
- Fate map and early development in Sea urchin, Amphibians, and Mammals

**UNIT II:**

Organogenesis:

- The stem cell concept and its origin
- Emergence of Central nervous system and epidermis-fate of neural crest cells-formation of eye
- Emergence of mesoderm -heart and blood vessels
- Emergence of endoderm-extra embryonic membranes
- Mammalian pattern of sex determination

**UNIT III:**

Post embryonic development:

- Cellular and Nuclear differentiation-Nuclear transplantation experiments
- Metamorphosis-Amphibian metamorphosis-Insect metamorphosis
- Regeneration-Morphallactic regeneration in Hydra-compensatory regeneration in Mammalian liver
- Germ cell determination and gamete maturation-role of Y factor in male

**UNIT IV:**

Cell communication in development:

- Cell adhesion during development-role of cadherins and integrins
- Cell-cell signaling during development-mechanism and proteins involved
- Paracrine factors- induction and competence
- Signal transduction cascades during induction
- Role of extracellular matrix (ECM)

**UNIT V:**

Medical aspects of Developmental biology:

- Genetic errors of human development
- Cell death and Ageing-genes involved and causes
- Embryological therapies (cancer as disease during embryonic development)
- Stem cell therapy and its applications
- Developmental plasticity and symbiosis

**REFERENCE BOOKS**

1. Gilbert, S.F., 2018. Developmental Biology. Sinuaer Associates, USA
2. Balinsky, B. I., 1981. Introduction to Embryology, Saunders C. Philadelphia.
3. Karp, G. and Berrill, N.J. 1981. Development. McGraw Hill, New York.
4. Saunders, J.W. 1982. Developmental Biology. MacMillan Co., London.
5. Nagabhushanam, R. and Sarojini, R. 2002 Invertebrate Embryology. Oxford and IBA Publishing Co.
6. Tyagi, Rajiv and Shukla, A.N. 2002. Development of Fishes. Jaya Publishing House, New Delhi.
7. Browder, W. 1984. Developmental Physiology. Saunders College Publishing, Rinehart and Winston.

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<b>Major - 9</b>	<b>Title: Immunology</b>		
<b>Credits:</b>	4		<b>Max. Marks. 75</b>

### Objective

To Understand the Structural and functional basis of Vertebrate immune system.

### Course outcomes

After completion of this course, students will be able to

CO1: Identify the tissues, cells and molecules involved in host defense mechanisms

CO2: Outline the types of immunity

CO3: Compare the antigens, antibodies, complements and other immune components

CO4: Choose the immune mechanisms in disease control and built clinical aspects

### UNIT-I:

#### IMMUNE BIOLOGY:

The cellular constituents of the lympho reticular system-phagocytic cells, polymorpho nuclear neutrophils, mono nuclear phagocytes, eosinophils and lymphocytes.

### UNIT-II:

#### IMMUNOGLOBULINS:

Immunoglobulins-structure, isotypes and biological function. Antigenic determinant on immunoglobulin-isotype, allotype and idiotype. Immunoglobulin superfamily, monoclonal and polyclonal antibodies. organization and expression of immunoglobulin genes. Synthesis of immunoglobulin and disorders of immunoglobulin synthesis.

### UNIT-III:

#### DETECTION AND APPLICATION OF ANITGEN ANTIBODY REACTION:

Precipitation - agglutination - complement fixation - immunoassay using labelled reagents (RIA).

Immunochromatography Test.

### UNIT-IV:

#### MECHANISM OF IMMUNE SYSTEM:

Antigen-antibody interaction and immunodiagnostics. MHC- Restriction organization and inheritance of MHC, Antigen processing and presentation. T-cell receptors, B-cell Receptors, cytokine, adhesion molecules.

### UNIT-V:

#### CLINICAL IMMUNOLOGY:

Immunity against viral, bacterial and parasitic infection –immunological basis of hypersensitivity – Graft rejection. Vaccines and Immunotherapy: Types and use-prevention of post natal diseases –Tetanus, Diphtheria, Whooping cough, Cholera, Japanese Encephalitis, Measles and HIV infection.

