



**MODERN COLLEGE OF ARTS,  
SCIENCE AND COMMERCE,  
GANESHKHIND, PUNE- 16  
(AUTONOMOUS)**

**Two Year M.Sc. Program in Zoology  
(Faculty of Science)**

**M. Sc. Zoology Syllabus  
Choice Based Credit System Syllabus**

**To be implemented from Academic year  
2022-2023**

**BOARD OF STUDIES IN ZOOLOGY**

**Progressive Education Society's**

**MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE, GANESHKHIND, PUNE-  
16  
(AUTONOMOUS)**

## 1) Title of the Course: M.Sc. (Zoology)

### 2) PREAMBLE

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. The advancements in biological Sciences demands a zoology student to be a master of many areas in the subject. This Postgraduate degree program has been designed by the Board of Studies in Zoology with a tangible understanding of what is needed from zoologists and what zoologists need to pursue as a skilled career. It emulates closely the Benchmark Statement for Biosciences and the guidelines laid down by the University Grants Commission, New Delhi. This Newly designed Curriculum is an appropriate blend of the classical aspects in Zoology which has been the "backbone" knowledge required for all zoologists and the recent and specialized areas. The flexibility in the Curriculum allows the students to choose their areas of interest leading to enhanced employability. Students will be provided sufficient number of hours for their skill development through the Lab Courses and the Project component. The lab courses have differing flavours and priorities to make a good zoologist. This degree offers specialization in Entomology along with a range of core courses like Biochemistry, Molecular Biology, Comparative Animal Physiology, Developmental Biology, Environmental Biology etc. Various cross cutting issues relating to Environmental biology have been aptly included to develop the students' sense towards human wellbeing. The field trip/surveys and study tours are included to give the student an enticing taste of what life is specially outside the walls of the classroom. On successful completion of the programme, the students are expected to understand the key life processes of human and other animal groups, the functioning of molecules, cells, tissues, organs and systems. Also the students will gain increased confidence to use initiative and judgement to make decisions in complex and changeable situations and reflect critically and analytically on personal experience and make informed decisions about further study, training and employment opportunities. The Master of Science (M.Sc.) in Zoology is a Postgraduate program under the Faculty of Science and Technology. The curriculum designed M. Sc. [I] Zoology encompasses subjects like Physiology, Entomology, Genetics, Cell Biology, Developmental Biology, Endocrinology, Biochemistry, Molecular Biology, Freshwater Zoology, Environmental Biology etc. Both classical and applied subjects of Zoology have been rightly blended to offer holistic understanding of the subject. The Choice Based Credit System (CBCS) will be implemented through this curriculum. This curriculum would certainly felicitate students to develop a strong base of the fundamentals and specialize in the desired area of their fondness and abilities. The students pursuing this program would get a privilege to select optional subjects of their choice. A total of 210 hours for theory lectures and 180 hours for laboratory work have been prescribed in each semester including a research project to inculcate the research culture amongst students. This curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills.

### 3) Introduction:

#### Salient Features of the Credit System:

1. Master's degree course in Zoology would be of 80 credits; where one credit



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course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 hours of laboratory exercise including the revision and setting up the practical. Thus, each credit will be equivalent to 15 hours.

2. Besides Credits related to practical Courses, students may be allowed to take courses with less weightage per semester on the condition they complete the degree in maximum of four years. This provision can be availed which is subject to the availability of concerned courses in a given semester and with a maximum variation of 20 credits (in case of fresh credits) per semester in the concerned department/college.

3. Every student shall complete 80 credits in a minimum of four semesters. All Semesters will have 20 credits each.

4. The student will be declared as failed if he/she does not pass in all credits within a total period of four years. After that such students will have to seek fresh admission as per admission rules prevailing at that time.

5. Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.

6. Project course should not be greater than 10% of the total credits of the degree course.

#### **Instructions for the Students:**

The students seeking admission to M.Sc. Zoology course is hereby informed that they are supposed to adhere to the following rules:

1. A minimum of 75 % attendance for lectures / practical is the pre-requisite for grant of term.

2. There shall be tutorial / practical / surprise test / home assignment / referencing of research papers / seminar / industrial visits/Field Visit / training course/viva-voce as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be permitted to the student absent for the test/s unless the case is considered by competent authority.

3. The students opting for dissertation course shall follow the rules framed for the same.

4. The students are supposed to attend all the Industrial Workshops / Laboratory Workshops / Training Programme/ symposia/ seminar/ field visit / study tour organized by the department/ college. The students shall attend these programmes at their own cost.

#### **4) Eligibility:**

The candidate should have a B.Sc. degree with Zoology as principal subject or B.Sc. (General) degree with Zoology as one of the subsidiary subjects. Graduates in any life science related subjects such as Biotechnology, Bioinformatics, Life science, Biochemistry, Microbiology, Agriculture, Veterinary sciences, Biology, Botany etc. Admission: Admissions will be given as per the selection procedure / policies adopted by the respective college, in accordance with conditions laid down



by the University of Pune. Reservation and relaxation will be as per the government rules.

### 5) Examination

#### [A] Pattern of Examination Evaluation of Students:

- 1) The In-semester and End-Semester examinations will be of 15 marks each for 2 credits and 35 marks for 4 credits and for End-semester 35 marks for 2 credits and 70 marks for 4 credits.
- 2) Student has to obtain minimum of 40 % separately in both the In-Semester and End- Semester.
- 3) A student cannot register for third semester if he/she fails to complete the 50% credits of the total expected within two semesters.
- 4) Internal marks remain unchanged and internal assessment cannot be repeated. If student remain absent during internal assessment examination, he/she will have second chance with the permission of the competent authority. But it will not be right of the student. It will be under the discretion of the competent authority and internal departmental assessment committee. In case he/she wants to repeat Internal, he/she can do so only by registering for the said courses.
- 5) There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.

#### i. In-semester Examination:

Internal assessment for each course would be continuous and dates for each tutorials/practical tests etc. will be pre-notified in the time table for teaching or placed separately as a part of time table. Department / College Internal Assessment Committee will coordinate this activity.

#### a) Theory Courses:

Students should be encouraged to participate in various academic activities. A teacher must select a variety of the procedures for conducting internal assessment suggested as follows.

- a) Multiple choice questions
- b) Combination of objective and subjective questions.
- c) Open book test (concerned teacher will decide the allowed books)
- d) Tutorial
- e) Surprise test specified topics in a given notified period
- f) Oral
- g) Assignments
- h) Review of research paper
- i) Seminar presentation
- j) Journal/Lecture/Library notes Student has to preserve the documentation of the internal assessment except midterm test answer script. It is the responsibility of the student to preserve the documents.

#### b) Practical Courses:

It is a continuous evaluation process. Practical courses will be evaluated on the





basis of the following:

1. Performance assessment of each experiment on the basis of attendance, punctuality, journal completion, practical skills, results, oral and analysis.
2. Assessment on practical course be conducted before the end-semester examination.
3. Assessment of each experiment shall be done for each practical weekly.
4. Assessment of the Activity will be based on any one of the following (per practical course).
  - i. Special training programs in recognized research institutes such as NCL, NIO, NIV, ZSI, BNHS, etc.
  - ii. Project on Research Methodology
  - iii. Industrial/Institution Visit report
  - iv. Field visit report/ study tour report.

