# Cotton University

Syllabus for Postgraduate Program in Zoology


**DEPARTMENT OF ZOOLOGY**
**COTTON UNIVERSITY,**
**GUWAHATI-781001, ASSAM**

**CBCS CURRICULUM OF M. SC. IN ZOOLOGY (HONOURS)**
**PART I**

## 1.1 Introduction

Zoology or animal behaviour is the field of biology that involves the study of animal kingdom. The word Zoology comes from the Greek word *Zoion* meaning "Animal" and *logos* meaning "the study off". It encompasses all aspects of scientific knowledge about animal kingdom specially embryology development, structure & evolution, behaviour, physiology, morphological diversity, habits and ecological distribution and systematic classification of animals both living and extinct. The famous quote that depicts the emphasized or importance of studying the living creature :

"Everything in nature is the result of fixed laws and the love for all living creature is the most noble attribute of man" - Charles Darwin.

"There no good biologist whose vocation was not born in deep joy in the beauties of living nature" - Konard Lorenz

Zoology deals with the study of animals and related aspects. It is a vast subject that include, structural diversity, anatomy, physiology, embryology, biochemical reactions that drive the living system, evolution, distribution of animals, both living and extinct and the interactions at various levels that spans from molecular to the organismic level. Apart from these basic subjects, modern Zoology has an interdisciplinary approach that includes biostatistics, bioinformatics, instrumentation, biotechnology and many more. As it covers a fascinating range of topics, modern zoologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a M.Sc. degree in Zoology is designed to advance their understanding in Zoology and get more expertise in few specialized subjects. The framework is made to fit into the expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Zoology, or in teaching-learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, assessment of student learning levels.

In the field of biology, zoology as a subject is very broad, zoology uses a wide range of approaches from the genetics to cellular and molecular biology, physiological processes, anatomy, whole animals, population ecology. Intention is to understand the subject of zoology in the evolving biological paradigm in the modern times; where, living beings need to be understood at the level of atomic interaction, comparative system of organism need to studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organism at morphological, cellular and molecular interactive and evolutionary level.

Being a wide range of approaches, Zoology plays a crucial role in understanding the natural world and it is essential for under graduate and post graduate students to study zoology as it helps them to gain a deeper understanding of animals world and it importance in the ecosystem. The study of zoology has significant benefits for both post graduate and under graduate

students. For under graduate level, Zoology as a subject built/provide a strong foundation in the biological sciences and teaches them about various principle of biology, evolution, genetics, biochemistry, immunology, parasitology, bioinformatics & computational analysis. The course also give exposure to the student to the variety of animal life, their structure and functional mechanism and how they adapt to different environments. This knowledge can be applied to ample of various field such as wildlife conservation, environmental management, veterinary medicine and livestock production, biomedical research and forensic sciences. Besides/Moreover studying zoology enhances critical thinking, skills, problem solving and scientific enquiry. Zoology students learn how to analyze scientific data, design and conduct experiments and communicate scientific findings effectively. These skills are transferable to many other fields including medicine, law, business, entrepreneurs and they are highly valued by employers.

Post graduate students, on the other hand can specialize in specific areas of zoology, such as animal behaviour, role of animal in nature balance, molecular biology, genetics, aquaculture, seribiology, physiology and immune-boosting mechanism, vector-borne disease and conservation biology. They can gain advanced knowledge and skills that can prepare them for careers in academia, research and industry. For example, zoologists can work as researchers, consultants for environmental organizations, wild life expert for Zoo's centuries reserve forest, government agencies and pharmaceutical companies, fishery & wetland development and management. They can prepare career as educators and science communicators sharing their knowledge to others and inspiring next generation scientists. Furthermore, the study of zoology has a significant impact on society and the environment.

Zoology play a vital role in conservation efforts to protect endangered species, restore ecosystem manage the wildlife population. They can also develop innovative solution to many environmental issues and challenges such as pollution control, habitat loss, climate change, strategies development to conserve biodiversity and promote sustainable development.

Being this subject a multidisciplinary approaches, studying zoology is essential for under graduate and post graduate students as the course curriculum provides fundamental understanding of animal world. It develop and enhances critical thinking, scientific reasoning, problem solving and opens up numerous career opportunities in multiple fields and also promoting conservation and sustainable development. It provides the students with knowledge and skill based that world enable them to undertake further the students in zoology and related areas that involve and advanced and modern biology and help to develop generic skills which is relevant to the wage of employment.

As the North*eastern region is a great treasure of biodiversity and vast wetland, with imparting knowledge of zoology students can contribute to the society especially the upliftment of rural populace in terms of economically dependance, self employment and entrepreneurship.

The modern era requires a classical Zoologist with modern multidisciplinary approach to master many branches of zoology. There is a need for the student to compete across the globe. Therefore the main focus of the course curriculum is to enable the student to be in depth knowledge skills, innovative, professionally competent and successful in career. Having Zoology as backbone of the curriculum, this course with department centric electives will enhance skills required to perform research in laboratory and experimental research. The curriculum can be modified to some extent at UG and PG level can be specialized in molecular

biology,immunology, entomology, conservation biology, For such specialization, curriculum focuses on the special skills to maximize student's employment probability; for example, few skill need by industry may include the species-specific monitoring for key species, handling of dangerous/poisonous/wild animals and the use of geographic information system.

### 1.2 Learning Outcomes-based Approach to Curriculum Planning and Development

The basic objective of the learning outcome based approach to curriculum planning and development is to focus on demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. 2 The expected learning outcomes are used to set the benchmark to formulate the course outcomes, programme specific outcomes, programme outcomes and graduate attributes. These outcomes are essential for curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general direction and guidance to the teaching-learning process and assessment of student learning levels under a specific programme.

The overall objectives of the learning outcomes-based curriculum framework are to:

- help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;

- enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study;

- maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility; and

- provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

### 1.3 Key outcomes underpinning curriculum planning and development

The learning outcomes-based curriculum framework is a framework based on the expected learning outcomes and academic standards that are expected to be attained by graduates of a programme of study. The key outcomes that underpin curriculum planning and development include Graduate Attributes, Programme Outcomes, Programme Specific Outcomes, and Course Outcomes.

#### 1.3.1 Graduate Attributes

The disciplinary expertise or technical knowledge that has formed the core of the university courses. They are qualities that also prepare graduates as agents for social good in future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

**1. Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines

**2. Research-related skills:** A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating

**3. Analytical reasoning:** Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others

**4. Critical thinking:** Capability to apply analytic thought to a body of knowledge

**5. Problem solving:** Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems

**6. Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally

**7. Information/digital literacy:** Capability to use ICT in a variety of learning situations; demonstrate an ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

**8. Self-directed learning:** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

**9. Cooperation/Teamwork:** Ability to work effectively and respectfully with diverse teams

**10. Scientific reasoning:** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective

**11. Reflective thinking:** Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.

**12. Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective

**13. Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work

**14. Leadership readiness/qualities**: Capability for mapping out the tasks of a team or an organization, setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that

vision, and using management skills to guide people to the right destination, smoothly and efficiently.

**15. Lifelong learning**: Ability to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of the work place through knowledge/skill development/reskilling.

### 1.3.2 Programme Outcomes (POs) for Postgraduate programme

POs are statements that describe what the students graduating from any of the educational programmes should able to do. They are the indicators of what knowledge, skills and attitudes a graduate should have at the time of graduation.

**1. In-depth knowledge:** Acquire asystematic, extensive and coherent knowledge and understanding of their academic discipline as a whole and its applications, and links to related disciplinary areas/subjects of study; demonstrate a critical understanding of the latest developments in the subject, and an ability to use established techniques of analysis and enquiry within the subject domain.

**2. Understanding Theories:** Apply, assess and debate the major schools of thought and theories, principles and concepts, and emerging issues in the academic discipline.

**3. Analytical and critical thinking:** Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.

**4. Critical assessment:** Use knowledge, understanding and skills for the critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.

**5. Research and Innovation:** Demonstrate comprehensive knowledge about current research and innovation, and acquire techniques and skills required for identifying problems and issues to produce a well-researched written work that engages with various sources employing a range of disciplinary techniques and scientific methods applicable.
**6. Interdisciplinary Perspective:** Commitment to intellectual openness and developing understanding beyond subject domains; answering questions, solving problems and addressing contemporary social issues by synthesizing knowledge from multiple disciplines.

**7. Communication Competence:** Demonstrate effective oral and written communicative skills to covey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study

**8. Career development:** Demonstrate subject-related knowledge and skills that are relevant to academic, professional, soft skills and employability required for higher education and placements.

**9. Teamwork:** Work in teams with enhanced interpersonal skills and leadership qualities.

**10. Commitment to the society and to the Nation:** Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

### 1.3.3 Programme Specific Outcomes (PSO) in M.Sc Zoology:

The programme specific outcomes (specific skills, generic skills and attributes) that a post-graduate student of Zoology will have at the end of the completion of M.Sc. degree in Zoology are as follows

**PSO1. Basic Concept**: Apply knowledge of Zoology, Life Sciences, and related subjects to comprehend complex life processes and phenomena.

**PSO2. Problem solving**: Identity, review, and analyze complex situations involving living forms.Design processes/strategies that meet the specified needs while taking into account public health and safety, as well as cultural, societal, and environmental factors.

**PSO3.Social responsibility:** Apply reasoning informed by contextual knowledge to evaluate societal, health, safety, legal, and cultural issues, as well as the responsibilities that come with them, in the context of professional engineering practise.

**PSO4. Understanding the environment:** Understanding the impact of natural and anthropogenic activities in societal and environmental contexts, as well as demonstrating knowledge of, and need for, sustainable development Identify and justify the conservation of a variety of invertebrates and vertebrates.

**PSO5. Developing ethical understanding and project management skill:** Understanding animal and professional ethical principles, responsibilities, and work/research practice norms. Demonstrate knowledge and understanding of Zoology and management principles, and apply them to one's own work as a team member and leader.

### 1.3.4 Course Level Learning Outcome Matrix

**Mapping of POs with Core course**

| POs | Core papers | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **701** | **702** | **703** | **704** | **705** | **801** | **802** | **803** | **804** | **805** | **901** | **902** | **903** | **1001** |
| In-depth Knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Understanding theories | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Analytical & critical thinking | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Critical assessment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Research and innovation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Interdisciplinary perspective | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Communication competence | | | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Career development | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Teamwork | | | ✓ | ✓ | ✓ | | | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Commitment to the society & to the nation | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Mapping of POs with Special paper and Elective**

| POs | 706 SEC (003S) | 904 SP1 | 904 SP2 | 904 SP3 | 904 SP4 | 905 OE1 | 1002 SP1 | 1002 SP2 | 1002 SP3 | 1002 SP4 | 1003 OE2 | 1004 DPW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In-depth Knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Understanding theories | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Analytical & critical thinking | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Critical assessment | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Research and innovation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Interdisciplinary perspective | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Communication competence | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Career development | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Teamwork | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Commitment to the society & to the nation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Mapping of PSO's with Core Papers**

| PSOs | Core papers | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **701** | **702** | **703** | **704** | **705** | **801** | **802** | **803** | **804** | **805** | **901** | **902** | **903** | **1001** |
| Basic concept | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Problem solving | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Investigating complex problems | | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Social responsibility | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Understanding the environment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ethics | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Project management | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Mapping of PSOs with Special Paper and Elective**

| PSOs | 706 SEC (003S) | 904 SP1 | 904 SP2 | 904 SP3 | 904 SP4 | 905 OE1 | 1002 SP1 | 1002 SP2 | 1002 SP3 | 1002 SP4 | 1003 OE2 | 1004 DPW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subject knowledge | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Problem solving | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Investigating complex problems | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Social responsibility | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Understanding the environment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ethics | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Project management | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

### 1.4 Teaching-learning process

The LOCF based syllabi of undergraduate programs of Zoologyhave been conceived with an aim to encourage students to gather subject-specific knowledge with an understanding of their applications in various fields. The syllabi will not only aid in acquiring professional skills for various Zoology-based fields but develop a rational thinking and problem-solving attitude in the students. For the successful execution of the syllabi of UG programs, support of various types of teaching-learning processes will be adopted.
Some of the relevant processes or tools of pedagogy are as follows:

**THEORY**

a) Lectures will be delivered using both conventional (chalk board and Charts) and modern (ICT) methods that includes PPT slides, animations etc.
b) Tutorials wherever necessary will be taken to address to personal problems faced by the students in the curriculum
c) Student seminars will be conducted to boost confidence as well as help them research on particular topic and help them make presentations
d) Assignments to enhance their scope of reviewing literature, learning and presentation.
e) Tests./assessment based on problem solving
f) Group discussions to encourage team work, logical argument and research on topic..
g) Interactive classes using tools like Socrative, edmodo etc
h) Arranging talks on subject related issues by the experts in the field to expose students to various current developments

**PRACTICAL**

a. Laboratory-based practical components and experiments will be conducted
b. Field-based learning through visits and report preparation
c. Advanced lab visits and exposure to the available techniques and instrumentation
d. Research problem discussion.
e. Encouragement of students to take up internship or summer training as and when possible.

All the above focuses on the pedagogy of the subject will be helpful to develop an amalgamation of teacher-centric methods, learner-centric methods, content-focused methods, and participative methods.

### 1.5 Assessment methods

A variety of assessment methods that are appropriate to the discipline are used to assess progress towards the course/programme learning outcomes. Priority is accorded to formative assessment. Progress towards achievement of learning outcomes is assessed using the following: closed-book examinations; problem based assignments; practical assignment; laboratory reports; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerised testing and any other pedagogic approaches as per the context.

**P.G.1st Semester**

**Paper: ZOO701C (Core)Biosystematics of Non-Chordates**

**Credits:4=4+0+0(64Lectures)**

**Learning Objectives:**

This course provides an understanding of the existence of various life forms on Earth, as well as detailed knowledge of biosystematics and taxonomic classifications. It will assist the student in comprehending the functional biology of non-chordates as well as the systematic organization of animals based on evolutionary relationships, structural and functional affinities.

**Course Outcomes:**

Upon completion of this course, students should be able to

**CO1**. **Understand** biosystematics, and structural organization of animals.

**CO2. Understand** functional and structural affinities of non-chordates

**CO3. Understand** the economic importance of non-chordates and their role in the ecosystem.

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**Unit1:Biosystematics and Taxonomy: 16L**

1. Basic concept of Biosystematics, taxonomy and classification; classical and recent taxonomic parameters2. Newer trends in biosystematics- chemo, cyto and molecular taxonomy (DNA barcoding in explaining 3. Taxonomic key, its types and their role in classification 4. Taxonomic characters and significance, ICZN, 5. Introduction of Species concept, biological and evolutionary species concept, difficulties in application of biological species concept, Supra and infra-specificandsiblingspeciescategories.

**Unit2:Biologicalclassification: 18L**

1.Theoriesofbiologicalclassification,2.Phylogenetictypesofclassification,systematicofanimals and hierarchic classification, Zoological nomenclature-basic knowledge of naming ongenus and species; Modern scheme of classification into sub-kingdom, division, section, phylaandminor-phyla.3.Pheneticmethodofclassification,numericalphoneticsandnumericaltaxonomy, preparation of data matrix and similarity matrix using distance method (Manhattandistance and Euclidian distance), 4. Cladistic method of classification, difference in application ofphoneticandcladistic classification,Cladogram,Eludisticmethods.

**Unit-3:Functionalbiologyofnon-chordates: 18L**

1.Osmoregulationinprotozoa;2.Colonialprotozoansandtheoriesoforiginofmetazoans;

3. Feedingpattern and digestion in lower metazoans,4. Life history pathogenecity and

controlof *Fasciola hepatica*, 5. Exocrine gland(Lac, Wax, Silk and Labial gland), 6. Larval forms ofechinoderms,metamorphosisandphylogeneticsignificance,7.Structureandfunctionofdigestive organs in insect-pleotropic membrane and filterchamber 8. Hydrostatic movement inEchinodermataandAnnelids9.Mechanismofrespirationbygills,booklungandtrachea 10. Respiratory pigments in non-chordates 11. Mechanism of Excretion and excretory organs inAnnelidsandArthopods.

**Unit-4:Minorphyla** **12L**

Salientfeaturesandaffinitiesof-1.Placozoa,2.Mesozoa,3.Ctenophora,4.Rotifera, 5.Phoronida,6.Sipuncula,and7.Bryozoa(Ectoporecta).