### REFERENCE BOOKS

1. Roitt, I.M. 1994. Essential Immunology. Blackwell Scientific, Oxford.
2. Richard A. Goldsby, Thomas T. Kindt and Barbara A. Osborne. 2000. Kuby Immunology. Freeman and Co., New York.
3. Stites, D.P., Terr, A.I. and Parsloio, T.G. 1997. Medical Immunology. Prentice Hall, New Jersey.
4. Janeway, C.A and Travers, P. 1997. Immunobiology. Current Biology Ltd., London.
5. Paul, W.E.M. 1989. Fundamentals of Immunobiology. Raven Press, New York.
6. Srivastava, R., Ram, B.P. and Tyle, P. 1991. Molecular Mechanism of Immune Regulation. VCH Publishers, New York.
7. Champion, M.D. and Cooke, A. 1987. Advanced Immunology. J.B. Lippincott Ltd., Philadelphia.
8. Kannan, I. 2007. Immunology. MJP Publishers, Chennai.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
<b>Year:</b>	II Year	<b>Subject Code :</b>	P18EZL301	<b>Semester :</b>	III
<b>Elective - 3</b>	Title: <b>Biophysics (Elective)</b>				
<b>Credits:</b>	3			Max. Marks. 75	

### Objectives

To imbibe the principles of physics involved in the structure of biomolecules, energy transformation in living systems and the modern physical instruments for the exploration of knowledge in biology

### Course outcomes

After completion of this course, students will be able to

CO1: Describe the basic structure of molecules of life

CO2: Compare the thermodynamic principles

CO3: Contrast the principles behind microscopes

CO4: Evaluate the photo & phono biophysics

### UNIT- I:

#### STRUCTURE OF BIOMOLECULES:

Electron configuration of an atom. Bonds - Covalent bond, Hydrogen bond. Forces between Molecules - Van der Waal's forces - hydrophobic and hydrophilic - biological importance.

### UNIT- II:

#### THERMODYNAMICS AND BIOLOGICAL OXIDATION:

Laws of Thermodynamics - Concept of free energy and entropy - Exergonic and Endergonic reactions.

Diffusion - Fick's Laws, constant laws.

Oxidation and reduction reactions - Redox potentials in biological system, High energy phosphate group.

### UNIT- III:

#### MICROSCOPY:

Electron microscope (SEM and TEM), Polarising microscope, Fluorescent microscope, Phase contrast microscope, Dark field microscope.

### UNIT- IV:

#### PHOTO BIOPHYSICS:

Electromagnetic spectrum - visible and invisible region. Principles involved in Photoelectric colorimetry. Principle of Spectroscopy - UV & IR Spectroscopy in biological investigation.

Radioactive isotopes - measurements - GM counter, Liquid Scintillation counters, alpha and beta counters.

Autoradiography-principle and applications. Effects of radiation in Biological systems.

### UNIT- V:

#### BIOPHYSICAL PRINCIPLES APPLIED TO PHYSIOLOGY:

Biophysical aspects of vision, hearing, ECG and EEG.

### REFERENCE BOOKS

1. Bose, S. 1982. Elementary Biophysics. Jyoth Books,
2. Burns, D.M. and MacDonald, S.G.G. 1979. Physics for Biology and Premedical students. ELBS and Addison - Wesley Publishers Ltd., London.
3. Casey, E.J. 1962. Biophysics concepts and Mechanism. Affiliated East-West Press Pvt. Ltd., New Delhi.
4. Das, D. 1982. Biophysics and Biophysical Chemistry. Academic Publishers. New Delhi.
5. Epstein, H.T. 1963. Elementary Biophysics, selected topics. Addison - Wesley Publishing Company Inc. London.
6. Palanichamy, S and Shanmugavelu, M. 1991. Principles of Biophysics. Palani Paramount, Publication; Tamil Nadu.
7. Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18EZL302	Semester :	III
Elective - 3	Title: <b>History of Indian Science</b>				
Credits:	3			Max. Marks. 75	

### Objectives

The course provides an insight into the status of science in ancient India, its gradual development, innovations and the pioneers in the field of science, reputed research institutions in India and cutting edge research in science.

### Course outcomes

On completion of this course, the students will be able to

CO1. Develop understanding of various branches of science during different eras

CO2. Analyze the role played by different Indian organizations in science

CO3. Appraise the contribution of different Indian Scientists.

CO4. Appreciate the starting and functioning of different Indian Research and funding institutions.

### UNIT- I:

History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India, Use of copper, bronze and iron in Ancient India, The geography in literature of Ancient India. Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine, innovations in the field of agriculture- new crop introduced new techniques of irrigation.

### UNIT- II:

Introduction of different surveyors, zoologists and doctors as early scientist in Colonial India, Indian perception and adoption for new scientific knowledge in Modern India, Establishment of Atomic Energy Commission, Launching of the space satellites, ISRO's accomplishments. Zoological survey of India.

### UNIT- III:

Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna, Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Vikram Sarabhai etc.