The student strength of practical batch should be 12

**Project Course:** Project will be evaluated by the examiner/s in consent with the project guide if required.

**ii. End-Semester Examination:**

The End-semester examination programme will be scheduled as per the notifications and guidelines issued by the Examination section of University of Pune.

**[B] Standard of Passing**

Student has to obtain 40% marks separately in In-Semester and End-Semester assessment.

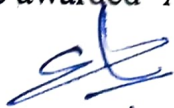
**[C] ATKT Rules**

A student cannot register for third semester if he/she fails to complete the 50% credits of the total credits expected to be ordinarily completed within two semesters.

**[D] Award of Class**

Grades will be awarded from grade point average (GPA) of the credits. GPA Rules:

1. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credit hours (Science). Total credit hours indicate the sum of credit hours of the courses which a student has passed.
2. A six point grade system [guided by the Government of Maharashtra Resolution No. NGO – 1298 / [4619] / UNI 4 dt. December 11, 1999 and University regulations] will be followed. The corresponding grade table is attached herewith.
3. If the GPA is higher than the indicated upper limit in the third decimal digit then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded 'A')



4. For Semester I, II, III examinations, only the grade points will be awarded for each subject. Final GPA along with final grade will be awarded only at the end of IV semester. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.

Final Grade Points	
Grade Points	Final Grade
5.00 – 6.00	O
4.50 – 4.99	A
3.50 – 4.49	B
2.50 – 3.49	C
1.50 – 2.49	D
0.50 – 1.49	E
0.00 – 0.49	F

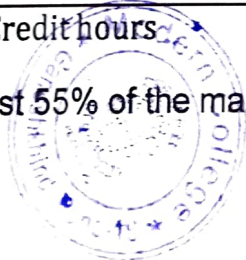
Grade and Grade Point Average		
Marks	Obtained Grade	Grade Points
100 – 75	'O' Outstanding	06
74 – 65	'A' Very Good	05
64 – 55	'B' Good	04
54 – 50	'C' Average	03
49 – 45	'D' Satisfactory	02
44 – 40	'E' Pass	01
39 and less	'F' Fail	00

Common Formula for Grade Point Average (GPA):

$$\text{GPA} = \frac{\text{Total of Grade Points earned} \times \text{Credit hours for each course}}{\text{Total Credit hours}}$$

B Grade is equivalent to at least 55% of the marks

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[E]External Students: There shall be no external students.

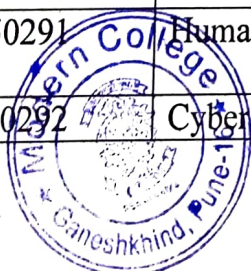
[F] Setting of Question Paper / Pattern of Question Paper

For core (compulsory) theory courses end semester question papers set by the University of Pune and centralized assessment for theory papers done as per the University instructions. Questions should be designed to test the conceptual knowledge and understanding of the basic concepts of the subject. Theory examination will be of 3 hours duration for each theory course of 4 credits. There shall be 3 questions each carrying marks as shown below. The pattern of question papers shall be:

**I. Course Structure with Credit Distribution of the First year  
M.Sc- Zoology Syllabus**

Semester	Course	Course code	Name of the Course	Credits
I	CCTP	22-ZOUT-111	Biochemistry and Biotechniques	4 Credits (60 L)
	CCTP	22-ZOUT-112	Cell and Developmental Biology	4 Credits (60 L)
	CCTP	22-ZOUT-113	Genetics and Skills in Scientific Communication	4 Credits (60 L)
	CBOP	22-ZODT-114	Biostatistics/ Freshwater Zoology	2 Credits (30L)
	CCPP (22-ZOUT-111 +22-ZOUT-112)	22-ZOUP-114	Zoology Lab- I	4 Credits
	CCPP (22-ZOUT-113 + 22-ZODT-114)	22-ZOUP-115	Zoology Lab-II	2 Credits
	Mandatory credit course	22-50191	Human rights- I	1 Credit
	Mandatory credit course	22-50192	Cyber security- I	1 Credit
Semester II	CCTP	22-ZOUT-121	Molecular Biology and Bioinformatics	4 Credit (60 L)
	CCTP	22-ZOUT-122	Endocrinology and Comparative Animal Physiology	4 Credit (60 L)
	CCTP	22-ZOUT-123	Parasitology and Environmental Biology	4 Credit (60 L)
	CBOP	22-ZODT-124	Bioenergetics/ Ichthyology	2 Credits (30L)
	CCPP (22-ZOUT-121 +22-ZOUT-122)	22-ZOUP-124	Zoology Lab- I	4 Credits
	CCPP (22-ZOUT-123+22-ZODT-124)	22-ZOUP-125	Zoology Lab-II	2 Credits
	Mandatory credit course	22-50291	Human rights- II	1 Credit
	Mandatory credit course	22-50292	Cyber security- II	1 Credit

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## II. Course Structure with Credit Distribution of the Second year M.Sc- Zoology Syllabus

Semester	Course	Course code	Name of the Course	Credits
III	CCTP	23-ZOUT-231	Entomology	4 Credits (60 L)
	CCTP	23-ZOUT-232	Animal systematics and Research methodology	4 Credits (60 L)
	CCTP	23-ZOUT-233	Insect physiology and biochemistry and Economic Zoology	4 Credits (60 L)
	CBOP	23-ZODT-234	Immunology/ Genetic Toxicology	2 Credits (30L)
	CCPP (23-ZOUT-231+23-ZOUT-232)	23-ZOUP-234	Special Zoology Lab- I	4 Credits
	CCPP(23-ZOUT-233+23-ZODT-234)	23-ZOUP-235	Special Zoology Lab-II	2 Credits
		23-ZOUP245	Research Project	
	Mandatory credit course	23-50392	Cyber security- III	1 Credit
	Mandatory credit course	23-50394	Skill based course	2 Credits
	Mandatory credit course	23-50395	Introduction to Constitution	2 Credits
Semester IV	CCTP	23-ZOUT-241	Advanced Entomology	4 Credit (60 L)
	CCTP	23-ZOUT-242	Mammalian reproductive physiology and Aquaculture	4 Credit (60 L)
	CBOP	23-ZODT-243	Histology and Histochemistry	2 Credit (30 L)
	CBOP	23-ZODT-244	Apiculture	2 Credits (30L)
	CCPP (23-ZOUT-241+23-ZODT-243)	23-ZOUP-243	Special Zoology Lab- III	4 Credits
	CCPP(23-ZOUT-242+23-ZODT-244)	23-ZOUP-244	Special Zoology Lab-IV	2 Credits
	CCPP	23-ZOUP245	Research Project	2 Credits
	Mandatory credit course	23-50492	Cyber security- IV	1 Credit
	Mandatory credit course	23-50494	Skill based course	2 Credits

**Note: 23-ZOUP245 Research Project is a compulsory course to be conducted throughout Semester III and IV, the assessment and evaluation will be done only in Semester IV**



### Detailed Syllabus with Recommended Books:

**Program outcomes (POs):** After successfully completing the M.Sc. Zoology program students will be able to:

**PO1. Zoology knowledge:** Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.

**PO2. Problem analysis:** Identify, review research literature, and analyse complex situations of living forms.

**PO3. Design/development of solutions:** Design processes/strategies that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in real situations.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and ICT tools for understanding of the subject.