**Booksrecommended:**


1. Barnes:InvertebrateZoology(Holt-SaundersInternational,4thedition,1980)
2. Barnes:TheInvertebrates –Asynthesis,3rdedition,Blackwell,2001
3. Hunter:Lifeof Invertebrates,Collier Macmillan Pub.1979
4. Marshall:Parker&HaswellTextBookofZoology,Vol.I,7thedition,Macmillan, 1972
5. Moore:AnIntroductiontotheInvertebrates,CambridgeUniversityPress,2001
6. Jordan&Verma:ChordateZoology(1998,S.Chand)
7. Sinha,Adhikari&Ganguly:BiologyofAnimals(Vol.II,1998,NewCentralBookAgency)
8. Chapman:TheInsects:structureandfunction,1998
9. Srivastava:AtextbookofappliedentomologyVolI&IIKalyaniPublishers,NewDelhi,1988 ,1993
10. KapoorV.C.:PrinciplesofTaxonomy
11. Parker andHaswell:A Textbook ofZoologyVol. I(Revised)
12. E.MayrandP.D.Ashlock:PrinciplesofsystematicZoology(2ndEdition)

**Paper: ZOO702C (Core)**
**Biochemical and Biophysical Science**
**Credits:4=4+0+0 (64 Lectures)**

**Learning Objectives:**

This course will provide a thorough understanding of general biochemistry and bioenergetics, as well as their biological significance. The core conceptual framework can also help students understand enzyme kinetics and metabolism. As a result, this course will lay the groundwork for further research into micro and macromolecular interactions in biological systems.

**Course Outcomes:**

Upon completion of this course, students are able to understand

**CO1.** To understand and analyze the role of chemicals in living system

**CO2.** To Learn and understand basic structural and functional chemistry of biomolecules.

**CO3.** Understand, analyze and apply the principles of Physics in the biological systems.

**CO4.** Kinetics of enzyme action and metabolism

**A. Biochemicalscience:**

**Unit-1:Generalbiochemistry**

**4.1** Waterandbiomolecules: **14L**

**1.** Biological importance of water, PH, PK and acid-base balance, Henderson-Hasselbachequation **2.** Types of Buffers and Biological importance **3.** Electrolyte and water balance,Acidosis,Alkalosis**4.**Conceptofchemicalbonding,itstypesandbiologicalapplication

**5.** Role of Carbon in life and its variety of functional group/ variety of functional groups ofcarbon and its biological role **6.** Natural products, their physiological & pharmacologicalimportance

**4.2** Proteinchemistryandfunction: **14L**

**1.** Protein structure and significance- Primary structure: peptide bond. Secondary structure(α helix, β pleated sheet and bends) **2.** Ramachandran plot. **3.** Tertiary structure: forcesstabilizing tertiary structure, domain and motifs. Quaternary structure **4.** Protein-proteininteraction **5.** Ligand and types of biological ligands. Ligand formation between protein andnucleicacid**6.**Lipidand its roleinbiomembrane.

**Unit-2:Functionalbiologyofnucleicacid** **8L**

**1.** Structure, folding motifs, conformational flexibility and supercoiling of DNA **2.** Mechanism ofDNAreplication**3.**RNA-Transcriptionandpost-translationalmodification

**B. Biophysicalscience:**

**Unit-3:Bioenergetics**

**16L**

**1.** Forces between molecules (electrostatic, van der Waals forces - hydrophobic and

hydrophilic)andtheirbiologicalimportance,**2.**Lawsofthermodynamics(zeroth,first, second laws)

**3.**

Conceptoffreeenergy(Gibbs),entropyandcalculationbasedonfreeenergychange,Endothermic and exothermic reactions. **4.** Biological applications of thermodynamics (open andclosed systems). **5.** Third law of thermodynamics - significance of hydrophobicity and entropy

inbiologicalreactionsystem.Freeenergyandequilibriumconstantofreactions,coupledreaction.

**6.**Bioenergeticsofmusclecontraction.

**Unit-4:Enzymekineticsandmetabolism 12L**

**4.1 Enzymeaction 4L**

**1.** Mechanismofenzymeaction(activesite,substratebindingsite,transitionstateanalogue). **2.** Concept of regulation of enzyme activity. **3.** Ribozyme, abzyme and isoenzymeandtheir biologicalandmedico-significance.

**4.2 Metabolism 4L**

**1.** Concept of metabolic pathway and their regulation. **2.** Energy transduction - glucose

andfattyacidasenergysources/metabolicfuel**3.**Respiratorychainandoxidativephosphorylation, **4.**Metabolicdisorder.

**4.3 EnzymeKinetics 4L**

**1.** Kinetic analysis of enzyme catalyzed reaction, Derivation Michaelis–Menten equation andrelatedcalculations(Lineweaver–Burkplot).2.Loweringofactivationenergy.

**Booksrecommended:**


1. Albertetal.:MolecularBiologyoftheCell(4thEd.),GarlandPublishingInc.,2002
2. Lodishetal.:MolecularCellBiology(5thEd.),FreemanandCompany,2004
3. Bergetal.:Biochemistry(5thEd.),FreemanandCompany,2002
4. Murrayetal.:Harper'sBiochemistry(26thEd.),Appleton&Lange,2003.
5. Bose,S.ElementaryBiophysics.JyothBooks,1982.
6. Bums,D.M.andMacDonald,S.G.G..PhysicsforBiologyandPremedicalstudents.ELBS andAddisson-WesleyPublishersLtd., London, 1979.
7. Casey, E.J. Biophysics concepts and Mechanism. Affiliated East-West Press Pvt.Ltd.,NewDelhi,1962.
8. Das,D.BiophysicsandBiophysicalChemistry.AcademicPublishers.NewDelhi,1982.
9. Epstein, H.T.. Elementary Biophysics, selected topics. Addisson - Wesley Publishing CompanyInc.London, 1963
10. Das,D.BiophysicsandBiophysicalChemistry.AcademicPublishers.NewDelhi,1982

**Paper: ZOO703C (Core)**
**Computational and Quantitative Biology**

**Credits:4=4+0+0(64Lectures)**

**Learning Objectives:**

This course is designed so that students can practice the various important skills related to biological data science that are important in the research and development sector. This course will teach computer-based programming for biological data, as well as a detailed overview of data types and statistical procedures for experiment design, data collection, and analysis of results.

**Course Outcomes:**

By studying this course, students will be able to

**CO1. Learn, understand and analyze** different forms of biological data using several statistical tools.

**CO2.Understanding** the importance of biostatistics in biological research.

**CO3. Learning and understanding** basics of computational biology tools and databases

**CO4. Analyzing** biological databases and learning their applications.

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**A.ComputationalBiology**

**Unit1:Computationalbiology&bioinformatics**

1.1:Computationalbiology 10L

**1.**Computationalbiology-definition&differentbranchesandapplication**2.**Biometrics-identificationsystem,accuracyandtechnologies,fingerscan&facialscanandapplication **3.**Bioinformatics-brainofbiotechnology.

1.2:biologicaldatabases 18L

**1.** Introduction to Genomic Data and Data Organization.**2.** Sequence Data Banks – Introductionto sequence data banks: protein sequence data bank, NBRF-PIR, SWISSPORT, UNIPROT **3.**NucleicAcid sequence data bank – GenBank, EMBL. **4.**Structural data bank – protein data bank, PDB andSCOP,TheCambridgeStructuraldatabase(CSD),**5.**SequenceAnalysis– Analysistoolsforsequencedata banks,**6.**Pair– wisealignment–NEEDLEMAN ANDWUNSCH ALGORITHM,

**7.** SMITH WATERMAN **8.** Multiple alignments – CLUSTAL, BLAST, FASTA algorithm to analyzesequence pattern, motifs and profiles Sequence retrieval system (SRS), Protein identificationresource(PIR); **9.** Fileformeting-FASTA, GCGandClustalW.

**Unit3:Quantitativebiology-1** **18L**

**1.**Variance,standarddeviation,standarderror,**2.**measureofskewnessandKurtosis,
**3.** coefficient of variance & calculation. **4.** Basics of Probability – Concept of probability, additionand multiplication laws of probability and application to the problems of biology; **5.** Probabilitydistribution–Definition,Types(bernoulli,binomial,poissonandnormaldistributions),propertiesandapplications.

**Unit4:Quantitativebiology-2** **18L**

**1.** Sampling- a)Concept of sampling and sampling methods, b) Test of significance for largesample (Z-test) and for small sample (t-test).c) Hypothesis formulation and testing of Hypothesis**2.**Chi-square analysis (goodness of feet, f-test).**3.**Correlation: a)Definition types of correlation, b)Methodsofstudyingcorrelation,KarlPearsoncoefficientofcorrelation,Rankcorrelationmethod.**4.**Regressionanalysis. **5.**Analysisofvariance.

**Booksrecommended:**


1. Barnes&Gray(ed):Bioinformaticsforgeneticists,Wiley(2003)
2. Lesk:Bioinformatics,Oxford(2003,Indianed)
3. Westheadetal:BioinformaticsInstantNotes,VivaBooks(2003,Indianed)
4. BruningJ.L.andB.L.KintzComputationalHandbookofStatistics,Scott,Foresmalnandcompany(1977).
5. DanielW.W.Biostatistics:AFoundationforAnalysisinHealthSciences,JohnWiley(2000).
6. MiltonJ.S.andJ.O.TsokosStatisticalMethodsintheBiologicalandHealthSciences,McGrawHillBookCo. (1983)
7. Quinn G.P. and Keough M.J. (2002) Experimental Design and Data Analysis for Biologists,CambridgeUniv.Press.
8. Techniquesinlifesciences–byTembhare
9. PracticalBiochemistryByPlummer
10. PrinciplesandtechniquesofPracticalBiochemistryEd.B.L.Williams&K.Wilson,ArnoldPublishers

**Paper:ZOO704C(Core)**
**Parasitology and Vector Biology,**
**Immunological Sciences &**
**MicrobiologyCredits:4=4+0+0(64Lectures)**

**Learning Objectives:**

This course is divided into two parts: advanced parasitology and immunological science.

There is an enormous diversity of parasites in nature, and knowing and understanding them well becomes critical in terms of effectively controlling and managing the parasites. The economic impact of these organisms is frequently enormous, making it all the more important to study them. Parasitology will allow us to correctly diagnose parasites, understand their life cycles, and control them effectively, as well as use some of them as biocontrol agents. Parasitology, particularly the study of parasite life cycles, has aided in breaking down stigmas and religious taboos in many societies, liberating many people from superstition and illness. Developing countries, such as ours, where the majority of the population is engaged in agricultural activities and lives in poverty, can benefit from parasitology research. The course will undoubtedly teach students to recognize, appreciate, and comprehend the various types of parasites found throughout the study of life.

The immunology section is designed to teach students the fundamentals of immunology so that they can develop an understanding of the subject, such as how the immune system works. What are the molecular and cellular components, as well as the pathways, that protect an organism from infectious agents or cancer? This comprehensive course answers these questions by delving into the structure, function, and genetics of the immune system's components.

**Course Outcomes:**
At the end of the course, the students should be able to:
**CO1.** Understand various parasites, parasitic invasion in both plants and animals; applicable to medical and agriculture aspects.
**CO2.** Understand the cellular and molecular basis of immune responsiveness
**CO3.** Understand immunological reaction and immunomodulatory strategies
**CO4.** Know about various vaccines and other immunotherapeutic strategies.

**AdvancedParasitologyandVectorBiology** **25L**

**Unit1:Parasitology** **17L**

1.1:Generalconsiderationofparasites:

1. Typesofparasites,Typeofhosts,parasiterelationship-Symbiosisandcommensalism

2. Distribution of diseases and Zoonosis caused by animal parasites 3. Molecular interactionbetweenhost&parasitesandevasionofimmunity4.Biochemicaladaptationsofparasites &parasitesofveterinary importance.

1.2 :Protozoanparasite

1.Distribution,habitandhabitat,structurelifecycleanddiseasescausedbyselectedpathogenicproto zoanparasitesofman:a)Entamoebahistolytica,b)Trypanosomagambiense,c)Leishmaniadonova ni,2.Physiologyofparasiticamoebaeofman.

1.3 :Helminthparasites

1.Generalcharacters,organizationandlarvalformsofPlatyhelminthesandNemathelminthes2.Dist ribution,habitandhabitat,structureandlifecycleofeconomically
important helminth parasites of man and domesticated animals: a)Echinococcus granulosus,b)Schistosomahaematobium,c)Trichinellaspiralis,d)Wuchereriabancrofti

**Unit2:Vectorbiology** **8L**

1. Vectors – insect vectors, mosquito, housefly, bedbug, head louse; 2. Biology of differentmosquito;3.Vectorborndiseases–
humandiseasesandtheircontrolmeasures4.Vectorborneviraldisease–
DengueandJapaneseencephalitis5.Vectorcontrol–Biological,chemicalandphysicalmethods

**B. Immunologicalsciencesandmicrobiology**
**39L**

**Unit3:Immunology** **24L**

1.Cellsoftheimmunesystem:T-cellgenerationactivationanddifferentiation,B-cell-generation activation and differentiation; 2.Antibody: types, structure, function, productionand diversity; 3. Epitopes and hapten; 4. Major Histocompatibility Complex (MHC)-generalorganizationandinheritanceoftheMHC,MHCmoleculesandgenes;4.Complementsystem
-
classical,alternativeandlectinpathways,regulationofcomplementsystem,biologicalconsequence sofcomplementactivation;5.Cytokinereceptors-propertiesofcytokines, cytokine receptors, cytokine 6. Hypersensitivity reactions- types, mechanisms oftype I to IV hypersensitivity reactions; 7. Autoimmunity and Organ specific autoimmunediseases(Rheumatoidarthritis,Grave'sdiseaseandtreatment);8.Transplantationimm unology-bloodantigens,transplantationrejection,graftrejection,immunesuppression.

**Unit4:Microbiology** **15L**

1. Structureandgrowthofbacteria;2.Structureofvirus&reproduction(Lyticcycle ,Lysogeniccycle&Roleoflambdarepressor);2.Pathogenicmicrobes-Rabies,3.Viraldisease-, Zika, Nipah, HIV, H1N1.;4. Antibiotics: Chemistry their mode of action 5. Vaccine:Types,Vaccinepreparation.

**Booksrecommended:**

1. Animalparasitology–J.D.Smyth(CambridgeUniv.Press.,1976).

2. Foundations of parasitology 6 ed. – L. S. Roberts & J. Janovy Jr (McGraw Hill Publ.,2000).
3. Parasitism–A.O.Bush,J.C.Fernandez&J.R.Seed(CambridgeUniv.Press,2000).
4. Helminthology–Eds.N.Chaudhury&I.Tada(NarosaPublg.House,1994).
5. Helminthes, Arthropods, & Protozoa of domesticated animals 6 ed. – EJL Soulsby(ELBS,1976).
6. Introductiontoparasitology–B.E.Matthews(CambridgeUniv.Press.1998).
7. EcologicalAnimalParasitology–C.R.Kennedy(BlackwellScientificPubl.,1975).
8. Immunology,Kuby,W.F.Freeman,U.S.A
9. FundamentalsofImmunology,W.Paul

**Paper:ZOO705L(Lab)**

**Lab1: Zoology Core Course LaboratoryCredits:4=0+0+4**

**(i) :PracticalonBiosystematicsofnon-chordates**

1. Taxonomichierarchicalclassificationinvertebratespecimensofnon-chordatesbylocal,binomial nomenclature( at least 3 representatives of museum specimen from each phyla) & 2minorphyla
2. Identification of at least one specimen from each typological species( supra, infra & sub speciescategories)
3. Permanentmounting(anythree)
   a) Protozoa(cilia-*Paramoecium*,flagella-*Euglena*)
   b) Porifera-freshwaterspongesspicules,Coelenterata-*Obelia*colony
   c) Cockroach–salivaryglandandtrachea,Daphnia,Cyclops
4. Studyofpermanentslides:Zoea,Megalopa(crustaceanlarvae),Glochidium,Echinodermlarvae
5. StudyofInvertebratefossils
6. Dissection:a)MouthpartsofCockroach,Housefly,Mosquito;b)Reproductivesystemofcockroachc)Nervoussystemof cockroach

**(ii) :Biochemicalandbiophysicalsciences**

1. Constructionofmodelsofbiomoleculesbywireandbits.
2. PreparationofdifferentbuffersanddeterminationofpHbypHmeter.
3. Chromatographicseparationofaminoacidandprotein(inbodyfluidandtissue)/phytochemical byTLC.
4. Enzymekinetics–Invitrodetectionofsalivaryamylaseactivityfromcockroachormaltosestandard/pepsinortrypsin(fromstomachoftoad).
5. QuantitativeestimationofproteinbySDS-PAGEelectrophoresis(Demonstration)
6. Quantitativeestimationofglucoseandprotein.
7. Separationofnuclei,celldebris,mitochondriabydifferentialcentrifugation.