### UNIT- IV:

History of animal tissue culture with context to India; green, white and pink revolutions in India: causes, details, and outcomes. The pioneers associated with. First gene cloning, First genome sequencing from India. Premier Research institutes and current eminent scientists in India, GM organisms.

### UNIT- V:

Establishment of premier research organizations like CSIR, DRDO, BARC, ICAR, ICMR, IIT's, IISc, DST, DBT etc

### REFERENCE BOOKS

1. Kuppuram, G. (1990) History of Science and Technology in India, South Asia Books.
2. Handa, O.C. (2014) Reflections on the history of Indian Science and Technology, Pentagon Press.
3. Basu, A. (2006) Chemical Science in Colonial India: The Science in Social History, K.P. Bagchi & Co.
4. Habib, I. (2016) A people's history of India 20: Technology in Medieval India, 5th Edition, Tulika Books.
5. Rahman, A. *et al* (1982) Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.
6. Subbarayappa, B.V. & Sarma, K.V. (1985), Indian Astronomy -- A Source Book, Bombay.
7. Srinivasan, S., Ranganathan, S. (2013) Minerals and Metals heritage of India, National Institute of Advanced Studies.
8. Srinivasiengar, C.N. (1967) The History of Ancient Indian Mathematics, World Press Private Ltd. Calcutta.
9. Bhardwaj, H.C. (2000) Metallurgy in Indian Archaeology. Tara Book Agency



Syllabus for M.Sc., Zoology effective from the year 2018-2019					
<b>Year:</b>	II Year	<b>Subject Code :</b>	P18EZL303	<b>Semester :</b>	III
<b>Elective - 3</b>	<b>Title: Intellectual Property Rights</b>				
<b>Credits:</b>	3			<b>Max. Marks. 75</b>	

### Objectives

The present course gives a detailed account of intellectual property right (IPR), its genesis and scope, the steps involved in submitting and publication of patent; trademark and copyright rules.

### Course outcomes

On completion of this course, the students will be able to:

CO1 Understand the concept of IPR

CO2 Differentiate between various agreements of IPR

CO3 Compare between copyrights, patents and Geographical Indicators

CO4 Examine various legal issues related to IPR

### UNIT- I:

Copyright Act and IPR and its importance. IPR in India and other countries of the world: Genesis and scope. IPR and WTO (TRIPS, WIPO). Objectives, Rights, Patent treaty, 1970 and its amendments.

### UNIT- II:

Protocol of obtaining patents, Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, License; Infringement of patents, Patent office.

### UNIT- III:

Copyrights: type of work protected under copyright laws, Rights, Transfer of Copyright, Infringement and penalties.

Trademarks: Objectives, Rights of holder, Assignment, Infringement, Remedies and Penalties. of India.

### UNIT- IV:

Concept of Traditional Knowledge, Holders, Traditional knowledge on the International Arena, at WTO, at National level, International enforcement of intellectual property rights. Bioprospecting and Bio-piracy, Commercial piracy, transnational lawsuits. Germplasm protection in India. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

### UNIT- V:

Biotechnological Inventions: Objective, Applications, Concept of Novelty, Concept Originality or creativity requirements. Patenting with microorganisms. Ethical issues in Patenting Biotechnological inventions. Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips etc..

### REFERENCE BOOKS

1. Gopalakrishnan, N.S. and Agitha, T.G. (2009) Principles of Intellectual Property right. Eastern Book Company, Lucknow.
2. David Kitchin, Q.C.; Llewelyn, D.; Mellor, J.; Meade, R.; Moody-Stuart, T.; Keeling, D. and Jacob, R. (2005) Kerly's Law of Trade Marks and Trade Names (14th Edition) Thomson, Sweet & Maxwell.
3. Narayanan, P. (2010) Law of Copyright and Industrial Designs; Eastern law House, Delhi.
4. Parulekar, A. and D' Souza, S. (2006) Indian Patents Law – Legal & Business Implications; Macmillan India Ltd.
5. Wadehra, B. L. (2000) Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year		Subject Code :	P18MZL401	Semester : IV
Major - 10	Title: <b>Research Methodology</b>				
Credits:	5				Max. Marks. 75

## Objectives

The main objectives of this paper are to expose students to state of the art instrumentation and acquire knowledge on scientific writing.

## Course outcomes

After completion of this course, students will be able to

CO1: Develop various scientific methods, concepts and steps in research

CO2: Compare the Quantitative and Qualitative Research

CO3: Illustrate the various techniques of Data Collection

CO4: Interpret the various types of Sampling and data analysis

## UNIT-I:

### AN INTRODUCTION TO RESEARCH METHODOLOGY

Meaning and objective of Research

Types of Research (Basic, Applied, Inter-disciplinary and Trans-disciplinary)

Research Designs

Funding Agencies (UGC, CSIR, DST, DBT ICMR and ICAR).