**PO6. The Postgraduate and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7. Environment and sustainability:** Understand the impact of the natural and anthropogenic activities in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. Identify a range of invertebrates and vertebrates and justify their conservation.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the work/research practice.

**PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10. Communication:** Communicate effectively on complex life activities with the scientific community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11. Project management and finance:** Demonstrate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a team.

**PO12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.





### Semester III

Course Code and Course Name:

23-ZOUT-231: Entomology- I (Special Paper)

(4 Credits: 60 Lectures)

After successfully completing this course, students will be able to:

- CO1: Define entomology and Insects and understand origin and evolution of insects and their relation to other arthropods.
- CO2: Give outline of Classification of insects up to family with distinguishing characters and examples of each order and family.
- CO3: Explain the structure, chemical composition and functions of Integument and Derivatives of Integument.
- CO4: Explain the structure, modifications of insect body regions and their appendages.
- CO5: Explain the Comparative anatomical and histological structure of various body systems.
- CO6: Explain the location structure and functions of various Endocrine and Exocrine glands.
- CO7: Explain the location and structure of Light and Sound producing organs in various insects

Sr. No.	Name of the topic	Lectures Allotted
1.	Introduction to Entomology: Definition, Origin, Evolution and Inter-relationship of insects with other arthropods.	(04L)
2.	General outline of Classification and Phylogeny of insects up to family: Apterygote insects (4 orders) and Endopterygote insects (9 orders).	(19L)
3.	Integument: Structure, chemical composition and functions. Derivatives of Integument: Cuticular appendages & Processes.	(02L)
4.	Comparative study of: Head and its appendages; Thorax and its appendages; Abdomen and its appendages. Abdominal sclerites and variation  Basic structure of male genitalia and variations. Basic structure of female genitalia and variations. Evolution of genitalia	(09L)
5.	Comparative anatomical and histological study of the following: Digestive system, Respiratory system, Circulatory system, Excretory system, Reproductive system, Nervous system and Sense organs.	(18L)
6.	Endocrine and Exocrine glands and Hormonal action.	(04L)
7.	Light and Sound producing organs, Thermoregulation in insects Insects Communication. Types of communication in insects.	(04L)





## REFERENCE BOOKS:

1. A Text book of Entomology-By H. H. Ross (John Wiley and Sons, Ins. New York,).
2. An Introduction to Entomology- By J. H. Comstock (Ithaca, New York).
3. General & Applied Entomology- By K. K. Nayar, T.N. Anathakrishnan & B.V. David, (Tata McGraw-Hill, New Delhi).
4. General Entomology, 2<sup>nd</sup> edition- By M.S. Mani Oxford & IBH Publishing Company, New Delhi.
5. Imm's text book of entomology by O. W. Richards and R. G. Davies (Methuen and com, London) vol. I and II
6. Introduction to comparative Entomology- By R. M. Fox and J. W. Fox (Reinhold, New York)
7. Modern Entomology, 2<sup>nd</sup> edition- By D. B. Tembhare (Himalaya Publication House, Bombay).
8. Principles of insect morphology- By R. E. Snodgrass (Tata Mc-Graw Hill Bombay).
9. The Insect: Structure & Function- By R. F. Chapman (E.L.B.S., & E.U.P. London).

*Note: Use the latest editions of the recommended books*

## Course Code and Course Name:

### 23-ZOUT-232: Animal systematics and Research methodology

(4 Credits: 60 Lectures)

After successfully completing this course, students will be able to:

#### Animal systematics

CO1: Explain principles, methods of biological classification and diversity in kingdom Animalia.

CO2: Explain the importance of taxonomic keys and taxonomic characters.

CO3: Explain the principles of zoological classification and nomenclature

CO4: Discuss the various taxonomic procedures and molecular phylogenetics & phylogeography.

CO5: Illustrate the methodologies used in systematics.

#### Research Methodology

CO1: Demonstrate knowledge of research processes (reading, evaluating, and developing)

CO2: Perform literature reviews using online databases.

CO3: Preparation of Dissertation for the project

CO4: Identify, explain, compare, and prepare the key elements of a research proposal/report.

CO5: Compare and contrast quantitative and qualitative research paradigms

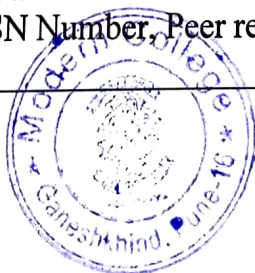
CO6: Applications of new techniques.

CO7: Justify the rationale for research ethics



Sr. No.	Name of the topic	Lectures allotted
	<b>Animal Systematics</b>	
1.	<b>Unit I: Science of Biosystematics and Species concept</b> Concept of Biosystematics, Terms used in systematic biology, Historical review of taxonomic philosophies, Future of taxonomic studies, Stages in taxonomy, Tasks of taxonomist, Systematics as a profession Historical perspectives of species concept (typological, nominalist, biological), kinds of species- sibling, sympatric, allopatric, syntopic, ring species, polytypic and monotypic species. Intraspecific groups (variety, morphs, subspecies, temporal subspecies, race and clines)	7L
2.	<b>Kingdoms of Life: General outline of kingdoms including Monera &amp; Protista. Broad outline &amp; Diversity in kingdom Animalia (Major and Minor phyla).</b>	5L
4.	<b>Taxonomic procedures:</b> Collection - Purpose, value, scope of collection, content of collection, significance of museum collections, legal aspects of collecting animals, post collection processes. Preparation and packaging of specimen for posting. Preservation - Methods, taxidermy, factors responsible for the deterioration of museum specimens. Curating of collections - museum collection policy, preparation of material for study, housing and cataloging Identification - Systematic process of sorting and labelling, procedure of identification; identification services.	5L
5.	<b>Taxonomic keys: Types of taxonomic keys, their merits and demerits. International code of Zoological nomenclature: Its operative principles, interpretation and application of important rules, zoological nomenclature, formation of names</b>	5L
6.	<b>Methodologies in systematics: Morphology based taxonomy, Numerical taxonomy, Cyto-taxonomy and chemotaxonomy, Molecular systematic, DNA fingerprinting &amp; Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.</b>	5L

7.	<b>Molecular phylogenetics and phylogeography.</b>	3L
<b>Sr. No.</b>	<b>Name of the topic</b>	<b>Lectures allotted</b>
	<b>Research Methodology</b>	
1.	<b>Research: Meaning, Objectives, Types of research, Literature review, Collection of literature from Books and Journals, Digital library, Search of articles - Google Scholar, Pub med, Infilbnet, Medline</b>	03L
2.	<b>Publishing of Articles: National and International Journals, Selection of Journals, Concepts related to journals- ISSN Number, Peer reviewed Journals, Science citation index, Impact factor.</b>	02L