**(iii) :Biostatistics,bioinformaticsandtooltechnique**

1. Dataprocessingandgraphicalpresentationofdata(bardiagram,histogram,piechart)usingexcelsheet.
2. Calculationofmeasureofcentraltendencies(meanandmedian),dispersion(standarddeviation,coefficientofvariance)from thedatacollected/provided.
3. Computationoftestofsignificance(T-test)fromthedatacollected/provided.
4. Computationone-wayANOVAincomputerbyusingsuitablesoftware/Excel.
5. Downloadproteinandnucleotidesequencesthroughbrowsingsuitabledatabasesandreporttobesubmitted(Proteinsequence:Hb,Myoglobin,TATA/boxbindingprotein.Nucleotidesequence:Cry1AC, BCl2/HSP70gene etc).
6. Design of a primer for gene amplification (offline and online for forward and reverse) andannotation,ORFfinderforeukaryoticgeneuseofARTEMISoranyothersuitablesoftware.

7. Construction of phylogenetic tree (through Clustal W, Megablast 7/PHYLIP) for DNA and proteinforanyfivesuitablevertebrateandinvertebrateanimalsandtheirinterpretation.

**(iii) :Biostatistics,bioinformaticsandtooltechnique**

1. Dataprocessingandgraphicalpresentationofdata(bardiagram,histogram,piechart)usingexcelsheet.
2. Calculationofmeasureofcentraltendencies(meanandmedian),dispersion(standarddeviation,coefficientofvariance)from thedatacollected/provided.
3. Computationoftestofsignificance(T-test)fromthedatacollected/provided.
4. Computationone-wayANOVAincomputerbyusingsuitablesoftware/Excel.
5. Downloadproteinandnucleotidesequencesthroughbrowsingsuitabledatabasesandreporttobesubmitted(Proteinsequence:Hb,Myoglobin,TATA/boxbindingprotein.Nucleotidesequence:Cry1AC, BCl2/HSP70gene etc).
6. Design of a primer for gene amplification (offline and online for forward and reverse) andannotation,ORFfinderforeukaryoticgeneuseofARTEMISoranyothersuitablesoftware.
7. Construction of phylogenetic tree (through Clustal W, Megablast 7/PHYLIP) for DNA and proteinforanyfivesuitablevertebrateandinvertebrateanimalsandtheirinterpretation.

**(iv) :Advancedparasitologyandvectorbiology,immunologicalandmicrobialscienceParasitology:**

1. IdentificationofdipteranvectorsandstudyofdifferentstagesofthelifehistoryofAnophelesCulex,Aedes,housefly,sandyfly (throughslides/chart).
2. Preparationofpermanentslideofinsectleg,antennae,wingsofmosquito/housefly/cockroach.

**Vectorbiology:**

1. Surveillanceandwritingareportonbreedinghabitatofmosquito/cockroach.Studyofmosquito/houseflydiversityspecies.1.Histologicalidentification:Primaryandsecondarylymphoidorgansthrough preparedslide.
2. Preparation of single cell suspension from bone marrow and spleen of mice. Cell-viability assayandcell counting fromspleen (splenocyte)/thymus.
3. Preparationandstudyofphagocytosisfromsplenic/peritonealmacrophages.Performingtheagglutinationorprecipitationtestin ABObloodgroup

**Immunology:**

1. Histologicalidentification:Primaryandsecondarylymphoidorgansthroughpreparedslide.
2. Preparationofsinglecellsuspensionfrombonemarrowandspleenofmice.Cell-viabilityassayandcell counting fromspleen (splenocyte)/thymus.
3. Preparationandstudyofphagocytosisfromsplenic/peritonealmacrophages.Performingtheagglutinationorprecipitationtestin ABObloodgroup

**Microbialscience:**

1. Mediapreparationformicrobialculture.Gramstainingofbacteria(*Lactobacillus*).

**Viva-Voce & Practical Records**

**Paper:ZOO706S (SEC)**
**Seri biology & Sericulture Practices**
**Credits:2= 2+0+0 (32Lectures)**

**Learning Objectives:**

The course will educate students on the importance of sericulture as a profitable business. It will assist students in comprehending the biology of silkworms and their nutritional requirements in order to secrete high-quality silk. The course would explain silkworm rearing techniques, silk reeling techniques, and various measures to be taken to maximize the benefits. It would also assist students in learning about the various applications of silk and developing the entrepreneurial skills required for self-employment in the sericulture and silk production sectors.

**Learning Outcomes:**

Upon completion of thecourse,studentsshouldbeableto:

**CO1.** Learning the history of sericulture and understanding its basics

**CO2.** Ability to recognize various species of silkmoths in India and their rearing techniques

**CO3.** Learning sericulture and the threats associated with it.

**CO4.** Generating understanding about the employment and entrepreneurship opportunities

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**Unit1:Introduction** **6L**

1. Sericulture: Definition, history and present status; Silk route 2. Types of silkworms, DistributionandRaces3.ExoticandindigenousracesMulberryandnon-mulberrySericulture

**Unit2:BiologyofSilkworm** **6L**

1.LifecycleofBombyxmori2.Structureofsilkglandandsecretionofsilk

**Unit3:RearingofSilkworms** **8L**

1. Selection of mulberry variety and establishment of mulberry garden 2. Rearing house and rearingappliances 3. Disinfectants: Formalin, bleaching powder, RKO 4. Silkworm rearing technology: EarlyageandLate agerearing5.Typesofmountages,Spinning,harvestingandstorageofcocoons

**Unit4:PestsandDiseases** **6L**

1.Pestsofsilkworm:Uzifly,dermestidbeetlesandvertebrates2.Pathogenesisofsilkwormdiseases: Protozoan,viral,fungalandbacterial3.Controlandpreventionofpestsanddiseases

**Unit5:EntrepreneurshipinSericulture** **6L**

1. Prospectus of Sericulture in India: Sericulture industry in different states, 2.Employment,

potentialinmulberryandnon-mulberrysericulture.3.Visittovarioussericulturecenters.

**Booksrecommended:**


1. ManualonSericulture;FoodandAgricultureOrganisation,Rome1976
2. HandbookofPracticalSericulture:S.R.UllalandM.N.NarasimhannaCSB,Bangalore
3. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt.Press,Bangalore
4. AppropriateSericulturalTechniques;Ed.M.S.Jolly,Director,CSR&TI,Mysore.
5. HandbookofSilkwormRearing:AgricultureandTechnicalManual-1,FuziPub.Co.Ltd.,Tokyo,Japan1972.
6. ManualofSilkwormEggProduction;M.N. Narasimhanna,CSB,Bangalore1988.
7. SilkwormRearing;Wupang—ChunandChenDa-Chung,Pub.ByFAO,Rome1988.
8. AGuideforBivoltineSericulture;K.Sengupta,Director,CSR&TI,Mysore1989.

**P.G.2nd Semester**

**Paper: ZOO801C(Core)**
**Analytical Techniques and Molecular Biology**
**Credits:4= 4+0+0 (64Lectures)**

**Learning Objectives:**

This course is divided into two sections. The first section provides an understanding of chordate functional biology, as well as detailed knowledge of diversity and taxonomic classifications. It will assist the student in understanding the functional diversity of chordates as well as the systematic organization of animals based on evolutionary relationships, structural and functional affinities. The second part of the course will give you a thorough understanding of biodiversity and its conservation. This course also includes a detailed examination of the economic significance of biodiversity.

**Learning Outcomes:**

Upon completion of this course, students should be able to
**CO1.** To develop understanding about the vertebrate body structure and their development.
**CO2:** Have complete insight into the functional biology of chordate structures
**CO3.** Understand the fundamentals of biodiversity conservation.
**CO4** Understanding the economic importance of biodiversity and its role in the ecosystem
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**A. Functional biology of chordate** **38L**

**Unit1:Vertebratebody plan**
**12L**

1. Mechanism of body support& movement 2.Ectothermic and exothermic mode of life; 3.Jawsuspension-functional&evolutionarysignificance,cranialkinetics,intra-cranialfeedingmechanism
4. General plan of neurocranium & dermatocranium 5. Temporal regions of reptiles, evolutionarysignificance; 6. Dentition& dentition formula in mammals; 7. Modification in beak, feet, palates inbirds

**Unit2:Functionaldiversityofchordates** **14L**

1.Aerialrespirationinvertebrates;2.Evolutionofcerebrum,AssociationofCNS,information process, encephalisation in higher brain; 3. Nitrogen excretion in vertebrates;
4. Communicationsignals-bioluminescence,pheromones,coloration&mimicry;5.Accessoryrespiratory organs in fish & air-sac in birds; 6. Adaptations to Stress- basic concept of environmentalstress, acclimation, acclimatization, avoidance and tolerance, stress and hormones; 7. Body fluids-major types of body fluids & fluid compartments: 8. Bonding biodiversity- molecular diversity &cellulardiversityin termsoffunctional diversity.

**Unit3:Receptorsinvertebrates** **12L**

1.Characteristicsofgeneralreceptors,receptorpotential&sensorycoding;2.Senseorgans&simple

receptors- organs of olfaction & taste, lateralline system, electro-reception; 3. Adaptation inorgansystem forreception-chemo-receptors&electricalreceptors.

**B. Biodiversityandconservation**

**Unit4:Biodiversityandconservation**
**(26L)**

4.1 :Introductiontobiodiversity
**8L**

1.Definition & indices of biodiversity 2. Biodiversity hotspot with reference to NE region 3.Types ofbiodiversity 4. Levels of biodiversity-genetic, species & ecological diversity 5. measuring biodiversity;interrelationship between diversity measures; pattern of local and regional biodiversity. 6. Speciesinteraction

4.2 :Biodiversityconservation **10L**

1. Biodiversity conservation- methods & strategy formation 2. Threats to biodiversity-vulnerabilityofspeciesextinction;3.Reddatabook;rarity,endemism,effectiveandminimumviable population,
4.Fragmentationofpopulationandmetapopulation

4.3 :Economicimportanceofbiodiversity **8L**

1. ForestBiodiversityformedicaluse
2.Valuesandusesofbiologicaldiversity,3.Invertebratediversity as bioindicator; putting a price on biological diversity; pollinating insect diversity and theirmanagementand utilizationinsustainableagriculture.

**Booksrecommended:**


1. Boolootian,R.A.andStiles,K.A.,CollegeZoology,10th edition,MacmillanPublishingCo.,Inc.New York,1981.
2. Colbert, E. H., Morales, M. andMinkoff, E. C. Colbert's Evolution of the Vertebrates: Ahistory of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York,2002.
3. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York,1971.
4. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication,NewYork,1958.
5. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., NewYork,1995.
6. Jordan,E.L.andVerma,P.S.,Chordate Zoology.S.Chand&CompanyLtd,1998.
7. Kotpal,R.L.TheBirds,4thedition,RastogiPublications,ShivajiRoad,Meerut,1999.
8. Primark:APrimerofConservationBiology(2nded.SinauerAssociates)
9. Odum.E.P.FundamentalsofEcology.NatarajPublishers,DehraDun,1996.
10. Berwer.A.TheScienceofecology.Saunder'scollegepublishing,1988.

**Paper: ZOO802C (Core)**

**Cell Biology and Genetics**

**Credits:4=4+0+0 (64Lectures)**

**Learning Objectives:**

This course will teach about the complex organization of the eukaryotic cell as well as the molecular mechanisms of the cellular processes found in all cell types. Genetics and Cytogenetics is a core course that teaches students the fundamentals of how organisms, populations, and species evolve. Aside from Mendel's laws and basic genetics, this course at the Master's level will provide some of the most incisive analytical approaches that are now being used across the spectrum of biological disciplines.

**Learning Outcomes:**

Thestudentswill:

**CO1.** To understand the cell functioning.
**CO2.** Gain knowledge about the techniques and experiments of cell and molecular processes.
**CO3.** Understand and analyse the physiological processes
**CO4.** Understanding about chromosomes and genetic basis of various disorders
**CO5.** Learn and understand the population genetics and its importance

**A. Cell biology & Cellular dynamics(30L)**

**Unit1:Cellbiology**
(20L)

1.1.Membranetransport: 10L

1.Structuralorganizationofcellmembrane;2.Transmembranetransportofionsandsmallmolecules (active,passive&bulktransport),Donnanequilibrium;3.Membranetargetingofproteins;vesiculartraffickingbetweenmembranes,Post-translationalmodifications,proteinsorting;
4. Nuclear Transport –Import and Export of protein; Export of different RNAs; 5. Nuleo-cytoplasmicinteractions&theirrole.

1.2:Cellcycleandcelldeath 10L

1. Eukaryotic Cell cycle- phases & cell cycle control, cyclin&cyclin dependent kinase; 2. Check point &regulation; 3. Apoptosis- cellular & molecular events; 4. Cancer – Phenotypic characters of cancercells; Genetic basis of cancers: Protooncogene, Oncogene, Tumor suppressor genes, Oncogenesis,Stemcells anddifferentiation.

**Unit2:Cellulardynamics** 10L

1. Cytoskeleton-Structure of a)microfilaments; b)microtubules; c)intermediate filaments; d) molecular motors; 2. Their role in cell shape and motility, cell structure and dynamics; 3.

CellSignaling-theirrolein Cell-cellinteraction.

**B. Cytogenetics&populationgenetics**

**Unit 3: Cytogenetics**
**(23L)**

3.1 :Chromatinstructure: 11L

1. Eukaryotic chromatin structure and chromosome organization; 2. Chromosomal proteins: histonesandtheirmodifications,non-histoneproteins,scaffold/matrixProteins;3.Levelsofchromatincondensationatinterphaseandmetaphasestages;4.Centromere,kinetochoreandtelomere;

3.2 :Humancytogenetics&geneticdiseases a12L

1.Karyotypeandnomenclatureofmetaphasechromosomebands,2.Geneticcounseling,3.Common syndromes caused by aneuploidy, mosaicism, deletion and duplication 4. molecular basisfora)Hemophilia,b)Sicklecellanemia,d)Thalassemia,e)Xerodermapigmentosum,f)Cysticfibrosis,
g)Duchennemusculardystrophy 11L

**Unit4:Populationgenetics 11L**

1. Hardy-Weinberg's law of equilibrium. 2. Forces of destabilization-mutation & mutation rates,natural selection- gamete, recessive & lethal selection, heterozygote advantages. 3. Factors changingallelic frequencies-mutation, selection, genetic drift, migration, meiotic drive 4. Variation-geneticpolymorphism,causesofgeneticvariation,populationvariation.5.Measureofgeneticvariation
6. Optimumphenotypeselection,Fisher'spressure,genetichomeostasis,geneticload&death,mutation load 7. Inbreeding: Measure of inbreeding. Inbreeding depression, heterosis; Gene &environmentinteraction

**Booksrecommended:**


1. Albertsetal,MolecularBiologyoftheCell,Garland,2002
2. Lodishetal,MolecuarCellBiology,Freeman,2004
3. Rooney&Czepulkowski,HumanCytogenetics-APracticalApproach,IRL,1987
4. Stratchan&Read,HumanMolecularGenetics,Wiley,1999
5. Watsonetal,MolecularBiologyoftheGene,Pearson,2004
6. GeneralgeneticsbyWinchester
7. MolecularBiologyofgenebyWatsonetal.VolI&II
8. GeneticsbyStrickberger
9. MolecularBiologybyFriefielder
10. GeneticsbyP.K.Gupta

**Paper: ZOO803C (Core)**
**Developmental Biology**
**Credits:4=4+0+0(64Lectures)**

**Learning Objectives:**

The primary goal of the Developmental Biology course is to provide students with a four-dimensional thinking approach that allows them to truly understand the patterns and processes of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo that is not necessarily shared with any other discipline in the biological sciences. The importance of Developmental Biology in the study of human disease will be demonstrated throughout by the use of various model organisms.

**Learning Outcomes:**

**CO1Understanding** the fundamental processes of gamete formation to fertilization to changes during embryogenesis leading to the final development of the organism

**CO2. Understand and analyse** the role of different cellular interactions during organ formation

**CO3.** Learn the physiological aspects of reproductive physiology

**CO4.** To learn the various assisted reproductive technology and its importance

**A. Developmentalbiology**

**Unit1:Gametebiology&earlydevelopment (18L)**

1. Gametosgenesis, 2. Fertlization in mammals: Isogamy & heterogamy, Recognition of gametes andacrosomal reaction, Prevention of polyspermy and gamete fusion, Activation of egg metabolism 3.Cryopreservation of gametes & embryo; 3. Cleavage pattern & chemical changes during cleavage, 4.Roleofnucleus&cytoplasmduringearlydevelopment,5.Morphogenesis-morphogeneticmovementduringdevelopment,6.Gastrulation:Presumptiveareas&Fatemaps,cellmovementandformationofgermlayersinmammal,7.Generalconceptofpotency,commitment,specification,induction (mesoderm development), competence & determination (imaginal discs of insects) 7. Axis&invertebrate.