## UNIT-II:

### PREPARATION OF MANUSCRIPTS

Preparation of index cards- Reference collection - preparation of thesis - preparation of scientific paper for publication in a Journal. Internet and e-journals. Computer aided techniques for data analysis, data presentation and slide preparation.

## UNIT-III:

### BIostatISTICS & BIOINFORMATICS

Student's 't' test, Skewness, Kurtosis, Chi – square (Computation required), Correlation analysis (Computation required), Regression analysis (Computation required) and ANOVA.

Internet - Worldwide Web - Search Engines - their functions. Boolean searching - file formats.

Biological data bases - searching source data bases - sequence similarity searches - FASTA and BLAST and Clustal-W.

## UNIT-IV:

### SPECTROSCOPY

Absorption and Emission principles - Principle and application flame photometer, Atomic Absorption and emission spectrophotometers, FTIR, GCMS, NMR and Mass spectrometer

## UNIT-V:

### CHROMATOGRAPHY & ELECTROPHORESIS

Principles and Application of Chromatography: Paper, Thin layer, column, Ion Exchange, Gel filtration, Gas Liquid, HPLC and affinity.

Principles and Application of Electrophoresis: Paper, Agarose, AGE, SDS-PAGE and Iso-Electric focusing.

## REFERENCE BOOKS

1. Anderson, Durston and Polle.1970. Thesis and Assignment writing. Wiley Eastern Ltd., New Delhi.
2. Comir and Peter Wood Ford.1979. Writing scientific papers in English. Pitman Medical Publishing Co., London.
3. Wilson and Walker. 2000. Practical biochemistry - principles and techniques. Cambridge University Press.
4. Milton, J.S. 1992. Statistical methods in Biological and Health Sciences. McGraw Hill Inc., New York.
5. Gupta, S.P. 1988. An easy approach to statistics. Chand & Co., New Delhi.
6. Kothari, C.R. 2004. Research Methodology: Methods and Techniques, New Age International Publishers Limited. New Delhi.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18MZL402	Semester :	IV
Major - 11	Title: <b>Evolution</b>				
Credits:	4	Max. Marks. 75			

(This Core Paper is compulsory for those not choosing Project /Dissertation with viva voce)

### Objectives

To comprehend the scientific concepts of animal evolution through an understanding of its evidences, its mechanics, process and products.

### Course outcomes

After completion of this course, students will be able to

CO1: Describe the historical background and patterns of evolution

CO2: Explain the principle of adaptation, providing examples from several fields of biology

CO3: Examine the molecular evidences for evolution

CO4: Analyse the evolution of behaviour

### UNIT I:

#### Historical Background and patterns of Evolution

- Importance of Evolutionary Biology and its application
- Evolution before Darwin and Evolution after Darwin
- Principles of evolutionary change based on systematics
- Evidences for evolution from taxonomy and fossils
- Trends and rates of evolution
- Theory of gradualism, Saltation and Punctuated equilibria

### UNIT II:

#### Evolutionary processes in Population and Species

- Variation and its sources
- Hardy-Weinberg principle and its significance
- Genetic variation in natural populations and its estimation
- Origin of Genetic variation-mutation-recombination-karyotype alterations
- External sources of variation-Hybridization, Horizontal gene transfer
- Genetic drifts and Neutral hypothesis

### UNIT III:

#### Natural Selection, Adaptation and Evolution above species level

- Natural Selection theory-experimental studies and methods of studying Natural selection
- Isolating mechanisms-barriers to gene flow-reproductive isolation-pre and post zygotic isolating mechanisms
- Species concept-modes of speciation (Allopatric, Parapatric, Sympatric, Polyploidy and Hybrid speciation)

### UNIT IV:

#### Evolution of behavior

- Behavior as phenotypic traits-variation within and among species
- The theory of foraging
- Evolutionary Stable Strategies (ESS)
- Sexual selection-concept-contests-paternity insurance-sperm competition-mate choice
- Social interaction and evolution of cooperation- theories of cooperation and altruism-inclusive fitness and reciprocation
- Interaction among related individuals-evidence for evolution by kin selection

### UNIT IV:

#### Patterns and Process of Behavior

- Micro-evolutionary and Macro-evolutionary changes in behavior
- Behavior and Adaptive radiation
- Use of phylogeny in studying behavior-Cladistics and Phenetics
- Origin and evolution of sociality in insects, mammals and primates
- Human behavior and Sociobiology- selfish gene and behavior, Advantages of social behavior

### References

1. Agarwal, V.K., 2012. Animal Behavior (Ethology). S. Chand and Co, New Delhi
2. Futuyma, D.J., 1998. Evolutionary Biology. Sinauer Associates, USA.
3. P.A.Moody. 1978. Introduction to Evolution. Harper International.
4. G.L. Stebbins. 1979. Process of Organic Evolution. Prentice Hall India, New Delhi.
5. E.O.Dodson. 1990. Evolution. Reinhold, New York.



Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18MZL403	Semester :	IV
Major - 12	Title: <b>Entomology</b>				
Credits:	5			Max. Marks. 75	

**Objectives**

To comprehend the classification of insects, physiology and economic importance of insects

**Course outcomes**

After completion of this course, students will be able to

CO1: Classify Insects up to orders

CO2: Describe the physiology of Insects

CO3: Make use of beneficial insects

CO4: Plan to control the spread of diseases and categorize insect vectors

**UNIT- I :****CLASSIFICATION**

Classification and General Characters of insects up to order level.

**UNIT- II:****PHYSIOLOGY OF INSECTS**

Physiology of Flight Muscle, Insect respiration, Structure of Secretory glands, Pheromones and Moulting Hormones

**UNIT- III:****BENEFICIAL INSECTS**

Species of Honey bees, Chemical composition of Honey, Biology of Honey bees and their management, By-products. Lac insects and their management.

**UNIT- IV:****INSECT PESTS AND THEIR CONTROL**

Insects as crop pests

(Paddy: Rice earhead bud bug-*Leptocorisa acuta*, Rice stem borer- *Scirpophaga incertulas*

Sugarcane: Leaf hopper – *Pyrilla perpusilla*, Shoot borer – *Chilo infuscatellus*

Groundnut: Red hairy caterpillar – *Amascta albistriga*, Pod bug - *Elasmolomus sordidus*

Cotton: Cotton aphid – *Aphis gossypii*, Bollworms – *Platyedra gossypiella* and *Helicoverpa armigera*)

Types of injuries and loss caused to plants in general. Factors governing the outbreak of pests.

Principles and methods of pest suppression: Conventional and Non- conventional, Biological and Integrated pest management.

**UNIT- V:****INSECTS AS VECTORS**

Insect Vector borne diseases (Protozoan – Malaria, Viral - Dengue, Chikenguniya and Zika).

Method of transmission and adaptation of parasitic agents.

**REFERENCES BOOKS**

1. William S. Romoser and John G. Stoffolano. W. M. 1994. The Science of Entomology C. Brown Publishers, England.
2. Yataro Tazima, Kodarsha .1978. The silkworm. An important laboratory tool. Scientific Book Ltd., Japan.
3. Ananthakrishnan, T.N. 2002. Insect Plant Interactions. Oxford and I.B.H, New Delhi.
4. P.G. Fenemore, Alkaprakash. 1992. Applied Entomology, Wiley Eastern Ltd., Delhi.
5. Chapman, R.F. 1988. The insect structure and Function. Cambridge University Press, U.K.
6. Richards, O.W. and Davies, R.G. 1997. Imm's General Text Book of Entomology Tenth Edition. Vol I and II. R.I Publications, New Delhi.
7. Rajeev K. Upadhyay, Mukerjee K.G. Chanda, B.P. and Dubey, O.P. 1998. Integrated Pest and Disease Management. APH Publishing Corporation, New Delhi.
8. Ramakrishna Ayyar T.V. 1989. Handbook of Economic Entomology for South India. Books and Periodicals Supply Service, New Delhi.

Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18EZL401	Semester :	IV
Elective - 4	Title: <b>Sericulture (Elective)</b>				
Credits:	3			Max. Marks. 75	

**(This Paper is compulsory for those not choosing Project / Dissertation with Viva voce)**

### Objectives

To infuse sound knowledge about the silkworm, their economic importance and diseases and to disseminate Sericulture as a need - based curriculum.

### Course outcomes

After completion of this course, students will be able to

CO1: Describe the Taxonomy and Morphological sex differences in silkworm

CO2: Construct an own mulberry farm.

CO3: Create a hybrid of silkworm

CO4: Evaluate the diseases and pests of *B.mori* and Mulberry and improve silk quality.

### UNIT -I:

#### ECONOMIC IMPORTANCE AND SILKWORM BIOLOGY

Prospects and status - Trends of production and its economic importance - demand and utilization. Silk producing species - their distribution - *Bombyx mori* - life cycle - organization of larvae, pupae and moth - structure of the silk gland.