3.	Dissertation: Structure, Components – Introduction, Review of literature, Materials and Methods, Presentation of Results, Discussion, Conclusions, Summary, Arrangement and how to quote references in thesis, Appendix.	02L
4.	Data Collection: Meaning, Methods and Tools of Data Collection Hypothesis Sampling, Data Processing, Analysis and Interpretation of Data.	02L
5.	Quantitative methods: Biostatistics used for analysis of Biological data	02L
6.	Computer application: Bioinformatics, Databases and their applications	03L
7.	Tools and techniques: <ul style="list-style-type: none"> <li>• Techniques used Purification and characterization of biomolecules: Recapitulation of centrifugation, chromatography and electrophoresis.</li> <li>• NMR, MALDI-TOF, X-ray crystallography, Circular Dichroism CD</li> <li>• Microscopic techniques including Fluorescence microscopy, Confocal microscopy, Atomic force microscopy and live cell imaging FACS analysis. Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarray.</li> </ul>	10L
8.	Intellectual property rights and patent law: Trade Related aspects of Intellectual Property Rights, Reproduction of published material- Plagiarism, Citation and Acknowledgement Patent Criteria and Procedure of patenting	02L
9.	Bioethics, Good Laboratory Practice (GLP) and Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) Guidelines- Introduction to Bioethics, Bioethic regulation frame work in India, GLP introduction and CPCSEA guidelines for laboratory Animal Facility	03L

## REFERENCE BOOKS:

### Animal Systematics :

1. Kato., The biology of biodiversity, Springer.
2. Avise J.C., Molecular markers, Natural history and evolution, Chapman and Hill, NY.
3. Wilson A.O., biodiversity, Academic Press, Washington.
4. Principals of systematic Zoology by Ernst Mayr.

### Research Methodology

1. Kothari, C.R. (1985): Research Methodology: Methods and Techniques, Wiley Eastern.
2. Dominowski, R.L. (1980): Research Methods, Prentice Hall Inc., New Jersey.
3. Mishra, R.P. (1980): Research Methodology, Handbook Concept Publishing Company, New Delhi.
4. IIPS (1996): Research Methodology, IIPS, Mumbai.
5. Research and Writtings – By-P. Ramdas , A.Wilson srnai M.J.Publisher (2009).
6. Scientific thesis writings and Paper presentations-N.Gurumani. M.J.Publisher (2010).
7. Anderson, Durston&Polle 1970: Thesis and assignment, writing Wiley Eastern Limited
8. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip & Techniques, MJP
9. Publishers, Chennai. [WWW.mjppublishers.com](http://WWW.mjppublishers.com)
10. Malter K, 1972: Statistical analysis in Biology, Chapman Hall, London.
11. Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education (5th edition). Oxford: Oxford University Press.
12. Leedy, P. D. (1980). Practical Research: Planning and design. Washington: Mc Millan

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**Course Code and Course Name:**

**23-ZOUT-233: Insect physiology and biochemistry and Economic Zoology**

**(4 Credits: 60 Lectures)**

**Insect Physiology and Biochemistry**

CO1: Explain the structure, Chemistry of integument and sclerotization.

CO2: Describe the process of digestion and metabolism

CO3: Explain the characteristics of haemolymph and types of haemocytes.

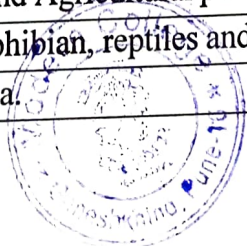
CO4: illustrate the structure, physiology and biochemistry of flight muscle.

CO5: Demonstrate the process of excretion, detoxification and water balance

CO6: Justify the role of insect hormones in physiological processes.

<b>Insect Physiology and Biochemistry</b>		
1.	Integument: Structure, Chemistry, Cuticle formation, Functions.	02 L
2.	Digestion: Alimentary canal, Digestion and Absorption of proteins, carbohydrates and lipids.	03 L
3.	Fat body: Structure, Development, Physiology, Biochemistry, Functions and role of Fat body cells in carbohydrate, lipid and protein metabolism	04 L
4.	Gaseous exchange: Tracheal system, Spiracles, Cutaneous gas exchange, Respiratory pigments, Gaseous exchange in terrestrial, aquatic and endoparasitic insects, other functions of tracheal system	04 L
5.	Haemolymph: Physico-chemical characteristics of haemolymph, types and structure of haemocytes and its functions.	03 L
6.	Muscle: Structure, Physiology and Biochemistry of flight muscles	03 L
7.	Excretion and salt and water regulation: Structure and functions of Malpighian tubules, Water regulation and Nitrogen excretion.	04 L
8.	Endocrine system: Chemical structure of hormones, Endocrine organs, Neurosecretory cells, function and mechanism of hormone action, chemistry and function of other peptide and steroid hormones	04 L
9.	Microsomal and extra-microsomal enzymes insecticide degradation and detoxification.	03 L
<b>Economic Zoology</b>		
1.	Animal husbandry: Poultry, Piggery, Dairy industry and wool industry.	08L
2.	Economic importance of insects: Apiculture, Lac culture, Sericulture, House hold insect and stored grain pest and Agricultural pest.	10 L
3.	Economic importance of amphibian, reptiles and birds.	02 L
4.	Vermiculture industry in India.	01 L

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5.	Prawn culture	01 L
6.	Helminthes as human and animal parasites.	01 L
7.	<b>Crustaceans (Important species and their Economic Importance)</b> Crab, lobsters, copepods.	02 L
8.	Concept of Coral reef and its significance.	01 L
9.	<b>Molluscans (Economically important species)</b> Eulamellibranchs Gastropods Cephalopods	02 L
10.	Parasitic protozoan's and their role in human welfare, soil protozoan's and their role in agriculture.	01 L
11.	Model animals in pharmaceutical industry.	01 L

### Reference books:

#### Insect Physiology and Biochemistry

1. Fundamentals of insect physiology, Blum N.S., John Wiley and sons, NY
2. An introduction to insect physiology, Bursell, e. academic press, NY
3. Insect biochemistry and function Candy D.J. and Kilby D.A. Chapman and hall, London
4. Comprehensive insect physiology, biochemistry and pharmacology, Kerkut G.A and Gilbert L.I., Vol 1 to 13 Pergamon press, Oxford, NY
5. The Insects: Structure and Function. Forth ed., Chapman R. F. (1998), Cambridge University Press, UK.
6. Insect Physiology. Prakash, M. (2008), Discovery Publishing House Pvt. Ltd., New Delhi.
7. Physiological Systems in Insects. Second ed., Klownden, Marc (2007), Elsevier, USA
8. The Principles of Insect Physiology, Seventh ed. Wigglesworth, V.B. (1972), Chapman and Hall, London.

#### Economic Zoology :

1. Economic Zoology: An Introductory Text-Book in Zoology, with Special Reference to Its Applications in Agriculture, Commerce, and Medicine, Herbert Osborn, Ulan Press (August 31, 2012)
2. Economic Zoology-Shukla and Upadhaya, Rastogi Publication, 2017
3. A Textbook of Economic Zoology, Dr Sanjeev Jain, Indian Books and Periodicals 2018.
4. Economic Zoology-Manju Yadav , Discovery Publication 2013
5. Economic Zoology-K.R.Ravindranathan , Om Publications 2013
6. Textbook of Economic Zoology- P.R.Venkitaraman Sudharsana Puubl. Kochi 1983
7. A Handbook on Economic Zoology , Dr Jawaid Ahsan And Dr Subhas Prasad Sinha S. Chand Group.
8. Encyclopedia of Economic Zoology, A.A.Khan. Anmol Publications

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9. Economic Zoology by. Manju Yadav, Discovery Publishing House Pvt. Limited. Economic Zoology by Malhotra ,Prakash, Adhyayan Publishers & Distributers
10. Introduction to Economic Zoology, Sarkar, Kundu and Chaki, New Central Book Agency; New edition edition (14 May 2014)

**Course Code and Course Name:**

**23-ZODT-234: Immunology**

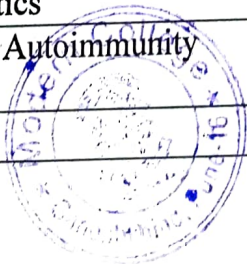
**(2 Credits: 30 Lectures)**

**Semester III**

After successfully completing this course, students will be able to:

- CO1: List the primary and secondary immune organs.
- CO2: Explain the concepts of immunity, self-nonsel immune response, autoimmune disease.
- CO3: Explain the theories of antibody synthesis and generation of antibody diversity.
- CO4: Explain the principle and application of the common techniques used in Immunology
- CO5: Illustrate the events and dynamics of inflammation
- CO6: Compare the MHC molecules and diseases associated with HLA.
- CO7: Differentiate between active and passive immunization
- CO8: Compare the three pathways of complement fixation pathway.