**Unit2:Organogenesis 20L**

1.Cell-cellinteraction,2.Neurulation(neuraltubeformation)&primordialorganrudimentsformation, 3. Origin & fate of neural crest cells, 4. Trans-differentiation & its medical implication-Metaplasia&regeneration;5.Homeoboxgenesinpatterning;6.insectimaginaldisc;8.Lateembryonic development- Vulva formation in Caenorhabditis; 9. Regeneration of Salamander limbs:PolarCoordinatemodel,10.Teratogenesis

**B. Reproductivephysiology**

**Unit3:Reproductivephysiology** **17L**

1.Implantation&pregnancy,placentalstructure&hormones,2.Endocrine,genetic&immunologicalfactorsinfluencingpregnancy;3.Parturition&lactation-recentconceptofphysiologicalmechanismofparturition,hormonalcontroloflactation&physiologicalimportance.

**Unit4:Medicalembryology** **9L**

1. Infertility;2.Gametemanipulation–a).MultipleovulationsandIn-vitrofertilization(IVF),b).Gamete Intrafallopian transfer (GIFT), c). Intra cytoplasmic sperm injection (ICSI),e). Chimeraformation, 3.Multiple ovulation & embryo transfer technology (MOET) 3. Embryonic stem cells-application,economical&clinicalsignificance,Surrogacy,Cryopreservationofgametes.

**Booksrecommended:**


1. AdashiandLeung(eds):TheOvary,Raven Press,1993.
2. Adashietal:Reproductiveendocrinology,SurgeryandTechnology,Lippincott-Ravenpublishers,1996.
3. Findlay,J.K.:MolecularBiology of theFemaleReproductiveSystem,Academic Press,SanDiego,1994.
4. Knobil&Neil(eds.):ThePhysiologyofReproduction,Vol.I&II,RavenPress,1994.
5. Lamming(eds.):Marshall'sPhysiologyofReproduction.Longman,Green&Co.,1984.
6. Mann&Lutwak-Mann:TheMaleReproductiveFunctionandSemen,Springer-Verlag,1981.
7. Paulsonetal(eds.):Andrology:MaleFertilityandSterility,AcademicPress,1986.
8. Yenetal(eds):ReproductiveEndocrinology,W.B.Saunders,1999.
9. IntroductiontoembryologybyBalinsky
10. DevelopmentalBiologyS.Gilbert
11. DevelopmentalBiologybyBerryl


**Paper:ZOO804C (Core)**
**Ecology and Environmental Science, Wildlife Biology**
**Credits:4=4+0+0(64Lectures)**

**Learning Objectives:**

The goal of this course is to raise awareness among young students about the

environment, the impact of climate change and how to mitigate it, and biodiversity.

**Learning Outcomes:**

**CO1.** Exposure to the fundamental aspects of ecology.
**CO2. To understand the** impact of anthropogenic activities on the environment.
**CO3.** To learn about the natural resources and their conservation.
**CO4.** To learn about various components and interaction of ecosystem.

**A. Ecology&populationecology**

**Unit1:Ecology (44L)**

1.1 :Principleofecology 8L

1.Introductiontoecology,2.Evolutionaryecology,environmentalconcepts– lawsandlimitingfactors, ecological models. 3. Biotic potential & environmental resistance. 4. Soil, types & importantsoilforvegetation.

1.2 PollutionEcology: 8L

1. Definition, sources, kind of pollutants, primary and secondary pollutants. 2. Definition, source, itseffectsandcontrolofa)airpollution,b)Water,Pesticide,Soilpollution,c)Soundpollution, d) Radioactivepollution,6.Bioaccumuation,biomagnification,biotransformationofxenobioticbiomedicalandhazardouswork.

1.3 :Populationecology&speciesinteraction 12L

1. Characteristics of population, population size 2. Population dynamics- a) Intrinsic rate of naturalincrease;b)Populationgrowthform(sigmoidcurve,Jcurveandhyperbola),logisticequation andconcepts relating to growth); c) life history pattern, fertility rate and age structure; d) Populationfluctuations and cyclic oscillation; e) Population density and structures; f) r- and k-selections andcarrying capacity; 3. Competition and coexistence, intra-specific and inter-specific interactions, 4.Scrambleandcontestcompetitionmodel,mutualismandcommensalism,prey-predatorinteractions; 5. Ecological genetics- Importance of genetics to ecological, reproductive system &geneticcensuresofdifferentreproductivesystems

1.4 :Natureofecosystem 8L

1. Nature of ecosystem, 2. Energy flow through ecosystem, 3. Biogeochemical cycles, 4. Resilience ofecosystem,5.Ecosystemmanagement.5.Thebiosphere,biomesandimpactofclimateonbiomes. 6.Typesofecosystem–freshwater,marineandterrestrial7.Wetland-thekidneyofnature.

1.5 :Conceptofhabitat 8L

1. Concept of habitat & niche-Definition & characterization of habitat niche determination, Gaussianprinciples 2. Species co-existence & community structure 3. Trophic levels & its organization withreferenceto energytransfer.4. Ecotoneconcept and edge effect;

**B. Environmentalbiology&Wildlifeecology**

**Unit2:Environmentalbiology 7L**

1. Introduction to environmental biology, 2. Concept of environment structure; 3. EnvironmentalStressesand their management

**Unit3:Wildlifeecology 3L**

1. Forest and wild life ecology- 2. Concept of indicator species and their environmental significance.3.Wildlifebiologyasresource,food, nutrition,requirementsetc.

**Unit4:Conservationbiology 10L**

1. Wildlife conservation and management; 2. Social forestry & tribal welfare of north. 3. Nationallegislationsforprotectingbiologicalresources–
BiodiversityAct,2002andBiodiversityRules,2004,
4. Important wildlife sactuaries & national parks in Assam & India in relation to specific conservationto wildlives. 5. Man-animal conflict in Assam-causes & their solution. 6. International bodies forconservationwithreferencetoreddata book.

**Booksrecommended:**


1. Harborne:IntroductiontoEcologicalBiochemistry4thEd.AcademicPress,1993.
2. Schoonhovenetal.:Insect-PlantBiology,ChapmanandHall1998.
3. ChapmanandReiss:Ecology-Principlesandapplications,CambridgeUniversityPress,1995.
4. RicklefsandMiller:Ecology4thed.FreemanandCo.2000.
5. TurkandTurk:EnvironmntalScience,4rthed.Saunders,1993
6. Primark:APrimerofConservationBiology,2nded.SinauerAssociates
7. Calabrese:PollutantsandHigh-RiskGroups,JohnWiley,1978
8. Raven,Berg,Johnson:Environment,SaundersCollegePublishing,1993
9. Sharma:EcologyandEnvironment,RastogiPublication,7thed.2000
10. Dasmann,R.,1981.WildlifeBiology,2nded.JohnWileyandSons,NY
11. Dobson,A.P.1996.ConservationandBiodiversity.ScientificAmericanLibrary,NewYork,U.S.A.
12. Jeffries,M.J.1997.BiodiversityandConservation.Routledge,NewYork,NewYork,U.S.A.


**Paper:ZOO805L(Lab)**
**Lab 2: Zoology Core Course**
**LaboratoryCredits:4=0+0+4**

**(i) :FunctionalbiologyofchordatesandBiodiversity**

1. Studyofskulltypeswithreferencetojawsuspension-fish,frog,calotes,snake,rat/rabbit(guineapig)

2. Dissectionofaccessoryair-breathingorganfromanyoneofmarketedspecimen(Anabus,Clarius,Heteropneustes/Channasp.).
3. Animalpopulationstudythroughquadrateanalysis(ants)
4. Enumeratebiologicaldiversity(zooplanktons&birds)fromlargehabitat(freshwaterlake/waterbody)within thevicinityof the city
5. StudyofPungmarkoftiger.

**(ii) :Cellbiologyandgenetics**

1. Studyofstructureofprokaryoticcellbystainingpreparationof Lactobacillusfromcurd
2. Studyofstructureofeukaryoticcellfromthepermanentpreparation
3. Study of eukaryotic cellorganelle bymaking preparation with suitable stain/permanentslides/ photographic model ( nucleus, mitochondria, Golgi apparatus, liposome, centrioles,ER).
4. StudyofpolytenechromosomefromChironomouslarva
5. Studyofsexchromatin(Barrbody)frombuccalepithelia
6. Measurementofcellsizebyocular&stagemicroscope
7. Identificationofmale&femaleDrosophila
8. StudyofgeneticfrequencyofhumanABObloodgrouptoseethevalidationofHardy-Weinbergequation&itssignificanceinpopulationgenetics

**(iii) :Developmentalbiology**

1. EstimationofLDHactivity
2. Histologicalslidesofreproductiveorgans
3. Studyofdifferentphasesofestrouscyclefromvaginalsmearofrat/mouse
4. Studyofdifferenttypesofeggsonthebasisofyolkcontent
5. Studyofdifferentdevelopmentalstagesofamphibia&chickembryo(wholemountpermanentslides)

6. Studyofdifferenttypesofmammalianembryo(alreadyexistingpreservedembryo)
7. Studyofdevelopmentalstagesofhumanembryo(throughalreadyexistingmodel)

**(iv) :Ecology,EnvironmentalScienceandwildlife biology**

1. DeterminationofpH,temperature,turbidityfromcollectingsamples.
2. Analysisoftypesofphytoandzooplanktonforthenearbysamplingofwaterbodies.
3. Determinationofprimaryproductivitybydarkandlightbottlemethod.
4. Determinationofrelativehumiditybyhydrogometerandanerometer.
5. Fieldvisittoandsubmissionofreport.

**PAPER:ZOO901C (Core)**
**MOLECULAR BIOLOGY AND ANIMALBIOTECHNOLOGY**
**(Credits:3+0+1=4)**

**Learning Objectives:**

This course will teach you about the complex organisation of the eukaryotic cell as well as the molecular mechanisms of the cellular processes found in all cell types. Genetics and Cytogenetics is a core course that teaches students the fundamentals of how organisms, populations, and species evolve. Aside from Mendel's laws and basic genetics, this course at the Master's level will provide some of the most incisive analytical approaches that are now being used across the spectrum of biological disciplines.

**Learning Outcomes:**
Thestudentswill:

**CO1.** Learn and understand the various aspects of DNA, its organization and molecular biology aspects.
**CO2.** To learn and apply the knowledge of cell culture in biotechnological applications.
**CO3.** To learn various biotechnological applications
**CO4.** Learning about transgenic animals and their applications in the fireld of biology.

## A. MOLECULARBIOLOGY

**Unit1:Molecularbiology(22L)**

1. Structureofprotein,Domainsandmotifs,
2.Transcriptionfactor,3.Proteinfolding,Ramchandranplot.
4. Molecular chaperons; 5. Genome organization in prokaryotes, eukaryotes & genome complexity. 6.Recombination, 7. Mobile genetic elements; 8. DNA damage & repair-types of DNA damages and repairsystems. **9.** Model organisms for molecular studies; 10. Somatic cell hybridization and chromosomemapping,Cellfusionandapplications, 11. Construction ofcDNA& genomicDNAlibraries.

## B. ANIMALBIOTECHNOLOGY

**Unit2:Generalbiotechnology (26L)**

**2.1** Use of animals as bioreactors; 2. Animal breeding & care; 3. Uses of animals in experiment: Selectionrationale&cruelty. 4L

**2.2: Cellculture8L**

1. Cell culture – a) Equipments and materials for cell culture technology, b) principle of

sterile techniquesand cell propagation, c) primary and established cell line cultures. 2. Mammalian cell lines & theircharacteristics. 3. Basic techniques of mammalian cell culture, disaggregating of tissue, maintenance of cellculture,cellseparation, cellsynchronization, cellcloning,micromanipulation, celltransformation.

**Unit3:Recombinantorganismsandtransgenicanimals5L**

1. Transgenic animals; creation of transgenic mice, retroviral vector method, Microinjection, embryonic stemcell method – short gun, electroporation, lipofection, microinjection. 3. Production of other transgenicanimals– cattle, sheep, pigs andfish.

**Unit 4:ApplicationofBiotechnology9L**

1.Application ofRFLPinforensicscience,2. hybridoma technologyandProduction monoclonalantibodies.

3.EnvironmentalBiotechnology-biosensorsinecotoxicologicalscreening; 4.Biofuels &biogasproduction

5.Biohazard&biosafetylevel-I, II,III, IV6. Intellectualpropertyright(IPR)

**<u>PRACTICAL:</u>MolecularBiologyandAppliedbiotechnology,Molecular techniques.Credit:1**

1. Study of colchinised metaphase chromosome in bone marrow of rodent species (mouse) by airflame drymethod.
2. Studyofsex chromatininhuman femalefromhairbudcells.
3. Preparationofhumankaryotype.
4. DemonstrationofculturingofE Colion solid onliquid medium.
5. Demonstrationofbacterialtransformationusingsuitableplasmid(withandwithoutinsert).
6. Identification and study of male and female drosophila, study of mutant variety of drosophila – eye andbodycolour, bodypattern,wings development fromthepermanentslides.
7. DemonstrationofSDS-PAGEfor proteinandvisualization.
8. DemonstrationofAgarosegel electrophoresisforDNA.
9. Estimationof cholesterolandLDH.
10. Demonstration ofanimal culturelab.

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**PAPER:ZOO902C (Core)**
**HISTOLOGY&HISTOCHEMISTRY,TOXICOLOGY**
**(Credits:3+0+1=4)**

**Learning Objectives:**

This course will teach you the techniques used in histological studies, as well as the specifics of histopathology. The course will also teach you about histochemistry and toxicology.

**Learning Outcomes:**

Upon completion of this course students will

**CO1.** To learn the use of different histological techniques to study histopathology and histochemistry.

**CO2.** Understanding the principlrs and applications of different biosinstrumentation tools

**CO3.** TUnderstand and apply the knowledge of toxicology in various biological field

**Unit1: Histology(19L)**

**1.1.Techniquesof histology: 6L**

1. Mechanism of Fixation and Fixatives-Types, Chemistry & Choice of Fixatives 2.Tissue Staining-Principle and Mechanism of histological staining, different types of dyes &, dye binding reactive groups,Histologicalstains; mordants & mordanting & histological lake, double staining technique 3. Tissueprocessing through microtomy technique-narcotization& excise the tissue sample, fixation processing,Dehydration,ClearingandEmbedding, blockmaking& trimming, sactioning&stretching.

**1.2:Histopathology**: 10L

1. Histological structure & functions of liver, kidney, & brain; 2.. Histological structure & functions ofimmunological organs thymus, spleen; 3. Cellular behavoiur in pathological state; 4. Cell injury- definition,pathogenesis of reversible & irreversible cell injury, concept of free radicals, oxidative state & oxidativestress; 5. Thrombosis- definition, types & mechanism of thrombosis, 6.Healing-definition, mechanism &factorscontrollingcellularhealing.

**Unit 2: Histochemistryandtoxicology:8L**

1. Principle and methods of histochemical reaction and localization of the following: Carbohydrate moieties:by PAS (Periodic Acid Schiff) method; 2. Protein by bromophenol blue method; 3. Lipid moieties by Sudanblack B method, 4. Nucleic acid: by methyl green pyronin method. 5. Enzymes: alkaline phosphatase bymetal precipitation method, cytochemical detection of calciu; 6. Basic concept and scope of toxicology, 7.Toxicity

principle and methods, 8. Different types of toxicity test (chronic, subchronic, acute, subacute); 9.Dose response relashionship, calculation of LD50, LC50, ED50, TI Index.; 10. Food toxicant and their controlmethod;11.Metaltoxicityon animal.

**Unit3:Bioinstrumentation-1**

1. Principle, different types of centrifugation (differential, density gradient and ultra centrifugation) andbiological applications. 2. IR and NMR spectroscopy. Principle and application in biology. GM tube andliquid scintillation counter, 3. Microscopy-a) principle of microscopy and application-Bright-fieldmicroscope, Dark-field microscope, b)Phase-contrast microscope, 4. Principle& application of a)Fluorescence microscope, Confocal microscope , b) electron microscopy (SEM & TEM) , 5**.**Spectrophotometrictechniques– principlesandbiologicalapplicationsof UV, Atomic absorptionandmass spectroscopy , 6**.**Chromatographic techniques – principle and types, applications of Gel filtration, ion-exchange, column, TLC, GC, HPLC; affinity of chromatography 5. Principle and application ofautoradiographytechniques

**Unit4:Bioinstrumentation-1I(8L)**

**1.** Electrophoresis techniques – principles and applications of Agarose- and polyacrylamide gel, Two-dimensional (2D), Isoelectrofocussing electrophoresis. **2.** PCR techniques- RT-PCR & QPCR, principle &application. **3.** Flowcytometry-principle & bio- application, **4.** Microarray techniques, 5. ELISA, 6.Flourescenceinsitu hybridization(FISH) technique.