### UNIT-II:

#### MORICULTURE

Mulberry - varieties - distribution - methods of cultivation and preparation - Harvest - Transport and preservation of leaves. Feeding and nutrition - specificity of diet - Factors of nutrition - Diet and growth. Pest and diseases.

### UNIT-III:

#### SILKWORM REPRODUCTION AND GENETICS

Reproduction - Growth and Development of silkworms - Physiology of molting in different varieties (Uni, bi and multivoltine) - Endocrinology of reproduction and development. Genetics - mutation breeding and development of new strains.

### UNIT-IV:

#### PATHOGENIC DISEASES AND PEST

Pathology - Viral, bacterial, fungi and protozoan diseases - control mechanisms. Uzifly menace.

### UNIT-V:

#### SILKWORM REARING AND SILK REELING

Rearing operations - Selection and construction of rearing house - Incubation - Hatching - brooding, Harvesting etc. Reeling techniques - lacing - skinning. Re-reeling etc,

### REFERENCE BOOKS:

1. Ganga, G. and Sulochana Chetty, J. 1997. An Introduction to Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Ganga, G. 2003. Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Hisao Aruga. 1994. Principles of Sericulture (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Veda, K., Nagai, I. and Horikomi, M. 1997. Silkworm Rearing (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Lu Yup-Lian and Liu-Fu-an. 1991. Silkworm Diseases – Published by by FAO - USA. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

<b>Year:</b>	II Year	<b>Subject Code :</b>	P18EZL402	<b>Semester :</b>	IV
<b>Elective - 4</b>	<b>Title: Beekeeping (Elective)</b>				
<b>Credits:</b>	3			<b>Max. Marks. 75</b>	

**(This Paper is compulsory for those not choosing Project / Dissertation with Viva voce)**

### Objectives

This course tells the students what tools and equipment will be needed, the main activities in the beekeepers year, the laws and by laws governing keeping bees; discover the principles of sustainable beekeeping and how these principles can guide your beekeeping into an enduring practice.

### Course outcomes

After completion of this course, the student should be able to:

- CO1. Explain what are the prerequisite to get started in beekeeping
- CO2. Identify where to purchase equipment and demonstrate how to assemble it
- CO3. Describe bee biology and anatomy from the perspective of managing bees
- CO4. Design a own beekeeping farm

### UNIT -I:

History of Bees and Beekeeping, Systematics, Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Foraging and Honey flow periods.

### UNIT-II:

Extent of Beekeeping in Maharashtra and India, Limitations on the development of beekeeping, Advantages of extensive Beekeeping. Beekeeping equipments: Bee box and tools and initiation into keeping a colony, the future of beekeeping..

### UNIT-III:

Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. taking care of bee diseases and enemies.

### UNIT-IV:

Establishment of a colony. Bee flora and planned pollination services. Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products.

### UNIT-V:

Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping.

### REFERENCE BOOKS:

1. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.

### Syllabus for M.Sc., Zoology effective from the year 2018-2019

<b>Year:</b>	II Year	<b>Subject Code :</b>	P18EZL403	<b>Semester :</b>	IV
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<b>Elective - 4</b>	<b>Title: Ornamental Freshwater Fish Production (Elective)</b>	
<b>Credits:</b>	<b>3</b>	<b>Max. Marks. 75</b>

**(This Paper is compulsory for those not choosing Project / Dissertation with Viva voce)**

### Objectives

To make the students aware of the vast potentials involved in ornamental fish farming and trading besides making them learn the diseases in fishes and other constraints in their culturing.

### Course outcomes

After completing this course, the students will be able to

CO1. Explain the scientific method of setting an aquarium

CO2. Describe the culture breeding and marketing techniques of common indigenous ornamental fishes

CO3. Evaluate the control of diseases

CO4. Design an ornamental fish arm

### UNIT -I:

Importance and history of aquarium fish keeping. Design and construction of aquaria: aquarium fabrication- shape, size, volume, type of glass tank, cutting of glass, preparation of glass tank, strengthening and supporting of tank, fitting of tanks into room settings; aquarium floor setting – type and size of pebbles, gravels, granites used for bed setting and its advantages. Filters- biological, chemical and mechanical. Aquarium accessories like aerators, decorative, lighting, heating and feeding trays. Water quality management in aquarium systems – sources of water, containers, storage, temperature, pH, dissolved carbon dioxide, ammonia, hardness, turbidity and ozone in aquarium. Aquarium plants: Uses of aquarium plants, different varieties of plants like submerged plants (tubers, rooted plants, cutting plants) and emerged plants.