Sr. No.	Name of the topic	Lectures allotted
1.	Introduction to Immune system. 1.1. Overview of Immunology 1.2. Innate and Adaptive immunity; Humoral immunity and cell mediated immunity 1.3. Primary and secondary lymphoid organ. Tissue, cells and molecules of the human immune system. 1.4. Immediate response to infection: inflammation, cell migration, acute phase response interferons and NK cell. 1.5. Concept of immunity (self- non self, antigen) and active and passive immunization (natural and artificial)	07L
2.	Antibody structure, antibody classes, subclasses, structure-function relationship, iso, idio and allo types., T cell receptors, Theories of antibody synthesis, generation of antibody diversity (molecular basis), antibody class switching.	04L
3.	MHC, HLA and disease association, immune deficiencies and disorders. Antigen processing & Immunogenetics	02L
4.	Immunological Tolerance, Autoimmunity	03L
5.	Hypersensitivity.	02L



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6.	Immunological memory, types of vaccines and vaccination Vaccines: conventional vaccines, Viral vaccines, Bacterial vaccines, peptide vaccines, genetically engineered vaccines, Production and application of lymphokines.	03L
7.	Immunotechniques: Antigen-antibody reaction and complement system and complement fixation test.	02L
8.	<b>Hybridoma Technology</b> Immunization of animals, isolation of stimulated spleen cells, Myeloma cell lines used as fusion partners. Fusion methods, Detection and applications of monoclonal antibodies.	03L
9.	Immunodiagnostic Procedures Various types of Immunodiffusion and immunoelectrophoretic procedures, Immunoblot, ELISA, RIA, , haemagglutination and inhibition.	04L

### REFERENCE BOOKS:

1. Immunology: Kindt T. J., Goldsby R.A. , Osborne B. A., Kuby J. : freeman WH publications.
2. Essential immunology, IvonRoitt, Blackwell Scientific publication, London.
3. Immunology, Roitt I. V., Butterworth Publishers, USA.

### Course Code and Course Name:

**ZODP 234 : Special Zoology Lab- I (4 Credits)**

### Practicals in Animal systematics

CO1: Identify museum specimen/pictures of minor phyla, Invertebrates, Protochordates and Vertebrates.

CO2: Identify animals with the help of taxonomic keys.

CO3: Collect and preserve animal samples using common methods.

CO4: Write scientific report of field/ institutional visit.

CO5: Compare the methods of collection and curation of insects.

### Practicals in Research Methodology

CO1: Writing of project proposal to a funding agency.

CO2: Use of MS excel in presentation.

CO3: Use of various statistical tools in biology.

CO4: Writing of review article.

CO5: Use of MS Power Point for presentation

CO6: Perform protein purification.

CO7: Knowledge of Microscopic techniques

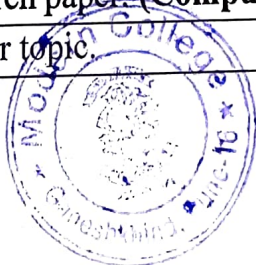
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<b>Module-I: Practicals in Entomology</b>		
1.	Method of collection, preservation & presentation of insects.	(02P)
2.	Study of Taxonomy and diagnostic features up to family of Apterygote, Exopterygote and Endopterygote insects (at least one insect from each order). (Compulsory- 3)	(06P)
3.	Study of generalized insect: Grasshopper/ Cockroach i. Systematic position, Habit, Habitat and Important morphological features. ii. Dissection so as to study: Digestive, Nervous and Reproductive system and Retro-cerebral complex. (Compulsory)	(03P)
4.	Temporary mounting of mouth parts, antenna, legs, wings, spiracles and tympanum of a generalized insect. (Compulsory)	(01P)
5.	Dissection of an insect pest (Plant bug or any insect pest as per local availability and legal permissibility) so as to study taxonomy, diagnostic features and anatomy pertaining to digestive, nervous and reproductive systems.	(03P)
6.	Study of head capsule: Structure of head capsule, head orientations and modifications. Study of types of mouthparts and antennae. (Compulsory- 1)	(02P)
7.	Study of general structure of legs and their modifications. Study of general structure of a wing and its modifications. (Compulsory)	(02P)
8.	Study of abdominal appendages.	(01P)
<b>Module-II: Practicals in Animal systematics</b>		
1.	To Study specimens of Minor phyla. (Compulsory)	1
2.	Study of museum specimens and slides of invertebrates, (2 examples from each phyla). (Compulsory)	2
3.	Study of museum specimens (protochordates and chordates, 1 or 2 examples of each phyla) (Compulsory)	2
4.	Identification of animals with the help of keys- House fly, Honey bee etc. (Compulsory)	1
5.	Introduction to taxonomic publications: contents, significance and applications	1
6.	Method of collection, Preservation, and Curing of any insect Specimen (Compulsory)	2
7.	Visits to Scientific Institute like Zoological Survey of India/ Animal Museum and Report writing.	2

<b>Practical Research Methodology</b>		
1.	Writing a project proposal to a funding agency (Compulsory)	1P
2.	Use of MS Excel in data presentation (Compulsory)	1P
3.	Examples of some common statistical tests (Compulsory)	2P
4.	Purification of a biomolecule.	1P
5.	Making a ICT enabled scientific presentation (Compulsory)	1P
6.	Microscopic techniques.	1P
7.	Presentation of any ONE research paper. (Compulsory)	1P
8.	Writing a review on a particular topic.	1 P

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Course code and course name

23-ZOUP-235: Special Zoology Lab-II

(2 Credits)

**Practicals in Insect Biochemistry and Physiology**

- CO1: Study of heart structure and haemocytes of cockroach.  
CO2: Understanding the effect of starvation on glycogen in insects.  
CO3: Studying the effect of temperature on water loss in cockroach.  
CO4: Detection of the amino acids in insect haemolymph by chromatographic method.  
CO5: Determination of the oxygen consumption in dragon fly nymph.  
CO6: Performing of Enzyme assays using insect samples.

**Practicals in Economic Zoology**

- CO6: Identify the poultry breeds.  
CO7: Identify edible freshwater fish from nearby area.  
CO8: Demonstrate the apiculture equipment.  
CO9: Demonstrate the methods of prawn culture.  
CO10: Compare various fishing tools, crafts and gears.