**PRACTICAL: Credit: 1**

1. Preparationofcommonlyused fixative, stain,vitaland supra vitalstain.
2. Histological preparation of tissue for microtomy technique. Paraffin (Necrotization, fixation,dehydroxation,
Clearing, parraffin embedding of tissues from any vertebrate specimen, sectioning of paraffin block,stretchingandspreadingsectionsonslides).
3. Histologicalstainingof paraffin tissue sectionusingH &Emethod.
4. Supravitalstainingof bloodcells/spleen.
5. Histochemicaldetectionofglycogen,acidic glycoproteinbyPASandAlcianblue (pH2.5)techniques.
6. Histochemical detectionofalkaline phosphataseinsitu.
7. Histochemical/cytochemical detectionofnucleic acid(DNAandRNA) bymethylgivenpyrominmethod
8. Detection ofDNAbyFeulgen method.
9. Cytochemicaldetection-SHgroupfor bloodsample
10. Study of histopathological and cytopathological changes. Cells or tissue samples from permanent slidesor photographs (cytomorphology blood, carcinoma cell, tissue necrosis and degenerative changes,fattyinfiltration,cytolysis).
12.Microscopic measurementof cellbyocularandstagemicrometer.

**Booksrecommended:**


1. Bancroft,J.D.&Stevens,A.TheoryandPractice ofHistologicaltechniques,Churchill-Livingstone,2002
2. Casselman,W.G.B.:Histochemicaltechniques,JohnWiley,1959
3. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones,1980-1993
4. Nelsonet al:. LehningerPrinciplesofBiochemistry(3rdEd.),MacMillan Worth,2000
5. Berget al.:Biochemistry(5th Ed.),Freeman,2002
6. Mathewsetal.:Biochemistry(3rd Ed.),Pearson,2004
7. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D B Peakall(Eds.),Taylorand Francis,NewYork, NY.
8. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu. Lewis publishers,Florida.
9. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –HillInternational edition. Singapore.


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**PAPER:ZOO903C (Core)**
**ENDOCRINOLOGYAND BEHAVIORALSCIENCE**
**(Credits:3+0+1=4)**

**Learning Objectives:**

The endocrinology section is designed to provide a thorough understanding of nom mammalian and mammalian endocrinology, as well as the physiological roles of the endocrine system. The section on animal behaviour focuses on the fundamental concepts of animal behavioural patterns.

**Learning Outcomes:**

At the end of this course students should enable to

**CO1.** Understand the role of different hormones in human physiology along with their biosynthesis in the body.

**CO2.** Understand and analyse animal behaviour.

**CO3.** Understanding the functioning and importanceof biological clocks

## A. ENDOCRINOLOGY

### Unit1:Non-mammalianandmammalian endocrinology

**1. Non-mammalian2L**

1.Endocrinecontrolofmolting&reproductionininsect**,2**.Structureof Pineal gland&itsfunctions.

**1.2 :Mammalianendocrinology 12L**

1.Introduction to endocrine system & classes of hormones-peptide, protein, steroid & prostaglandins, 2.Endocrine cells of pancreas, pancreatic hormones & its role in glucose homeostasis 3. Thyroid Gland-Biosynthesis of thyroid hormones, Control of secretion & their Physiological roles. 4. Adrenal gland- a) itssecretion, physiological action of adrenal hormones b) Adrenal Medullary hormones-Catecholaminebiosynthesis, release and its physiological roles, 5. Synthesis of steroid hormones & synthesis ofcorticosteroid hormones, 6. Role of parathormones in Calcium & phosphate homeostasis, Hormones assecondmessenger.

### Unit2: Reproductiveendocrinology10L

1. Testis- Organization, Physiological roles of androgens & inhibin, Ovary- Organization, Physiologicalroles of Estrogen, Progesterone, Relaxin&Inhibin. 2. Human reproductive pheromones, role of pheromonesinpuberty, Physiologicalchanges &hormonalregulationof onsetpuberty3.Placentalhormones,

### Unit3: Endocrinedisorders6L

1. Overview of endocrine disorders-a).Pituitary gland- Acromegaly & Diabetes incipidus b). Thyroid gland-Goiter &Myxoedema c). Parathyroid gland- Osteoporosis d). Islets of Langerhans- Diabetes mellitus e).Adrenalgland-Cushing’ssyndrome

f).Ovary&femaleinfertility-Polycysticovarian disease g). Obesity

## B. ANIMALBEHAVIOUR

**Unit4:Behaviouralbiology(18L)**

**4.1:BiologicalRhythms& control:6L**

1.Definition & types of rhythms, Zeitgebers, circadian rhythms, Basic types of exogenous rhythms in thehuman and their significance, Photoperiodism, annual and lunar periodicity. 2. Role of melatonin &neurotransmitters in circadian control, Role of SCN in the human, photic andnon photic pathways,pacemaker function oftheSCN.

**4.2:Mimicry&coloration: 3L**

1.Definition ofmimicry&coloration,Typesof mimicry, Batesion and mullerianmimicryand significance.

**4.3 :Interspecificrelationship: 2L**

1.Definitionof Interspecificrelationship,Aggregationsandsocialorganization.

**4.4 Animalbehavior& pattern: 7L**

1.Animal behavior-innate or inherent behavior, learned behavior, vision and behavior, sound and behavior,Social behaviour: mating, family, and group behavior, advantages of social behavior, Habitat selection andforaging behavior 2. Genetic, hormonal and evolutionary aspects of behavior. 3. Sexual conflict &Sexualselection: a) intra sexual selection (male rivalry), b) inter-sexual selection (female choice), c) infanticide,sperm competition, d) mate guarding, sexual selection in human, e) consequences of mate choice for femalefitness,f) monogamousversespolygamous sexualconflict.4.Parentalcare.

**PRACTICAL:Non-mammalianandmammalianendocrinology andbehavioral science Credit:1**

1. Dissectionofpituitarygland fromsuitable marketed fish
2. Demonstration of thyroid , adrenal, pancreas & gonads of any suitable vertebrate specimen throughdissection
3. Dissectionsofneuroendocrine complexininsect(cockroach)
4. Parabiosis(parabiotic behavior)incockroach
5. Studyofhistologicalpreparation ofpituitary&thyroid gland
6. Study of pituitary, thyroid, parathyroid, pancreas, adrenal, testis & ovary of mammal through permanentslides
7. Castration&ovarioctiomizationin rat
8. Identificationof gonadotropininhumanurine sample
9. Effectofinsulin/adrenalineonblood glucose level inrats
10. Studyof medianthresholdconcentrationof sucrose/glucosesolutionineliciting feedingresponseinants
11. Methylenebluevisualization ofsensoryneuronsinDrosophila
12. Recording&analysisofinsect(cricket)&birdscalls
13. Studyofsocialinsectcolonies

14. Studyoflaboratorybehaviorinmicebyusingzigzagor T-shapedmaze
15. Tostudythegeotaxis behaviorofworm
16. Tostudyorientalresponsesof 1stinstarlarva ofphotostimuli

**Booksrecommended:**


1. ComparativeEndocrinologyof InvertebratesbyHighman and Hill.
2. 2Comparative VertebrateEndocrinologybyP.J.Bentley,Cambridge Univ.Press.
3. 3Generaland Comparative EndocrinologybyE.J.W.Barrington, Oxford ClarendanPress
4. 4EndocrinologyVol.1-3byDeGroot L.J.et.al.
5. 5Text BookofEndocrinePhysiologybyC.R.Martin, Oxford Univ.Press, NewYork.
6. TextBookofEndocrinologybyTurnerandBangnara(W.B.Sanders).
7. VertebrateEndocrinologybyMc.Hadley.
8. Text Book of Comparative Endocrinology by Gorbman A, and Bern H.A., John Harley and Sous, NewYork.
9. Alcock: Animal Behaviour-An EvolutionaryApproach.(7thed.) SinaurAssociates, Inc. 2001.
10. Drickamer&Vessey:Animal Behaviour – Concepts,ProcessesandMethods(2nded.),Wadsworth,1986.
11. Gadagkar: SurvivalStrategies-CooperationandConflictinAnimalSocieties.UniversitiesPress,1998.


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**(Special Paper)**

**PAPER:ZOO904SP1**

**CELL&MOLECULAR BIOLOGY -I**

**(Credits:3+0+2=5)**

**Learning Objectives:**

This course aims to provide a detailed understanding of cell biology covering all the basic structure and dynamicity of cell, cell communications, cell signaling and details about cancer cell and apoptosis. This paper is the part of the specialization in cell and molecular biology. Therefore, this paper aims to cover the foundation of the subject.

**Learning Outcomes:**

Upon completion of this course students should be able to-

**CO1.** Understand and interpret structure and dynamicity of cell.

**CO2.** Have clear knowledge about the cell communication and signaling.

**CO3.** Have understanding about protein sorting and transport.

**CO4.** Understandand get prepared for advanced cell and molecular biology.

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## A. CELLSTRUCTURE& DYNAMICITY

### Unit 1: Cellstructure&Cellcycle (23L)

#### 1.1 : Cellcytoskeleton:5L

1.Prime cytoskeletal proteins & functional roles 2. Assembly & disassembly of microtubules, dynamicstability of microtubule proteins, molecular motor, cargo protein 3. Actin structure, polymerization & actinbindingprotein4.Intermediateprotein (laminin)&rolein evolution ofcellular regulation.

#### 1.2:Chromosomestructure: 7L

1. Circular & linear chromosomes, Ultrastructure of chromosome based on different models (multiple strand,single strand, unineme, molecular model, 2. Variations & abnormalities in chromosome structure & number (breakage, fusion-bridge cycle, deletion, duplication, translocation, aneuploidy, polyploidy) 3. Satellitechromosome & satellite DNA 4. Role of centromere & telomere in chromosome & Chromosomecondensation 5. Nucleosome & its phasing 6. Sex determination & dosage compensation & Mitochondrialinheritance

#### 1.2: Cellcycle, cancer&apoptosis: 5L

1.Cellcycle-molecular basisofmitosis&meiosis,mitoticinhibitors2.Cyclins&CDKsincellcyclephases & Molecular mechanism of M-CDK activation 3. Genetic regulation of cell cycle, deregulation led tocancer 4. Molecular basis of cellular checkpoints & their roles in cell 5. Synaptonemal complex &recombination molecule 6. Ageing: Cellular & molecular mechanism of ageing, genetic control, Oxidant as amajorcontributorto cancer&ageing.

**1.3 Cancer& apoptosis- 6L**

1. Epidemiology, causes, properties & types of cancer 2. Proto-oncogene & viral oncogene, mechanism ofoncogene activation, Tumor marker & tumor suppressor genes 3. Molecular approaches in cancer therapy 4.Apoptosis & pathways (Caspases 5. BCl2, P53, Bax & BAK gene activation pathways of apoptosis,Mitochondrial pathways ofapoptosis).

**Unit 2: Cell signaling & communication (13L)2.1: Cellsignaling &receptors: 4L**

1.Cell signalingmolecules&forms of intracellular receptors, Surfacereceptors &cytokinereceptors 2.

Mechanism of signaling from plasmamembrane to nucleus 3. Signal amplification &signal transductionpathways(JAK-STAT, MAPkinase, RTK &RAS, TGF signaling,Wnt &Hedgehogpathways).

**2.2:Cellcommunication5L**

1. Cell-cell adhesion by cadherin & selectin 2. Cell junction & organization (Tight junction, Gap junction,anchoring, 3. Cell- matrix interaction-integrin, collagen & fibronectin 4.Focal adhesion & desmosome,Extracellularmatrix,5.Compartmentalization ofcellorganelle&peroxisomes

**2.3:Protein sorting& proteintransport 4L**

1. Insertion of protein in ER, intracellular& molecular mechanism of protein transport (Golgi trafficking,Calthrin Cop I & Cop II mediated transport), 2. Receptor mediated endocytosis & Regulatory protein intransport(SNARF &Rabprotein), Lysosomal assembly&function.

## B. MOLECULARCYTOLOGY

**Unit 3:DNAdamage &repairmechanism5L**

1. Free radicals & damage to DNA & nucleoprotein, DNA damage by photosensitization 2. High fidelity ofDNA sequence & Concept of eukaryotic DNA repair system ( Direct repair, mismatch repair, basic excisionrepair,recombinantrepair)3. RoleofDNApolymerases inerrorcorrection ofreplication.

**Unit 4:HumanMolecularGenetics 7L**

1. Basic attributes and polymorphic structures in human protein coding genes. 2. DNA polymorphism (Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Basic concept in Molecularphylogenetics) 3. Molecular biology in forensic science: (Protein comparisons, DNA comparisons, RFLPs,geneticfinger-printing, VNTRs) 4. Human genome projects &age ofgenomics.

**PRACTICAL:Credit:2**

**(Cellstructure,Dynamicity,MolecularCytology)**

1. Totalleucocyte,erythrocyteanddifferentialcount ofleucocyte.

2. Preparation & study of effect of colchicine treatment on the behaviour of mitotic chromosome in onionroottip/ mouse bone marrow.

3. Preparationofsexchromatin(Barr body)fromhumanbuccalepithelium.

4. Preparation of chromosome bending pattern (G-C) from the mitotic chromosome preparation from themammalian blood/bone marrow.

5. Supra-vital stainingoflivingcellfromblood/liningprotozoan/spleen

6. Detection of localization (changes in epithelial cell, liver/kidney) of some cell organelle (mitochondria,Golgi -in situ)fromthechickepithelialcell/liver/kidneycellsbyusingspecificstain.

7. Histochemicallocalizationoflipidperoxidasegranules.

8. Identification and localization of nucleolar organizer region (NOR) on polytene/bone marrowchromosome.

9. Preparationofcellsuspensionand assays(countof)viable cells bytryphaneblue exclusion.

10. CellviabilitybyMTTassays/Assayingof phagocytosisinmouse macrophage.

11. Assayingofapoptosisin mousethymuscellbyacrilineorange andpropidiumiodinestaining.

12. Cytochemical/ histochemical detection of lipid granules by Sudan Black method from blood/animaltissue.

13. Studyofbehaviouralresponseoferythrocyte celltodifferentconcentrationsofphysiologicalsaline.

14. Determinationof oxidativestressenzyme SOD/LPO/Catalase.

15. Identificationofdifferenttypesofcancer cellsfrompermanentslides

*16.* Studyof mutantvarietyof*Drosophila*

17. Practicalrecordbook&vivavoce.

**Booksrecommended:**


1. G.M.CooperandR.E. Hausman:TheCell,AMolecularApproach. 5thEd.ASM Press(2009)
2. Bostock&Sumner:EukaryoticChromosome (North-Holland,1987)
3. Karp:CellandMolecularBiology(JohnWiley&Sons, 2002)
4. Lewin, GenesVIII(Wiley,2004)
5. Lodish etal:MolecularCellBiology(Freeman, 2000)
6. Pollard& Earnshaw: Cell Biology(Saunders, 2002).
7. Albertsetal: MolecularBiologyof the Cell (4thEd.), Garland,2002
8. A.Paul:CellandMolecularBiology,BooksandAllied(P) 2nd Edn.(2009)
9. Lodish etal:MolecularCellBiology(5th Ed.), Freeman, 2004
10. DeRobertis&DeRobertis:Cell&Molecular Biology,Lea &Febriger,1987
11. Friefielder:MolecularBiology
12. Darnell,LodishandBaltimore:Molecular cellbiology(Scientific AmericanBooks)
13. H.D. Kumar:Molecularbiology

14. W.H. Elliotand D. C.Elliot: Biochemistryand molecular biologyby(OUPress)
15. G.Plopper,D.Sharp,E.Sikorski:Lewin’s Cells,3rdEdn.JonesandBartlett Learning.

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**PAPER:ZOO904SP2**

**ECOLOGYANDWILDLIFEBIOLOGY– I**

**(Credits:3+0+2=5)**

**Learning Objectives:**

The purpose of this course is to introduce students to abiotic and biotic interactions in ecosystems, with a focus on environmental variables and different levels of organisation in the ecological hierarchy. Starting with species diversity, this course delves into system stability, ecosystem productivity, and biogeochemical cycling. It also sheds light on various livelihood issues associated with tangible and intangible ecosystem services.

**Learning Outcomes:**

Upon completion of this course, students should able to

**CO1.** Understand basic pattern of interaction between environmental variables and biota with special reference to limit of tolerance.

**CO2**. They will be able to link the different levels of organization in ecology with the basic ecosystem functions.

**CO3.** The understanding of the livelihood issues will make students more scientific in their approach while implementing conservation action plans at all scales.