### UNIT-II:

Fresh water ornamental fishes : Common ornamental fishes- indigenous and exotic species; Identification and biology of the common ornamental fishes. *Cyprinus carpio* (koi carp), *Molliesia sphenops* (black molly lyre tail), *Poecilia reticulata* (guppy), *Poecilia latipinna*, *Xiphophorus helleri* (red sword tail) *Xiphophorus maculatus* (red platy) *Pterophyllum scalare altum* (angel fish) *Carassius auratus* (red oranda) *Betta splendens* (Siamese fighting fish) *Trichogaster leeri* (pearl gourami). Live bearers and egg layers. Sexual dimorphism in ornamental fishes.

### UNIT-III:

Indigenous ornamental fishes - Common indigenous ornamental fishes. Identification and biology of the common ornamental fishes. Cyprinids : *Puntius denisonii* (red line torpedo fish), *Puntius fasciatus* (melan barb), *Puntius filamentosus* (Indian tiger barb), *Puntius curmuca* (red tailed silver shark), *Danio malabaricus* (Malabar danio); Loaches: *Nemacheilus triangularis* (Zodiac loach), *Lepidocephalus thermalis* (Malabar loach); Cichlids: *Etroplus maculatus* (yellow and orange chromides), *E. suratensis* (pearl spot), Anabantids: *Anabas testudineus* (climbing perch) and Catfishes : *Horabagrus brachysoma* (Yellowish catfish), *H. nigricollaris* (White collared imperial catfish).

### UNIT-IV:

Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio. Brood stock management- selection of brooders, maintenance and management of brood stocks. Selective breeding and hybridization techniques. Induced breeding. Colour enhancement techniques.

### UNIT-V:

Food and feeding - live feed and formulated feed. Preparation and culture of live feed (Artemia, Infusoria, Spirulina). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes - their causative agents - virus, bacteria, fungi, protozoa and nematode; symptoms, treatment and prophylactic measures.

### REFERENCE BOOKS:

1. Axelord, H.R. (1967). Breeding aquarium fishes, T F H Publications.
2. Mills, D. (1981). Aquarium Fishes, Arco publishing.
3. Mills, D. and Vevers, G. (1982). The Practical encyclopedia of fresh water ,Tropical Aquarium fishes, Salamander Books limited, London.
4. Gahlawat, S.K., et.al. (2007). Manual of experimental Ichthyology, Daya publishing House, Delhi.
5. Brunner, G. (1973). Aquarium plants, T F H Publications, Inc. Ltd., Hongkong.
6. Hansen, J. (1979). Making your own aquarium, Bell and Hyman Ltd., London.

7. Lovell, T. (1998). Nutrition and feeding of fish second Ed. Kluwer Academic publishers.
8. Talwar, P.K., and Jhingran, A.G. (1991). Inland fishes Oxford and IBH Publishing Co. PVT LTD, New Delhi



Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18MZLP41	Semester :	IV
Practical - 3	Title: <b>Animal Physiology Developmental Biology and Immunology</b>				
Credits:	5			Max. Marks. 75	

### Objectives

To demonstrate the various experiments connected with Animal Physiology, Developmental Biology and Immunology

### Course outcomes

After completion of this course, students will be able to

CO1: Demonstrate stress physiology in animals and blood physiology in humans.

CO2: Describe the various embryological stages of Animals

CO3: Apply the various immunological techniques in Biology

### ANIMAL PHYSIOLOGY

1. Salt loss- salt gain with reference to hypotonic & hypertonic condition – Fish (every half an hour –up to one hour).
2. Study of Respiratory Quotient (RQ) with reference to temperature
3. Estimation of total carbohydrate and protein in fish muscle tissue by standard graph
4. Estimation of blood urea and cholesterol
5. Blood clotting time, Bleeding time and Preparation of Haemin crystals
6. Principle and Application of Sphygmomanometer, Kymograph, Electrophoresis, Haemoglobinometer, ESR
7. Estimation of Haemoglobin and ESR

### DEVELOPMENTAL BIOLOGY (slides/Models/Charts/Xerox)

1. Structure of sperm and egg of Seaurchin and a Mammal
2. Fatemap of Seaurchin, tunicate, frog, fish and mammal
3. Different stages in frog development – (2-cell stage, 4 cell stage, 8 cell stage, blastula and gastrula)
2. Development of chick stage – (Blastodisc stage, primitive streak, 24hrs embryo, 48hrs embryo, 72hrs embryo and 96hrs embryo)
3. Demonstration of uterine cycle in a mammal (Rat).
4. Study of slides showing of larval forms: Trochophore, Nauplius, Zoea, Bipinnaria,

### IMMUNOLOGY (slides/charts/Demonstration/spotters)

1. Lymphoid organs of Rat
2. Principles of Antigen-Antibody interactions
3. Blood typing by agglutination
4. Quchterlony diffusion on gels of antibody titration
5. Immunoelectrophoresis
6. Westernblot
8. Spotter- Spleen, T.S. of bone, Thymus and Lymph node.