**Practicals in Immunology**

- CO1: Identify the pattern of identity of antigen- antibody reaction.  
CO2: Identify the microscopic structure of the lymphoid organs.  
CO3: Demonstrate immunoelectrophoresis technique.  
CO4: Demonstrate the double diffusion techniques.  
CO5: Detect the human blood groups by antigen -antibody reactions  
CO6: Prepare the human blood smear to identify various blood cells.

<b>Practicals in Insect Physiology and Biochemistry</b>		
1.	Oxygen consumption in dragon fly nymph (Compulsory)	1P
2.	Study of heart and haemocytes of cockroach (Compulsory)	1P
3.	To determine the trehalase activity in haemolymph of any insect	1P
4.	Amino acid in haemolymph of any insect by chromatographic technique	2P
5.	Study of fat body glycogen of cockroach and effect of starvation (Compulsory)	1P
6.	Effect of temperature on water loss in cockroach (Compulsory)	1P
7.	Von Wisinghs test for presence of chitin in insect cuticle (Compulsory)	1P

<b>Practicals in Economic Zoology</b>		

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1.	Physico-chemical analysis of honey.	1P
2.	Study of Apiculture equipments. <b>(Compulsory)</b>	1P
3.	Study of Poultry breeds, feeding utensils in poultry. <b>(Compulsory)</b>	2P
4.	Study of Fishing tools: crafts and gear <b>(Compulsory)</b>	
5.	Study of economic importance of freshwater fishes- <i>Catla</i> , <i>Rohu</i> , <i>Labeo</i> , <i>Mrigala</i> , <i>Notopterus</i> , <i>Mystus</i> sp., <i>Clarius</i> , <i>Channa</i> , <i>Heteropneustes</i> , <i>Reba</i> , <i>Wallago</i> . <b>(Compulsory)</b>	2P
6.	Collection and identification of locally available/cultured fishes.	2P
7.	A visit to piggery/ poultry/ pearl culture centre/ apiculture centre/ sericulture centre and report writing <b>(Compulsory)</b>	1P

Practicals in Immunology		
Sr. No.	Name of the topic	Practicals allotted
1.	Double diffusion or Ouchterlony technique (using kit). <b>(Compulsory)</b>	(2P)
2.	Demonstration of Immuno-electrophoresis (using kit). <b>(Compulsory)</b>	(2P)
3.	Separation of $\gamma$ globulins from the serum using native PAGE.	(2P)
4.	Histology of lymphoid organs: skin, spleen, thymus, ileum lymph node and bone marrow. <b>(Compulsory)</b>	(1P)
5.	To study the differential count of WBCs. <b>(Compulsory)</b>	(1P)
6.	Cell counting and viability testing using splenocytes (from goat spleen)	(2P)
7.	To estimate the antigen concentration by rocket electrophoresis (kit using). <b>(Compulsory)</b>	(2P)
8.	To study the immunology of blood transfusion (universal donor, universal recipient, Bombay blood group and erythroblastosis foetalis). <b>(Compulsory)</b>	(1P)
9.	Blood group analysis with reference to cross matching.	(1P)
10.	Demonstration of Various routes of egg inoculations for vaccine production using dye. (amniotic, yolk sac, allantoic and chorio-amniotic)	(1P)

## Semester IV

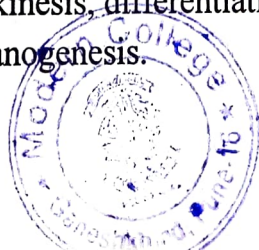
Course Code and Course Name:

23-ZOUT-241: Advanced Entomology (Special Paper) (4 Credits: 60 Lectures)

After successfully completing this course, students will be able to:

CO1: Explain Gametogenesis, Fertilization and oviposition.

CO2: Explain embryonic developmental stages such as Cleavage, Blastoderm and Germ band formation; Gastrulation, Blastokinesis, differentiation of germ layers, Segmentation and Appendages formation and organogenesis.





CO3: Explain post-embryonic developmental stages such as Nymph, Naiad, larva, Pupa and Metamorphosis.

CO4: Explain specialized reproductive mechanisms.

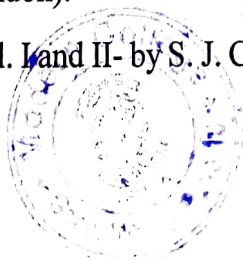
CO5: Explain Hadorn's experiments with imaginal disc, Regeneration and Aging.

CO6: Explain Occurrence, Initiation, Preparations for diapauses and its Controls.

Sr. No.	Name of the topic	Lectures allotted
1.	General outline of Classification and Phylogeny of insects up to family Exopterygote insects (16 orders)	(08L)
2.	<b>Gametogenesis:</b> Spermatogenesis, Seminal transfer and spermatophore formation; Oogenesis, Structure and Types of insect eggs. Fertilization and oviposition.	(08L)
3.	<b>Insect embryonic development:</b> Cleavage and Blastoderm formation, Germ band formation, Gastrulation, Embryonic membranes, Blastokinesis, Dorsal closure and dorsal organ, Fate/ differentiation of germ layers, Segmentation, Appendages formation and organogenesis in brief.	(10L)
4.	<b>The post embryonic development:</b> Eclosion from the egg. The developmental stages: Nymph, Naiad, larva, Pupa, Emergence from the pupa/ cocoon. Metamorphosis and Growth. Hormonal Control of Metamorphosis in Insects. Different types of insect pheromones and its functions	(14L)
5.	<b>Types of reproduction and specialized reproductive mechanism:</b> Oviparity, viviparity, polyembryony, paedogenesis and parthenogenesis.	(05L)
6.	Hadorn's experiments with imaginal disc, Regeneration and Aging. Determination and Pattern Formation in The Imaginal Discs Of <i>Drosophila</i>	(07L)
7.	<b>Diapause:</b> Occurrence, Initiation and Preparations for diapauses. Diapause development and Controls. Difference between quiescence and diapause Hormonal Regulation of Diapause and Development in Insects.	(08L)

### REFERENCE BOOKS:

1. 'The Insect- structure and Function' - by R.F. Chapman , ELBS, London
2. 'A Text book of Entomology' - by H. H. Ross (John Wiley and Sons, Ins, New York,
3. 'Imms' Text Book of Entomology- by O. W. Richards and R. G. Davies, (Methuen & Cc., London, ), Vols. I & II.
4. 'Embryology of Insects and Myriapods' - by O. A. Johanson and F.H. Butt, (McGraw Hill, New York,).
5. 'The ecology of insect populations in theory and practice' - by L.R. Clarks P. W. Geier, R.D. Hughes, R.F. Morris (Methuen, London).
6. 'Developmental system: Insects' Vol. I and II- by S. J. Counce and C.H. Waddington (Academic Press, London,).



Course Code and Course Name:

23-ZOUT-242: Mammalian Reproductive Physiology and Aquaculture

(4 Credits: 60 Lectures)

After successfully completing this course, students will be able to:

**Mammalian Reproductive Physiology**

- CO1: Explain the male and female reproductive systems and sexual dimorphic characteristics
- CO2: Explain the sexual cycles with examples
- CO3: Illustrate the reproductive dysfunctions.
- CO4: Diagrammatically represent the hormonal regulation of reproductive processes like pregnancy, lactation and parturition.
- CO5: Prepare the flow chart to demonstrate the hormonal coordination of reproductive Processes
- CO6: Justify the artificial control of reproduction.