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**Unit 1— Environmental variables and limits,**
**Community (14L)1.1— Environmental variables**
**andlimits7L**

1.Organismand its environment:Limits ofTolerance ,2.Adjustment to tolerant limit,3. Interaction
betweenenvironmental variables,4. Macroandmicroenvironments.

**1.2—Community(7L)**

1.Community and ecosystem; community level organisation, 2. Analysis of food web design, nutrientflow within community, 3. Niche relationship, parallel and niche overlaps and competition, nicheseparation,4. Population structure, populationcycles in invertebrates.

**Unit2-Speciesdiversityandcoevolution, Stability(13L)**

**2.1-SpeciesDiversity(7L)**

1.Diversity as a descriptor of ecological community, 2. Measures of the diversity, factor promotingspecies diversity, 3. Co-evolution, plant-insect interaction, larger herbivores population, 4. Theories ofdiversitiesand factorspromotingspecies diversity

**2.2-Stability (6L)**

1.Definition, stability of single species, two three species system, 2. Diversity and stability, May'sparadox,3. Stabilityoffood web design, 4. Energeticofstablesystem

**Unit 3: Ecosytem and its Productivity, Energy and Mineral**
**cycle (14L)3.1- Ecosytemand ItsProductivity (7L)**

1.Typesofforests,wetland andgrassland, 2.Ecosystemproductivity,3. MethodsofAssesementof

EcosystemProductivity,4.EcosystemGoodsandServices,GreenIndia Mission

**3.2 Energy andMineralcycles(7L)**

1.Energy flow model, application of law of thermodynamics, 2. Hydrological, mineral cycle, 3.Artificialinputsinecosystemandits impact,4.Soil: structure,characteristics andagriculturalpractices

**Unit 4— Ecosystemserviceandlivelihoodissues(7L)**

1.NTFP (Non timber forest product), Rural employment and ecosystem services, MGNREGA, 2. Forestright act, biodiversity act 2002, IPR, Ramsar conventions, 3. Wetland and forest ecosystem service, 4.Climate change- expectedimpact onecosystem service, pollinators

**PRACTICAL:**

1. Ecologicalsamplingandcensus techniques
2. Fieldequipments onpopulation studyand analysis,cameratrapping
3. Estimation of density, frequency and abundance of animals/ plants in a community using transect/quadratemethods.
4.Study of diversity index/
dominance index5.GIS,GPSand
RStechnology.
6.PracticalRecordbook andViva voce

**BooksRecommended:**


1. Anathakrishnan:Bioresourcesecology, Taylor and Francis, 1982
2. Bouhey:Ecologyofpopulations,(2nd edition)Macmillan,1973.
3. Dowdoswell:Anintroduction toanimalecology,Methien, 1967.
4. Kormondy: Conceptsofecology,Prentice-Hill, 1984
5. May: StabilityandComplexityin Modelecosystems (Vol.6th). Princeton universitypress, 1974
6. Odum: FundamentalofEcology(5thedition),Thomas Brooks/Cole, 2005.
7. Pawlosuske:Physico-chemicalmethodsforwaterandwastewatertreatment (vol19)Elsvier,1982.
8. Wetzal:Limnology:LackandRiverEcosystem(3rd edition)Academicpress2001.
9. Arora : Fundamentals ofenvironmental biology
10. Anathakrishnan:Bioresourcesecology,Kalyani publishers1985.


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**PAPER: ZOO904SP3**
**ENTOMOLOGY–I**
**(Credits:3+0+2=5)**

**Learning Objectives:**

Insects are considered as an important subject under phylum Arthropoda. Entomology comprises basic information relating to insect diversity, taxonomy. Also, different ethnozoological and ecological aspect relevant to medical and forensic entomology are being taught under this course.

**Learning Outcomes:**

Upon completion of the course students should be able to-

**CO1.** Understand the classification and identification of insects.

**CO2.** Understand various morphological characters of insects and its modifications.

**CO3**. Know the diversity and ecological correlates of insects.

**CO4**. Know the application of insects in various fields like medical and forensic science.

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**(INSECTSTRUCTURE ANDFUNCTION, ECOLOGY)**

**Unit 1 :5L**

1. Modern scheme of classification of insects, distinguishing characters, general biology, habit andhabitats ofinsectorders.

**Unit2 :Insect morphology**16L

1. Head – origin, structure and modification – types of mouthparts, antennae, tentorium and necksclerites; 2. Thorax – areas and sutures of tergum, sternum and pleura, wings: structure andmodifications; venetion, wing coupling apparatus and mechanism of flight, legs: structure andmodification – mechanism of walking; 3. Abdomen – segmentation and appendages; genitalia and theirmodifications.

**Unit 3:5L**

1.Structureand functionof– thevisual organs, thesenseorgansand the effectororgans in insect.

**Unit4:Insect diversity andecology**15L

1. Abundance and diversity of insects; reasons for success. Basic principles of abiotic factors and theirgeneralized action on insects. Biotic factors – food as a limiting factor for distribution and abundance; 2.Life tables and their application to insect biology. Survivorship curves. Population dynamics – factorseffecting abundance; environmental factors, dispersal and migration; 3. Insect plant interaction; hostplant selection byphytophagous insects, signsofdamagecaused byforestinsects.

**Unit5 :Medicalentomology**7L

1. Insect of medical importance (Life cycle and control) – Mosquitoes (Aedes, Anopheles, Culex); flies(housefly, horsefly, tsetse fly and sandfly); 2. Study of viral diseases – Dengue, Malaria, Kala-azar,JapaneseEncephalitis, chikungunya,zika; 3. Insect in forensicscience.

**PRACTICAL: Credit-2**

1. Mountingofmouthpartsofmosquito,cockroach,butterflyandhoneybee

2. Mountingoflegs, antennaeand wings (at leastoftwo types)

3. Preparationofarolium,empodium,tentoriumandpollenbasket.

4. Identificationofmedicallyimportantinsects.

5. Studyofinsectcollectingdevices.

6. Studyofmethods ofinsectcollectionandpreservation.

7. Field visit to Agricultural field/Wild life institute/National Park/Forensic lab visit and submission offieldreport.

8. Practicalrecordbook.

9. Vivavoce.

**BooksRecommended**


1. *Ageneraltext book of entomology*, Imms, A. D.,Chapman and Hall,UK

2. *Introduction to the study of insects*, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M SaundersCollege Publication, USA

3. *PrinciplesofInsectMorphology*,Snodgrass,R. E.,CornellUniv.Press,USA

4. *Host Selection by Phytophagous insects*, Bernays, E. A., and Chapman, R. F., Chapman and Hall,NewYork, USA

5. *Insect Plant Biology*, Schoonhoven, L. M., van Loop, J. A., &Dicke. M. Pub. Oxford Univ. Press.USA

6. *Insects:StructureandFunction*. ChapmanRF.1998. ELBSEd.,London.

7. *The Insects:Structure,Function andBiodiversity*. DuntsonPA.2004.Kalyani Publ.,New Delhi.

8. *Physiology ofInsects*. PatnaikBD. 2002.Dominant, NewDelhi.

9. *Entomology.*10th Ed.Vol. 1.*Structure, Physiologyand Development.*Chapman &Hall, NewYork.

10. *Entomology ata Glance*.Saxena RC&Srivastava RC. 2007Agrotech Publ.Academy, Jodhpur.

11. *Ecology: Principles & Applications*. 2nd Ed. Chapman JL & Reiss MJ. 2006. Cambridge Univ.Press, Cambridge.

12. *AdvancesinInsectBiodiversity*.GuptaRK.2004.Agrobios,Jodhpur.

13. *InsectEcology*.3rd Ed.PricePW.1997. JohnWiley, NewYork.

14. *Ecology of Insects: Concepts and Application*. Speight MR, Hunta MD & Watt AD. 2006. ElsevierSciencePubl.,TheNetherlands.

15. *Modernentomology*2014.ThembraeDB,HimalayanPublishingHouse

16. *Biology of DiseaseVectors*,2ndEd;MarquadrtWC, 2004, ElsevierAcademicpress

17. *Medical entomology* : A textbook on Public Health and Veterinary Problems Caused by Arthropods,Revised Edition,Edited byBruce EldridgeandJohnEdman

18. *MedicalandVeterinary Entomology*Mullen,G.,Durden,L.,A.


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**PAPER:ZOO904SP4**

**FISHBIOLOGYANDFISHERYSCIENCE–I**

**(Credits:3+0+2=5)**

**Learning Objectives:**

Fishes are considered as an important subject under aquaculture. Fish biology and fishery science comprises basic information relating to fish diversity, fish physiology both in terms of morphometric and meristic counts. Also, different genetically relevant topics viz., fish barcoding can be assessed and learnt. Basic and advanced knowledge pertaining to fish culture can also be gathered along with different techniques of fish breeding.

**Learning Outcomes:**

Upon completion of the course students should able to-

**CO1:** Understand the most important outcomes underlines the assessment of diversity in relation to identification and classification of species.

**CO2.** Understand the basic anatomy and structures of various fish fauna along with its physiological phenomenon.

**CO3.** Know the different culture practice along with feeding formulations under the heading of aquaculture.

**CO4.** Know advance techniques related to fish breeding.

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**(TAXONOMY,ANATOMY, PHYSIOLOGYAND OSTEOLOGY, AQUACULTURE)**

**Unit 1. Taxonomy(5L)**

1.Taxonomic characterisation, taxonomic keys, taxonomic methods for identification of freshwaterteleosts,2. Molecular taxonomyinfishes.

**Unit2. Anatomy,Physiology andOsteology11L**

1.Overviewofexternaland internalfish anatomy,Major anatomicalfeatures ofdifferent typesoffishes,

2. Sensory and related anatomical features of fishes, 3. Skin, Scale and Fins of freshwater fishes, 4.Digestion: digestive system and feeding types in fish, 5. Respiration: Structure and function of gills,accessory respiratory organs, 6. Excretion: Kidney: structure and function, osmoregulation in freshwaterand marine teleost, 7. Reproduction and development of teleost, 8. Osteological study of skull, pectoralandpelvicgirdle, vertebralcolumnoffreshwaterteleost.

**Unit3.AquacultureI16L**

1.Scopes of aquaculture including fisheries, 2. Types of aquaculture (warm and cold water), aquaculturesystems (monoculture, polyculture, semi-intensive, intensive culture, monosex culture), 3. Fish breedingtechnology(induced,hatchery,hapa,bundhbreedingandstripping)anditsimportance,4.Integratedfish farming (paddy cum fish, duck cum fish, pig cum fish, fish cum livesock), 5. Composite fishfarming: methods and importance, 6. Culture of ornamental fishes (exotic and indigenous) and theirimportance.**, 7.** Aquatic weeds, 8. Larvivorous fishes, 9. Threatened and endemic fishes of NortheastIndia withspecialreference to Assam,10.Fishgenetic diversity, conservationmethodsandstrategies.

**Unit4. Aquaculture II16L**

1.Types of capture fishery resources, 2. Fishery resources in major river systems of India with specialreference to Brahmaputra and Barak river system, 3. Hill stream fisheries: Mahaseer fisheries, 4. Floodplain wetland (beel) fisheries of Assam, their problems and management, 5. Fundamentals of marinefisheries (Sardine and Meckerals), 6. Fishing gears in inland fisheries and fishing crafts in marinefisheries., 7. Migration of fish, 8. Sewage fed fisheries, 9. By-products of fish, 10, Transportation of fishseedand fishes, 11. Principleand practice offish preservation, processingandcare.

**PRACTICAL:Credit- 2**

1. Morphometricandmeristic analysis ofteleost.
2. Studyof skeletal systemoffreshwater fishes.
3. Dissections:Accessoryrespiratorysystem of*Anabas*sp.,*Channa*sp. and*Heteropneustes fossilis.* Urino-genitalsystemofcarp, Weberianossiclsofcarp, IXthandXth cranialnervesin carps.
4. Induced breedingtechniquesofIMC.
5. Identification ofornamentalfishesoffreshwater withreasons up toorder.
6. Identification offreshwaterexoticfisheswithreasonsupto order.
7. Identification offishesofthe riverBrahmaputrawithreasonsup toorder.
8. Identification ofmarinewater fishes.
9. Studyoffishinggears usedinAssam.
10. Submission offish specimens representingdifferentgroups(at least10noumbers).
11. Submissionoffish skeleton representingdifferent groups.
12. Visittofishfarm, wetlandswithin Assam.

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**(OpenElective)**
**PAPER:ZOO905 OE1**

# GENERALTOXICOLOGY–I

**(Credits:3+0+1=4)**

**Learning Objectives:**

General toxicology aims to study the possibility of chemical causing negative health effects following a single or multiple exposures, whether accidental or intentional. The kind and intensity of the effects are determined by elements such as the toxicity mechanism, chemical bioavailability, exposure route, and the amount of chemical a human or animal is exposed to. When designing and conducting general toxicological research, all of these issues must be taken into account.

**Learning outcomes:**

Upon completion of the course students should able to-

**CO1:** Demonstrate a knowledge of toxicology's key principles, such as hazard identification, exposure assessment, dose-response assessment, and an understanding of toxic substances' mechanisms of action and consequences at many levels of biological organisation.

**CO2.**Demonstrate an awareness of the relevance of risk analysis, management, and communication in the field of toxicology. Students will be able to recognise and debate current toxicological issues.

**CO3.** Know the technical aspects and experimental approaches in toxicological research, testing, and risk assessment.

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## Unit1:INTRODUCTIONTOTOXICOLOGY(11L)

1. Definition, Scope and sub division of toxicology. 2. Classification of toxic agents, 3. Dose, Dose effect andDose response relationship – Acute toxicity and Chronic Toxicity. 4. Factors affecting toxicity 5. AbsorptionandDistributionoftoxicants

## UNIT2: BIOCHEMICALTOXICOLOGY 10L

### 2.1. Mechanismoftoxicity

1.Reaction of toxicants with target molecules 2. Cellular disrepair and repair mechanisms. 3. Lipidperoxidation– ROS and RNS, Superoxide, Hydrogen Peroxide and Hydroxyl radicals in toxicity ofXenobiotics. 4. Oxidative Stres, 5. Xenobiotic induced alterations in intracellular calcium distribution,disruptionofcellularenergy production.6. IntroductiontoPhase IandIIreactions. 31

## Unit3:SYSTEMICTOXICOLOGY12L

### 3.1 Basics of Organ toxicity

1.Target organs, Organ selectivity and specificity.2. Hepatotoxicity- susceptibility of the

Liver, types ofLiverinjury and Biochemical mechanism.3. Pulmonary toxicity – Lung injury, Systematic Lung toxins, Lung,pathology4. Renal toxicity – susceptibility of the Kidney to toxicants, Chemical induced renal injury5. Neurotoxicity – Effect of toxic agents on Neurons,Axonopathy, Myelionpathy,ionchannel, neuro toxins, Lesions ofspecific neurons.

**Unit4:SYSTEMICTOXICOLOGYAND CHEMICALCARCINOGENESIS(15L)**

**4.1 ReproductiveToxicology :4L**

**1.** Reproductiveorgans,Chemicalsaffectingreproduction2.Teratogenecity.

**4.2 Endocrine toxicology :3L**

1.Toxicity of Adrenal,2.Thyroid and3.Pancreas.

**4.3 Bio-magnification,bio-transformationofxenobiotics**

**4.4 Genotoxicity:4L**

1. DNA interaction,2.DNAadductsandMutations3.DNA repair

**4.5 Carcinogenesis:4L**

1.Typesof carcinogens2.Mechanismsofaction

**PRACTICAL:(Allexperimentsinvolvinglive animalsare fordemonstrationonly)Credit:1**

1. DeterminationofLC50/LD50ofselectedtoxicant(bioassaymethod)
2. EffectofselectedtoxicantonPhaseI enzymeactivity (CytP450)(enzymaticassay)
3. EstimationofLPOactivitybyTBRASmethod
4. EffectoftoxicantonGlycogen,Glucose andAmino acids
5. Hepato-toxicanteffectonTotalBilirubinContent(directandindirectmethod)
6. EstimationofSGOT andSGPT as amarker enzyme for hepatotoxicity
7. Estimationof SerumCreatinineactivityasamarkerenzyme forRenal toxicity
8. Micronucleitest
9. Effectoftoxicantonspermmorphology

**RecomendedBooks:**

1. Principles of ecotoxicology- 3rd edition 2006, C H Walker, S P Hopkin, R N Sibly and D BPeakall (Eds.),TaylorandFrancis,NewYork, NY.

2. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu.Lewis publishers,Florida.

3. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –HillInternationaledition. Singapore.

4. Principlesof toxicology2010edition,AnjuAgarwalandKrishnaGopal,ibdcpublishersIndia.

5. Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency,New Delhi,India.