Syllabus for M.Sc., Zoology effective from the year 2018-2019					
Year:	II Year	Subject Code :	P18MZLP42	Semester :	IV
Practical - 4	Title: <b>Research Methodology Evolution and Entomology</b>				
Credits:	5			Max. Marks. 75	

**(This Core Practical Paper is compulsory for those not choosing Project /Dissertation with viva voce)**

### Objectives

To demonstrate the various experiments connected with Research methodology, Evolution and Entomology

### Course outcomes

After completion of this course, students will be able to

CO1: Apply the various statistical methods and instruments in research.

CO2: Evaluate various proofs of evolution

CO3: Describe various physiological structures of insects

### RESEARCH METHODOLOGY

1. Calculation of measures of Central tendency and deviation using neem leaf length/serrations or length and weight of fishes (if available)
2. Problems relating to test of significance (Chi - square test and t - test)
2. Problems relating to correlation and regression.
3. Familiarization of biological and bioinformatics web sites.
4. BLAST search for similar nucleotide sequences (demo).
5. Spectrophotometric estimation of any biological constituent.
6. Electrophoresis - Paper / Agarose gel / PAGE
7. Preparation of index and reference cards.

### EVOLUTION

1. Observation of forelimbs or hind limbs of vertebrates (Amphibian, reptiles, aves and Mammal) to demonstrate the common pattern of pentadactyl limb and common ancestry of vertebrates.
2. Observation of fossils for paleontological evidences of evolution.
3. Observation of leaf insects and stick insects in the museum to demonstrate adaptation by cryptic colouration and natural selection.
4. Observation of Monarch and Viceroy butterflies to demonstrate Batesian mimicry.
5. Visit to a natural history museum (compulsory)

### ENTOMOLOGY

1. Study of morphology of an insect (local insects to be used).
2. Dissection of digestive, nervous, systems of a typical insect – Silkworm/Mylabris
3. Mounting of different types of mouthparts to understand the mode of feeding.
4.
  - a. Field study to collect insect species
  - b. Identification and preservation of at least 10 insects belonging to different orders.
  - c. Submission of insect box.
5. Field study for various methods of pest management.

## Syllabus for M.Sc., Zoology effective from the year 2018-2019

<b>Year:</b>	II Year	<b>Subject Code :</b>	P18EZLP41	<b>Semester :</b>	IV
<b>Elective Practical - 2</b>	<b>Title: Sericulture</b>				
<b>Credits:</b>	3			<b>Max. Marks.</b>	75

**Objectives**

To demonstrate the various sericulture techniques

**Course outcomes**

After completion of this course, students will be able to

CO1: Describe the morphological and physiological aspects of silkworm

CO2: Design an own silk farm unit

**SERICULTURE**

- Sericulture maps:
  - World maps and Silk Road.
  - Sericulture map of India and Tamil Nadu.
- Preparation of histograms and pie charts on:
  - Production of textile fibers in India.
  - World silk production.
  - Pie chart on mulberry and non-mulberry silk production in India.
- Taxonomic description of mulberry.
- Study of any 5 popular mulberry cultivars of Tamil nadu
- Study of external morphology: egg, larvae, pupa & adult.
- Life cycle analysis of *B. mori*
- Sex separation in larva, pupa and adult of the silkworm *B. mori*
- Dissection and display of:
  - Digestive system of larva.
  - Silk glands.
  - Mounting of larval mouth parts.
  - Nervous system of silkworm larva.
- Study of silkworm rearing and reeling operations (Field visit and photographs to be pasted)
  - Chawki Rearing
  - Netrika and Chandrika
  - Model Reeling Unit
  - Reeling machines
  - Model rearing house
- Study of silkworm pathology - viral - bacterial - fungal diseases (Field visit-slides specimens/Xerox)
- Study on the locally cultivable mulberry varieties
- Visit to Central Silk Board/Tamil Nadu Silk Development Board and report submission with photograph
- Visit to a sericulture farm in nearby villages and study on the economics, design and farm management