**Aquaculture**

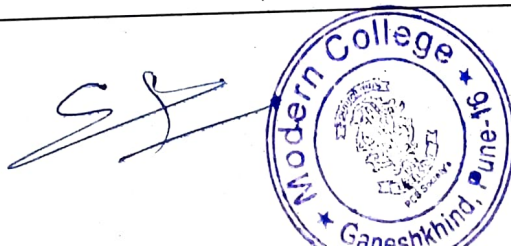
- CO1: Identify the fish diseases and the causative organisms
- CO2: Mention the various composite fish culture with significance of each type.
- CO3: Describe the methods of freshwater prawn culture and its management.
- CO4: Explain the methods of pearl culture and pearl harvesting.
- CO5: Illustrate the preparation and management of fish culture ponds.
- CO6: Demonstrate the methods of packaging and transport of fish and brood fish.
- CO7: Illustrate techniques of fish harvesting, preservation & processing.
- CO8: Compare the techniques used in fishery development.

Sr. No.	Name of the topic	Lectures allotted
	<b>Mammalian Reproductive Physiology</b>	
1.	Reproductive Systems: Anatomy of Male Reproductive System, Accessory organs and their function Spermatogenesis, Function of Sertoli cells, Blood Testisbarriers, inhibin, Leydig cell, Capacitation. Functions of Androgens.	05L





	<b>Anatomy of Female Reproductive System.</b>	
2.	Reproductive patterns: Environmental factors and breeding, continuous and seasonal breeders.	02L
3.	Sexual cycles: puberty, oestrous and menstrual cycles and its hormonal regulation. Ovarian cycle and its hormonal regulation. Cycling of non-pregnant uterus and vagina.	04L
4.	Hormonal regulation: GnRH, pituitary gonadotropins, behavioural effects, testicular hormones, testosterone derivatives, inhibin, ovarian hormones: Pituitary gonadal axis, Oestrogen, progesterone's feedback relationships Prostaglandins and their role in reproduction.	04L
5.	Fertilization, Gamete Transportation Pregnancy: conception and blastocyst formation, implantation and delayed implantation, hormonal regulation in pregnancy. Growth and differentiation of the pregnant uterus, Regulation of gestational length	04L
6.	Placenta: formation, classification, Placental function – metabolism, transport and endocrine Animal models for studying placental development and function	02L
7.	Parturition; birth process, Ferguson reflex, neuroendocrine control, purperium	02L
8.	Lactation: Anatomy and growth of mammary glands, Lactogenesis and galactopoiesis. Hormonal regulation and suckling reflex	02L
9.	Reproductive dysfunctions: Aging and reproduction. Climacteric, anatomical, endocrine and genetic disorders.	01L
10.	Artificial control of reproduction: increasing reproductive potential, artificial insemination, in vitro fertilization and embryo transfer, induced breeding, physical, physiological, surgical, chemical methods of contraception in male, female. Infertility: its causes and treatment, Recent advances in female contraception. Prenatal diagnostic test for genetic disorders-foetal ultra-sonography, Amniocentesis, Chorionic villi sampling,	04L
	<b>Aquaculture</b>	
1.	Basics of Aquaculture- Scope and importance of Aquaculture- Indian Fisheries – World Fisheries.	(1L)
2.	<b>Physicochemical parameter of water for fish culture</b> pH, Calcium, Total Alkalinity, Nitrate, Ammonia, Total hardness of fresh water	(3L)
3.	<b>Construction and management of fish culture pond:</b> Construction of ponds, management of ponds, Predatory and weed fishes and their control, Aquatic weeds and their control, Aquatic insects and their control, fish feeding: natural and artificial.	(3L)
4.	<b>Fish breeding: natural and induced.</b> Natural breeding in pond water, Induced breeding- Pituitary extract, selection of breeders, injection of pituitary extract, spawning, Advantages of induced breeding.	(2L)
5.	<b>Transport of fish seed and Brood fish:</b> causes of mortality in transport, methods for packaging and transport, open systems, closed systems, use of chemicals in live fish transport, anesthetic drugs, antiseptics & antibiotics.	(3L)



6.	<b>Fish culture:</b> Selection of cultivable fish, monoculture, composite culture, culture of Indian major carps, Culture of common carps, culture of cat fishes, paddy cum fish culture, mari culture, cage culture, integrated fish farming	(7L)
7.	<b>Fish preservation, processing and byproducts.</b> Fish preservation techniques, fish biproducts.	(2L)
8.	<b>Fish pathology:</b> bacterial, fungal, protozoan and worm diseases of fish.	(2L)
9.	<b>Fresh water prawn culture (<i>Macrobracium rosenbegii</i>):</b> Seed procurement from natural resources, breeding and larval rearing of fresh water prawn, management of cultural ponds, harvesting and marketing.	(2L)
10.	<b>Pearl Culture:</b> Composition & quality of pearl, collection of oysters, rearing of oysters, insertion of nucleus, pearl formation, harvesting of pearls.	(2L)
11.	<b>Technologies in Fisheries development:</b> Geographic Information System (GIS) technology, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects.	(2L)

### References:

#### Mammalian Reproductive Physiology

1. Austin C.R. and Short R.V., Reproduction in mammals Books 1-5, Univ. of Cambridge
2. Hogarth P.H. biology of Reproduction, Blackie and Son, Glasgow, London.
3. Nalbandov, AV, Reproductive Physiology, Lea and Febiger, Philadelphia
4. Turner and bagnara .General Endocrinology Sixth Edition, W.B. Saunders Company,

#### Aquaculture

1. Agustí, S. 1991. Light environment within dense algal populations: cell size influences on self-shading. Journal of Plankton Research, 13(4): 863-871.
2. Ahamad Ali, S. 1982. Relative efficiencies of pelletized feeds compounded with different animal proteins and the effect of protein level on the growth of the prawn *Penaeus indicus*. Proceedings of the Symposium on Coastal Aquaculture, Marine Biological Association of India, 1: 321-328.
3. Biswas, K. P. (2002), **A Text Book of Fish, Fisheries & Techonology**, Narendra Publishing House, Delhi.
4. Jain, K.K. 2003, **Indused breeding of carps by hypophysation**. In: Carp and Cat fish breeding & culture CIFE. PUBLication, Versova. Mumbai.
5. Jyoti, M. K. & Sharma, A. 2006. **Fishes, Aid to collection, preservation and identification** daya Publishing House, New Delhi.
6. Langur, R.K., 2002. **Management of carp rearing ponds**. 62-65. In: Carp and catfish breeding & culture. C.I.F.E., Versova, Mumbai.
7. Mark, D.L. (1983) **Fish Diseases**. T.F.H. Publication Inc. New Jersey.
8. Sharma, B.D. and Sanjappa, M. 1993., **Flora of India**. Botanical Survey of India, Calcutta. 1-639.
9. Sinha, V.R.P. 1999. **Rural Aquaculture in India**. RAP Publications, 21, Bankok, Thhailand.



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10. Srivastava, C.B.L. 2005, **A textbook of Fisheries and Indian Fish.**  
 11. Tamot/P, Mishra,R, Somdutta (2008). Proceeding of taal, 2007 : In 12<sup>th</sup> Lake Conference : 318-324.