6. Principlesof BiochemicalToxicology-Jatimbrell;Taylor andFrancisLtd,London.

7. BasicEnvironmentalToxicology–LorrisG.Cockerham,BarbaraS Shane; CRCPress,London.

8. Hand book of Toxicology – Thomos J Haley, Willan O Berndt; Hemisphere Publishingcooperation,Washington.

9. Modern Toxicology (3 Volumes) - P K Gupta and Salunkha; B V Gupta Metropoliton BookCo., Ptv Ltd, NewDelhi.

10. EncyclopediaofToxicology – OP Jasra.

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**PAPER:ZOO1001C (Core)**

**EVOLUTIONARYANDAPPLIEDANIMALBIOLOGY**
**(Credits:3+0+1=4)**

**Learning Objectives:**

The purpose of this course is to provide students with a thorough understanding of how evolution works as well as a broad awareness of the most relevant research problems in evolutionary biology. Students will learn about all elements of evolutionary biology in this course. Again from the second part student will learn the basic principles involved in the culture and breeding of common edible and ornamental fishes; applications of insects in Medical&forensic field; Solid waste management,Organic farming and medicalapplication.

**CO1:** To understand the basic and advanced concepts of evolution and population genetics

**CO2.** To learn the conspts of molecylar evolution and its applications

**CO3.** To know and apply the knowledge of Zoology in understanding the importance of several animals from economic point of view

**CO4.** To learn about the medical zoology and its applications

**GENERAL AND MOLECULAR EVOLUTION(25L)**

**Unit 1:General evolution**
**(15L)**

**1. 1: Non-Classicaltheoryofevolution3L**

1. An overview of evolutionary thoughts, developments and the concept of synthetic theory 2. Basicconceptofsynthetictheorywith referenceto Hardy-Weinbergequilibriuminpopulations.

**1.2 :Othertheoriesofevolution7L**

1. Goldschmidt‘s concept of micro- and macroevolution; 3. Macroevolution & concept of phylogeneticgradualization 5. Speciation: Biological & phylogenetic species concept, allopatric speciation, sympatricspeciation&parapatric speciation,6. Reproductiveisolation mechanism.

**1.3 : Evolutionofeukaryotes:**
**5L**

1.Concept ofevolutionofeukaryotes 2.Zenith ofinsectevolution & Evolutionofsocialityininsectsociety

3.Evolutionaryoriginof fishes,tetrapod, bird&mammals.

**Unit 2: Molecular & genome evolution**
**(11L)**

**2.1:Molecular evolution5L**

1. Molecular concept of Origin of life &Origin of molecular divergence (protein& nucleotides); RNA world2.Conceptof evolution ofMolecularclock& moleculardrive.

**2.2: Genomeevolution6L**

1.Genome evolution: Evolution of multi gene family, Acquisition of new genes, Exon theory & mechanisms4.Gene duplication , Kimura's hypothesis & divergence, 5. Genetic variation in population, Causes ofgenetic variation, geneticpolymorphism& measuringgenetic variation

**B. APPLIED ZOOLOGY& AQUACULTURE (23L)Unit 3:Appliedentomology (9L)**

**3.1: Generalapplicationof insects 5L**

**1.** Insect as pollinators in agriculture 2. Role of insects in tropical forest ecosystem. 3. Lac & silk products&industrialeconomy3.Insect as bioreactors &insectincellculture

**3.2: Medical&forensicentomology4L**

1.Pests of public health importance and their control (Mosquitoes, house flies, bad bugs, fleas) 2. Insectbornediseases

**Unit 4: Economic zoology(14L**

**4.1. Generaleconomic zoology8L**

1. Solid waste management with vermicompose, 2. Organic farming 3. Biology and importance of finfish(Indian major carps, freshwater catfish) and shellfish (Prawns and shrimps). 4.Composition and nutritivevalue of raw fish, processed fish & preserved fish 5. Ornamental fishes, Exotic & indigenous ornamental fish&economicimportance, 6.Honeybeeproducts &economy.

**4.1: Medicalzoology 3L**

1. Preliminary knowledge on zoonotic diseases 2. Genetics of Neurological Diseases; Pharmacogenetics andapplication3.Venom&allargens-types, delivery&medicalapplication

**4.2:Aquaculture3L**

1. Integrated fish farming-(Fish cum livestock farming& paddy cum fish culture) 2. Polyculture of fish forhighyield3.Edible oyster &pearloyster.

**PRACTICAL:**

1. To study the copentadactyl limbs and common ancestry of vertebrates throughobservation offorelimbsand hindlimbmmon pattern of s(frog, Calotes,bird andmammal).

2. Identification of5 economicallyimportant insectspecimenbelongtodifferent order.

3. Identification and study of morphological differences of any three economically

important fishspeciesi.e., Majorcarps, exotic,indigenous, ornamentaland medicinallyimportant fishes.

4. Studyandidentificationofatleasttwo insectsandtwovenomous snakesand theirimpact.

5. Insilico analysis ofphylogenetictreeof5vertebrateanimals.

6. Estimationofprotein and lipid from edibleinsect/anymarketablefish.

7. To studythe median threshold concentration ofglucose solution infeedingresponseinants.

8. Study of learning behaviour in mice by using zig-zag or T-shaped maize/ To study the geotaxisbehaviour ofearthworm.

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**SPECIALPAPER:ZOO1002SP1**
**CELL&MOLECULAR BIOLOGY -II**
**(Credits:3+0+2=5)**

**Learning Objectives:**

This paper aims to provide detailed information about DNA structure and its organization along with its application in molecular biology. This paper is the final part of specialized study in cell and molecular biology and comprised of most of the related fields of cell and molecular biology.

**Learning Outcomes:**

Upon completion of the course students should able to-

**CO1.** Various structure of DNA and its organization in prokaryote and eukaryote.
**CO2.** Transcription and translation
**CO3.** Have a clear understanding about metabolic disorders.
**CO4.** Various applications of molecular biology such as tissue culture, stem cell biology etc.

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## A. MOLECULARBIOCHEMISTRY

### Unit1: MolecularBiochemistry(17L)

#### 1.1 : DNAstructure&reactionofDNA8L

1. Helix parameter of DNA (A, B, C and Z DNA), triplex DNA, Interrupted DNA & functional role 2.Biological significance of double strandness, DNA re-association kinetics ( Cot curve analysis) 3.Supercoiling of DNA & Topoisomerase I & II, C-value paradox 4. DNA replication (inhibition, elongation& termination) in eukaryotic & prokaryotic cells 5. Telomere shortening & its replication 6. Gene library –Construction of C-DNA & genomic library. 7.Isolation and sequencing of DNA, Maxam-Gilbert, Sanger'sdideoxymethods.

#### 1.2 : RNA& Transcription4L

1. Transcription in Prokaryote and Eukaryote 2. Transcription factors-RNA binding motif and proteins,Activators and repressor of transcription 3. Post transcriptional processing (Capping, Tailoring, splicing andalternate splicing, mRNA Stability, RNA degradation, RNA editing )4. Transcription Attenuation and RNAExport

#### 1.3 :Protein andTranslation 5L

1. Protein folding: enzymes for protein folding, processing and thermodynamics Ramachandran plot.Molecular chaperonin and chaperones 2. Prion structure and function. 3. Translation machinery: Translationin prokaryotic and eukaryotic, fidelity of translation and post-translational modification. 5. Proteinsequencingmethod.

## B:GENOMEORGANIZATION

### Unit2:GenomeOrganization andgeneexpression:8L

1. Organization of genome in prokaryotic and eukaryotic cells. 2. Genetic features of nuclear genome,organelle genome organization - mitochondria and chloroplast, virus genome and

mobile DNA element(Transposable element, IS element, P element, retrovirus and retro-transposome). 3. Mapping of genome –physical and genetic mapping. 4. Genome sequencing and High-throughput screening and sequencing {next-Gen},Geneticmarkers.5.Genome analysistechnique(RFLP,AFLP, RAPD,ISSR)and PedigreeAnalysis.
6. Gene silencing (DNA methylation and acetylation, doses compensation, histone code, RNA Interference,antisense RNA)and gene amplification.

**Unit 3: Molecular diseases: (6L)3.1: Neurodegenerativedise ase:**

1.Molecularpathwaystoneurodegeneration.2.Misfoldingandaggregationof diseaseproteins-Parkinson,
Alzheimer &Huntington'sdisease.

**3.2:Metabolicdisorders:**

1. Molecular mechanisms of metabolic diseases - inborn errors of metabolism, Alkaptonuria,Phenylketonuria

**C:APPLIEDMOLECULARBIOLOGY**

**Unit 4: AppliedMolecular Biology(16L)**

**4.1 :Cell& tissue culturetechnique 3L**

1. Cell culture media properties & preparation 2. Primary & secondary cell culture, continuous cell lines-lymphocytes & fibroblast cell culture, cell separation by FACS 3. Application of animal cell culture (in-vitrodrugtesting).

**4.2 : Stemcell biology 3L**

1. Properties and types of stem cells (embryonic, umbilical, adult), Haemopoietic stem cells and formation ofblood cells, bone marrow transplantations. 2. Stem cell disorders - Stem cell therapy, Stem cell and cancer,Stemcell research inIndia.3.Stemcellsandtissueengineering - ethical,legalandsocial implications(ELSI)ofstemcell technology.

**4.3 : Applicationof MolecularBiology10L**

1. Concept of System biology - Transcriptomics, proteomics, metabolomics, lipidomics, glycomics, andphosphoproteomics. 2. Nano biology & application - Elementary concept of nanotechnology and itsapplications, bio-inspired nanomaterials for a new generation of medicine and nanoscience in medicine,vaccine and delivery system, nanoparticles in medical detection and diagnoses. 3. Antisense and ribozymetechnology 4. Hybridization techniques – Southern- Northern hybridization, Chromosome painting, FISH,DNA chip technology. 5. Gene therapy & application - (Gene therapy for inherited immunodeficiencysyndromes,Cysticfibrosisand HIV-1genetherapy,Retroviralmediatedgenetransfer.)

**PRACTICAL:Credit- 2**

1. Preparationofdifferenttypesof buffer &cellculturemedia usedinmolecularbiology.

2. Proceduresof autoclavingofmaterialsrequiredin moleculartechniques.
3. DemonstrationofAgaroseGelElectrophoresis for DNAandits visualization.
4. Isolationof genomic DNA frommouseliver cell.
5. SDS-polyacrylamide GelElectrophoresisfor proteinandits visualization.
6. Short-termcultureofwholeblood&lymphocyteculture frommammalian blood/bonemarrowcell.
7. Histochemical detection of DNA by Feulgen reaction/DNA, RNA from animal tissues by Methyl greenpyronin method.
8. Biochemical estimation of DNA (diphenyl method) and RNA from blood and tissue collected fromslaughter house.
9. Biochemicalestimationofalkalinephosphatase&LDH.
10. Isolation ofmitochondria byultracentrifugationtechniquefromsuitabletissuematerial.
11. Insilicodesigningof primer 16sRNA,18sRNA,degenerate andspecificprimer,n/pblast.
12. Studyof molecular evolutionandconstrictionofPhylogenetictree,in silico.

13. InsilicostudyofDNA microarraytechnique.

14. Visittoadvancedlaboratory/institution(Reporttobe submitted)

15. Practicalrecordbook&vivavoce.

**Booksrecommended:**

1. T.A.Brown:Genomes3(2ndEd.),Geraldpublication,2009

2. J.D.Watsonetal.:Molecular BiologyoftheGene(4thEdn.)Benjamin/CummingsPubCo.(2010)

3. R.R.Sinden:DNAStructureandFunction,AcademicPress,1998

4. D.L.Hartl andE.W.Jones:Essential Genetics:A Genomic Perspective,Jonesand Bartlett(2002)

5. B.Lewin:GenesVIII,Prentice Hall; Tchedition(2004)

6. B.Albertsetal.GeraldPublications;6thEdn.(2014)

7. J.F. Atkins et al.: RNA Worlds: From Life's Origins to Diversity in Gene Regulation Cold Spring HarborLaboratory
Press,U.S;1stEdn.(24 September2010).

8. V. Ramamurthy and S. Raveendran, Fundamentals of Biochemistry, Aruna Publications, Koradacherry(2010)

9. J.L.Jain, FundamentalsofBiochemistry, S.Chandand Co. Ltd. New Delhi.

10. L.Stryer,Biochemistry, W.H.Freemanand Co.NewYork.(1988)

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**PAPER: ZOO1002SP2**

**ECOLOGYANDWILDLIFEBIOLOG**
**Y-II**
**(Credits:3+0+2=5)**

**Learning Objectives:**

This course is designed in such a way that it provides a detail understanding about wildlife management strategies and their implementation while conserving threatened faunal elements with special reference to northeast India. The course also provides insight on the need of studying wildlife behaviour as well as use of advance tools and techniques in wildlife studies.

**Learning Outcomes**:

By studying this course students will be able to
**CO1.** To learn various wildlife conservation laws
**CO2.** Apply conservation management strategies in the conservation actions.
**CO3.** Work on various conservation agencies with this thorough knowledge of wildlife conservation laws and techniques required to implement any conservation projects.
**CO4.** To learn about GIS and importance of wildlife conservation

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**WILDLIFEMANAGEMENTANDCONSERVATION (48L)**

**Unit–1:DefinitionsandActs, EcologicalRole ofWildlife(13L)**

**1.1 Definitionsandacts7L**

1) Wildlife Conservation Models, Human Wildlife Conflict and Its Impact on Natural Systems, Eco-Tourism, 2) Indian Constitution Provisions of Environment Protection, 3. CITES, CMS, LegalDefinitions of Forest, Biodiversity, Wildlife Crime, Conservation Breeding, Importance of DNA Bar-coding and Forensic, 4. Major Groups of Mammals, Social Structure in Elephants, Tiger, Gibbons, 5.Birds: Residential and Migratory birds, Endangered and Threatened birds of N.E India, MigratoryRoutes,6. Food and FeedingBehaviourof: Rhino, Gibbon,Golden Langur, Leopards, Pigmyhog.

**1.2 EcologicalRoleof Wildlife6L**

1) Mega Herbivore, Elephants as Ecological Engineer, Ecological Role of Water Buffalo, 2) Key StoneSpecies, Umbrella Species, Flagship Species: Its Importance and Its Conservation, 3) ForagingStrategies,Optimal ForagingTheory,4)EcologicalRoleofHerpato- Fauna andClimate Change .

**Unit-2: WildlifeHabitat,ConservationBiology(17L)**

**2.1 Wildlife habitat 8L**

1) PA Network in India, Other Habitat Conservation Initiatives: IBA (Important Bird Area), 2) HabitatConnectivity and Corridors, Source and Sink Population, Meta-Population, 3)

Habitat UtilizationPattern of Rhino, Tiger, Pigmy Hog, 4) Wetland and Grassland as Wildlife Habitat, 5) Man- AnimalConflicts:Cause, Impactand MitigatingMeasures,6) Man and BiosphereProgramme

**2.2:ConservationBiology9L**

1) Introduction of Conservation Genetics, 2) Genetic Management of Wild Population, 3) Genetics andthe Fate of Endangered Species, 4) Impact of the Reduction of Population Size: Loss of GeneticDiversity,InbreedingDepression.

**Unit– 3:Wildlife Services8L**

1) Principles of Wildlife Management in Kaziranga and Manas, 2) Ethics of Wildlife Management, 3)Development in the Use and Management of Wild Animals, 4) Estimation of Population Size andManagementofLargeHerbivores

**Unit -4: GIS for Wildlife Management, Wildlife Behaviour (10L)4.1:GISforWildlifeManagement 5L**

1)AssessmentandPlanningofWildlife, 2) WildlifeProtectionActs,Wildlife MonitoringthroughGIS,

3)WildlifeHealthand GISGeneratingMitigatingPassages,4)HabitatMapsUsingGIS

**4.2:WildlifeBehaviour5L**

1) BehaviouralStudiesofEndangered SpeciesofBirdsofN.EIndia, Its Relation toEcological Aspects,

2) Primates,Behaviour ofCappedLangur, StumpTailed Macaque,etc.in Wildlife Sanctuaries.

**PRACTICALS:**

1. Ecological sampling and census technique- Direct and Indirect methods. Field based studies of birdand butterflycensustechniques and speciesidentification

2. Studyofdiversityindex,dominanceindex

3. GIS, GPSand RStechnology

4. Soil analysis-N,P, K,macroandmicroanalysis,soil organiccarbon,moisture

5. Wateranalysis-TDS,Conductivity, TSS,BOD, Chloride,Fluoride

6. Plankton-Limnologicalstudies.

7. Data representation-Constructionofcomposite climatographandErgo graphs

8. TaxonomicStudy:Studyoflocalbirds/butterflies/herpetofauna.

9. Report onfieldvisittoBiodiversityricharea.

**RecommendedBooks:**

1. Wildlife Ecology and Management Author : Eric G.Bolen and William Robinson,Pearson; 5th Edition(July20, 2002 ).

2. SacredEcologyAuthor: FikretBerbes, Routledge;1stEdition ( March 2,2008).

3. Wildlife Ecology, Conservation and Management, John M. Fryxell, Anthony R.E. Sinclair, GraemeCaughley.Wiley– Blackwell: 3 rd Edition ( August11, 2014 ).
4. EssentialsofConservationBiology,RichardB.Primack.SinaeurAssociates,OxfordUniversity :6thEdition (May9, 2014).
5. Essential Reading in Wildlife Management and Conservation, Paul R. Krausman, Bruce D. Leopold ,JohnsHopkins UniversityPress ; (February7, 2013 ).
6. Traditional Ecological Knowledge and Natural Resource Management, Charles R. Menzies,UniversityofNebraskaPress:(November 1, 2006).
7. Forest Health and Protection, Robert L. Edmonds, James K. Agee, Robert I. Gara, Waveland Pr Jnc :2ndEdition, (May1, 2010).
Remote Sensing for Ecology and Conservation: A Handbook of Techniques (Techniques in Ecology &Conservation) : Ned Horning, Julie A. Robinson, Eleanor J. Sterling, Woody Turner, Sacha SpectorOxfordUniversityPress; 1stedition (August 20, 2010)

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**PAPER: ZOO1002SP3**
**ENTOMOLOGY- II**
**(Credits:3+0+2=5)**

**Learning Objectives:**

Insects are considered as an important subject under phylum Arthropoda. Entomology comprises basic information relating to insect diversity, taxonomy. Also, different ethnozoological and ecological aspect relevant to medical and forensic entomology are being taught under this course.

**Learning Outcomes:**

Upon completion of the course students should be able to-

**CO1.** Develop a deeper understanding of insect physiology and its functioning.

**CO2.** Understand the immunology of insect defense mechanism.

**CO3**. Know the basics of insect genetics and develop understanding in their developmental processes.

**CO4**. Learn the various aspects of pest management, insect toxicology and apply the knowledge in pest management strategies.

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**(INSECTPHYSIOLOGY& GENETICS; & PESTMANAGEMENT)(48L)**

**Unit 1:Insect physiology**20L

1. Structure and Physiology of – Integumentary and musculature system, digestive, respiratory andcirculatory system, excretory, nervous and reproductive system, 2. Endocrine system and functions:Anatomical organization, hormones, Endocrine control of growth and metamorphosis, reproduction,diapauses, 3. Glands and organs of secretion; Ectohormones: Pheromones and allomones, 4. Immunityin insects: Mechanism of innate immunity, antibacterial immunity; signaling pathways, antiviralimmunity: antiviral RNAi response, regulation of antimicrobial peptide gene expression by JAK-STATpathways;bacterial resistancetoinsect immunity.

**Unit2:Insect genetics**12L

1. Insect as genetic tool, 2. Genome study in insects: Expression of p-elements in Drosophila, 3. Geneticregulationofinsect development

**Unit3:Pestecology andmanagement**16L

1. Economically important pest and their status, nature of damage and control measures of pest ofcereals, pulse, crops, vegetables, fruits, sugarcane and stored grains, 2. Integrated Pest Management –concept of injury level, economic injury level, and economic threshold level. Tools of pest managementand their integration - legislative, cultural, physical and mechanical methods. 3. Chemical control –classification of insecticides on the basis of their mode of entry, mode of action and chemical nature;Organochlorines, organophosphates, carbamytes, pyrethroids and botanicals. Developmrnt of pesticideresistance, metabolism and degradation of pesticides – Phase I and Phase II reaction, 4. Hormonalcontol: concept and use of Juvenoids, ecdysoids and IGRs, 5. Biological control: Use of parasite andpredatorsand Use ofectohormonesinpest control,6.Geneticcontrolofvector borne diseases and pests.

**PRACTICAL: Credit2**

1. Dissectionofmale andfemale reproductivesystemofcockroach.
2. Dissection ofnervoussystem of grasshopper andcockroach.
3. Mountingofsalivaryglandsofcockroachandhoneybee.
4. Alimentarycanal ofhousefly.
5. Mountingofhepaticcaecaand Malphigiantubules
6. Mountingofstingapparatusofhoneybee
7. Dissectionofdrosophilaimaginaldisc, polytenechromosome
8. Preparationand identification ofhaemocytes
9. Detection ofurease
10. Detection ofchitin
11. StudyofmutantvarietiesofDrosophila
12. IdentificationofRicepest, Tea pest, vegetable pest, stored grainpestetc.
13. EstimationofLD50/LC50usinginsects
14. Visitto an advancelab/Institutionand submission ofreport
15. PracticalrecordbookandVivavoce

**BooksRecommended**


1. *TheInsects: Structure andfunction*,Chapman,R.F.,Cambridge UniversityPress,UK
2. *PhysiologicalsysteminInsects*,Klowden,M. J.,Academic Press,USA
3. *TheInsects, An outlineof Entomology*, Gullan,P. J. , andCranston,P. S.,WileyBlackwell, UK
4. *InsectPhysiology andBiochemistry*, Nation,J.L., CRCPress,USA
5. *TheCompleteBook ofpesticide management*,Whitford, F.,WileyInterscience,JohnWileyandSons,UK
6. *SaferInsecticides*, Hodgson,E., andKuhr, R.J., (ed), MarcelDekker Inc.,New York,USA
7. *Pesticide ApplicationMethods*,Matthews, G,A.,BlackwellScience,London,UK
8. *Pesticide BiochemistryandPhysiology*,Wilkinson,C.F.,PlenumPress,NewYork,UK
9. *Metabolic pathways of agrochemicals Part II*, Roberts, T. R., and Hutson, D. H. The Royal Society ofChemistry,UK
10. *Chemical EcologyofInsects*, Carde, R.T., andBell, W. J., Chapman&Hall, NewYork, USA
11. *Entomology&Pest Management*,Pedigo,L.P.,Prentice Hall,NewJersey,USA
12. *Conceptsof IPM*,Norris, Caswell-Chenand Kogan,Prentice-Hall, USA
13. *Agricultural insect's pests of the tropics and their control*, Hill, D. S., Cambridge University Press,UK.


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**PAPER:ZOO1002SP4**
**FISHBIOLOGYANDFISHERYSCIENCE-II**
**(Credits:3+0+2=5)**

**Learning Objectives:**

Fishes are considered as an important subject under aquaculture. Fish biology and fishery science comprises advance information relating to FishGrowth, FishPathology, FishGenetics.Also, different FisheryBiotechnology, Limnological aspect are also being taught under this course.

**Learning Outcomes:**

Upon completion of the course students should able to-

**CO1:** Understand the most important outcomes underlines the assessment of pathology in relation to their clinical aspects

**CO2.** Understand the advance Geneticsof fishes andFisheryBiotechnology.

**CO3.** Know the different limnological aspects.

**CO4.** To understand and apply the knowledge of fisheries in assessing the fish productivity

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**Unit 1: FishGrowth9L**

1.Factors controlling reproduction and development of fish. 2. The types of fish growth. Length-weightrelationship. Annual growth. Factors affecting the age and growth. Condition factor and theirsignificance. 3. Nutritional requirements of fishes: Protein, Carbohydrate, Fat, Vitamin and Minerals. 4.Feed manipulation in fish growth, growth promoter agents., 5. Hepatosomatic index, Gonadosomaticindex,Index offullness, Ponderal index, Index ofpropagation –their estimation.

**Unit 2:FishPathology7L**

1.Diseases: definition, disease problem of aquaculture, infectious and non-infectious diseases.2.Bacterial, fungal, protozoan diseases, their clinical symptoms and prophylaxis., 3. Diseases caused byother factors- hereditary, tumour ofhereditaryorigin, benign and malignanttumour.

**Unit 3:FishGeneticsandFisheryBiotechnology16L**

1.Cytogenetics of fishes. 2. Hybridization, Polyploidy, Androgenesis and Gynogenesis in fishes. 3.Population genetics and selection. 4. Sex determination in fishes. 5. Biochemical and moleculartechniquesand theirapplicationsin fisheries. Geneticbiotechnologyin fish healthmanagement.
Nutraceuticals and fish health, 6. Gene transfer and transgenic fish., 7. Hormonal biotechnology inaquaculture. 8. Cryporeservation technology. 8. Culture of fish cell lines. Germ cell transplantationtechniques.

**Unit 4:Limnology 16L**

1.Physical and chemical characteristics of fresh water: pH, DO, TA, TH, Free CO2. 2. Productivity ofwater bodies: primary, Secondary and Tertiary. Factors affecting primary production., 3. Plankton: itsimportance inaquaculture. Classification, Structuraldynamics

and seasonal variationofplankton.
Plankton sampling: collection, preservation and identification., 4. Benthos: collection, preservation andidentification. Nektons.

**PRACTICAL: Credits- 2**

1. EstimationofHI,GI,IF, PIand IP.
2. Studyofprepared slides ofdiseasecausingorganisms offresh water species.
3. Estimation ofphysicaland chemicalparametersof fresh water: pH, DO, CO2, TH.
4. Studyofpreparedslidesofplankton andtheirstructuraldynamics.
5. Studyofbenthicfauna of freshwater.
6. Estimationofrelative and absolute growth,LW relationshipandanimal growthmarks through scales.
7. Isolation ofnucleicacids from fish tissue/ blood.
8. Horizontal gelelectrophoresisforDNAestimation.
9. ProteinextractionfromfishtissueandestimationinSDSPAGE.
10. Spectrophotometricestimation ofnucleicacids andprotein.
11. Polymerasechainreactionfortargetedfishgene amplification.
12. Methodsofcloning.
13. *In-silico*: data retrieval and data submission tools, construction of phylogenetic tree, primerdesigning.
14. Visittoadvancedlaboratory/ institution/researchcentre ofIndia.

**RecommendedBook:**


1. Freshwater fishes oftheworld. Gunther.
2. Fish and fisheries. S. K.Gupta.
3. Limnology.Wetzal.
4. Fishbiotechnology. Naik and Rao. PacificBooksInternational, New Delhi.
5. Textbookoffishgeneticsand biotechnology.ICAR, NewDelhi.
6. Fisheries biotechnology. Lakra, Abidi, Mekherjeeand Ayyappan. NarendraPublishingHouse, Delhi.
7. Fundamentalsofenvironmentalbiology. Arora.
8. Limnology.Goldman.
9. Biologyoffishes. Boneand Moore.Taylore andFrancis Group,CRC Press, U.K.
10. The physiologyoffishes.Evans and Claiborne. .Taylore and Francis Group,CRC Press, U.K.
11. Physiologyoffishes.Brown.
12. Fishphysiology-recent advances.Nilsson.
13. Fish andfisheriesof India.Jhingran.
14. FishesofIndia.C. B.L. Shrivastava.
15. Anintroduction tofishes.S. S. Khanna.
16. Handbook offisheriesand aquaculture.ICAR,NewDelhi


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**(OpenElective)**

**PAPER: ZOO1003OP2**

**ADVANCED TOXICOLOGY–II**

**(Credits:3+0+1=4)**

**Learning Objectives:**

This course aims to study advance toxicological aspectsrelated to environmental, and industrial attributes. It aims to study the approach to ecotoxicology in ecosystems, Eco-toxicologyofheavymetals, Integrated approachto wildlifetoxicology, Bioremediation and prevention ofoccupationaldiseases.

**Learning outcomes:**

Upon completion of the course students should able to-

**CO1:** Predict harmful responses to representatives from important chemical classes in terms of target organs, physiological processes, and toxicity molecular pathways.

**CO2.** assess the risk of environmental and occupational risks..

**CO3.** Understand the technical principles of toxicological research, testing, and risk assessment, as well as experimental techniques.

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**ZOPEL-PG-402: ADVANCEDTOXICOLOGY-IICredit:3(48L)**

**Unit1:Environmentaltoxicology12L**

**1.1 Environmentalpollution:**

1. Sources and types of Pollution, important pollution events, 2. Scientific approach to ecotoxicology- entry,movementand fate ofpollutants in ecosystems.

**1.2 Eco-toxicologyofheavymetals:**

1.Mechanismof heavy metaltoxicity,2. CasestudiesofArsenic,Mercuryand Cadmium.

**1.3 Environmentalpersistenceofpollutant:**

1.Abioticdegradation,Bioticdegradation,2.Nondegradative eliminationprocess.

**1.4 Sourcesoftoxicants:**

1.Sourcesof toxicantstotheenvironmentandtransportprocess

**1.5 Bioaccumulation-**

1.DefinitionofBioaccumulation 2. Factorsinfluenceonbioaccumulation.

**Unit2: Toxicity of Pesticides and Solvents (10L)2.1:Pesticides:**

1.Definition&ClassificationofPesticides2.Bio-magnificationofPesticides.

**2.2 :Pesticidetoxicity:**

1.IntrodutiontoPesticidetoxicity2.Haematotoxicity: Reproductiveanddevelopmental effects, 3. Carcinogenecity, Immunological effects. 4. Environmental problems by organochlorine andorganophosphate.

**2.3 :PrinciplesofSolventtoxicity :**

1.Nature of toxic effects, toxicity of Aliphatic solvents –a) Carbon tetra chloride b) Chloroform c) toxicity ofalcohols.

**2.4 : Toxicity ofFoodAdditives-**

1. Nature and types of Food Additives 2. Polycyclic hydrocarbons, Hydrocyclic-amines, Nitroso aminesandsynthetic carcinogens.

**Unit3: Occupational and Industrial Toxicology 14L3.1:Occupationalhazards:**

1. Concept of Occupational hazards- physical, chemical, biological and mechanical hazards. 2. Occupationaldiseases: Pneumoconiosis, Silicosis, Asbestosis, Anthracosis. 3. Occupational Cancer – Skin cancer, Lungcancer,BladdercancerandLeukemia;

**3.2:PreventionofOccupationaldiseases.**

1.Riskassessmentandmanagementof industrialchemicals,2.Introduction,LegislationandRegulation.

**Unit4:Appliedtoxicology12L**

**4.1Toxicologyof chemicalWarfare agents**

1. Chemical weapons,classificationofchemicalwarfareagents.2. Management ofwarfareagents.

**4.2. Veterinarytoxicology:**

1. Common toxicity in Dog, Cat and Poultry by herbicides, 2. House hold chemicals, heavy metals,mycotoxinsetc.

**4.3 Wildlifetoxicology :**

1. Susceptibility of wild life to chemicals, 2. Acute ecological hazards,toxicology of chemicals in birds andmammals,3. Integrated approachto wildlifetoxicology.

**4.4 Cosmetictoxicology:**

1. Toxicity of shampoos, conditioners, bleechers and Dyes, 2. Bioremediation and prevention ofoccupationaldiseases.

**PRACTICAL:(Allexperimentsinvolvingliveanimals arefordemonstrationonly)**Credit:1

1. PesticidesreducesbyTLCtechniques.

2. Estimationof HemoglobinandRBCinLeadexposedexperimental animals.
3. Dermalsensitizationtest.
4. Estimationof Acheactivityas a markerofpesticidepoisoning.
5. Quantificationof DNAdamage bySCGEtechnique(COMETassay).
6. Effectoftoxicantsonchromosomal aberrationsandsisterchromatidexchanges.
7. Analysisofpesticideresiduesindifferenttissues of fishbyTLCtechnique.

**RecomendedBooks:**


1. Principles ofecotoxicology-3rd edition 2006,C HWalker,SPHopkin, RNSiblyand DB
2. Peakall(Eds.),Taylor and Francis,NewYork, NY.
3. Introduction to Environmental toxicology -3rd edition 2003, W.G.Landis and M.H.Yu.Lewis publishers,Florida.
4. Text Book of Modern Toxicology 2000 edition, Ernst Hodgson and Patrica Levi, McGraw –HillInternational edition. Singapore.
5. Principlesoftoxicology 2010edition, AnjuAgarwalandKrishna Gopal,ibdcpublishersIndia.
6. Essentials of Toxicology 2011 edition, Vijay Kumar Matham, New India Publishing Agency,New Delhi,India.


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**PAPER:ZOO1004DPW**

**DPW**

**(Credit:6)**

**Paper onDissertationandProject Work(DPW)– I**

The dissertation/projectwork tobecarried outin4thsemester forallthe specialpapers.

1. DPWfor Celland Molecular Biology6 Credit
2. DPWforEcologyandWildlife Biology6 Credit
3. DPWforEntomology6Credit
4. DPWforFish Biologyand FisheryScience 6 Credit

Submissionofprojectreportandpresentationforallspecialpapers andviva voce

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