**Course Code and Course Name:**

**23-ZODT-243: Histology and Histochemistry**

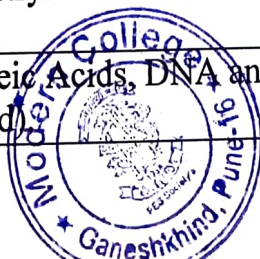
**(2 Credits: 30 Lectures)**

**Semester IV**

After successfully completing this course, students will be able to:

- CO1: Explain the fundamental tissues in details.  
 CO2: Describe the process of histological preparations.  
 CO3: Illustrate the tools used in histological preparations.  
 CO4: Justify the use of various stains and dyes used in histochemical detection of biomolecules.  
 CO5: Justify the importance of Immunohistochemistry.  
 CO6: Draw the structures of various tissues and label them.

Sr. No.	Name of the topic	Lectures allotted
1.	Scope and importance of Histology and Histochemistry Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.	05L
2.	Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra-microtome, cryostat, problems and troubleshooting.	04L
3.	Techniques in histology: General principles for the preparation of Tissue for Histological studies. Fixation – Principle, Aims and Objectives of fixatives. Chemical action of fixatives on cells and tissue components Processing of fixed samples, dehydration (procedure and significance), embedding, block making, Temporary and permanent preparations, whole mount preparation	05L
4.	Staining (staining methods histochemical and immunohistological methods) dyes and dye binding reactive groups, mordants and mordanting	02L
5.	Fundamentals of histochemical techniques: Histochemical classification of Carbohydrates and Principle for the Identification of Carbohydrates- glycogen (Periodic acid/Shift method (PAS)	02L
6.	Histochemical Technique for Proteins, Carbohydrates and Lipids) i) Protein:-Ninhydrin Schiff Method (Amino groups) ii) Carbohydrates- PAS reaction (Bauer-Feulgen method -Glycogen) iii) Lipids – Oil Red O Method, Sudan black B method.	04L
7.	Histochemical classification of Proteins- Principles and mechanism for the identification of total Proteins and Glycoproteins (Bromophenol Blue & Congo red method). Importance of Enzyme histochemistry. -Localization of enzymes in tissues, Alkaline and Acid phosphates.	04L
8.	Histochemical localization of Nucleic Acids, DNA and RNA (Feulgen reaction & Pyronin method)	02L



**Reference books: -**

1. Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo.
2. Histology: Roland lesson and Thomas Leesan WB Saunders company Co., Canada
3. Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY
4. Histochemistry in Focus, A source book of Technics and Research needs (2007), K. Shyamasundari and K. Hanmantha Rao, MJP Pulpishers, Chennai.
5. An introduction to Functional Histology, Bourne, G.H. (1988), Churchill, London.
6. Histochemical Techniques, Cassilman, W.G.B (1988), Methuen, London

**Course Code and Course Name:**

**23-ZODT-244: Apiculture (2 Credits: 30 Lectures)**

After successfully completing this course, students will be able to:

CO1: Explain the basic concepts of apiculture like systematics, colony organization, polymorphism, morphology and foraging.

CO2: Explain the tools and management of apiary.

CO3: Explain the importance of institutions pertinent to

apiculture. CO4: Discuss the setup of beekeeping business.

CO5: Illustrate the bee keeping as occupation.

CO6: Justify the presence of bees to increase the agriculture productivity.

Sr. No.	Name of the topic	Lectures allotted
1.	Biology of Bees : History, Classification and Biology of Honey Bees. Social Organization of Bee Colony, Relation between honeybees and plants o Flora for Apiculture	05L
2.	Rearing of Bees : Introduction to apiculture practices and handling of Beehives. Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth , Selection of Bee Species for Apiculture, Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern), Honey composition, quality and importance	11L
3.	Diseases and Enemies Bee Diseases and Enemies Control and Preventive measures, Hormones in Apiculture.	06L

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4.	Bee Economy : Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc.	03L
5.	Entrepreneurship in Apiculture Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	05L

### References:

- 1) Bees and Beekeeping D. P. Abrol, Kalyani Publisher, New Delhi. 51
- 2) A Comprehensive guide to Bees and Beekeeping, D. P. Abrol. Scientific Publisher, New Delhi.
- 3) Honey bees and their management S. B. Withhead. Axis books Publisher, Jodhpur.
- 4) Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal, M.J.P Publisher, Chennai.
- 5) A Handbook of Beekeeping Dharamsing and D. P. Singh (Agrobios India (Publisher), Jodhpur.
- 6) Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
- 7) Bisht D.S., Apiculture, ICAR Publication.
- 8) Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.
- 9) Introduction to disease of bee – Bailey, L
- 10) World of honeybee – Butter C. G.
- 11) Beekeeping in India – Sardar Sing (ICAR).
- 12) The Principle of Insect Physiology-Wigglesworth, V.S.
- 13) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)
- 14) D.K. Belsare Beekeeping for livelihood

### Course Code and Course Name:

23-ZOUP-243: Special Zoology Lab- III (4Credits)

### Advanced Entomology

- CO1: Identify the histological structure of male and female reproductive system of insect.
- CO2: Identify the eggs of different insects.
- CO3: Identify the different embryonic stages of insects.
- CO4: Identify the different post-embryonic stages of insects.
- CO5: demonstrate various body organs, systems and appendages of housefly and butterfly.



## Histology and Histochemistry

CO1: Identify the various tissues with the help of permanent slides. CO2: Demonstrate the effect of fixatives on tissues.

CO3: Detect the biomolecules with histochemical staining methods. CO4: Sketch and label the microscopic details of tissues.

CO5: Prepare the permanent histological slides.

<b>Module- I : Practical in Advanced Entomology</b>		
1.	Study of types of Eggs in insects. <b>(Compulsory)</b>	(01P)
2.	Early embryology of insect: cleavage, blastula, germ band, gastrula, embryo- 1 day old, 2 day old and 3 day old in suitable insect.	(01P)
3.	Study of post embryonic development of insects: Collection and study of types of Nymph, naiads, larvae and pupae. <b>(Compulsory)</b>	(02P)
4.	Dissection of House fly/ Grass hopper: The digestive system, Nervous system, Male and Female Reproductive System; Temporary mountings of antenna, halter, legs and ovipositor. <b>(Compulsory)</b>	(03P)
5.	Histological studies of male reproductive system (Testes, Vas deferens, Ejaculatory duct, Accessory gland and spermatogenesis). <b>(Compulsory)</b>	(01P)
6.	Histological studies of female reproductive system (Ovariole, lateral oviduct, common oviduct, Accessory glands, bursa copulatrix, spermatheca). <b>(Compulsory)</b>	(01P)
7.	Calculation of insect diversity, indices- Shannon's, Simpson's and Avalanche, understanding their associations and parameters that affect their values	(03P)
8.	Field visits to understand different ecosystems and to study insect occurrence in these systems <b>(Compulsory)</b>	(02P)
<b>Module- II : Practical Histology and Histochemistry</b>		
1.	Study of different types of tissue with help of permanent slides <b>(Compulsory)</b>	(2P)
2.	Study of histological structure of following organs – Stomach, intestine, pancreas, liver, Kidney, testis, ovary, thyroid, adrenal and pituitary.	
2.	Preparation of different reagent/stains for histology <b>(Compulsory)</b>	(2P)
3.	Block preparation and sectioning <b>(Compulsory)</b>	(2P)
4.	Effect of fixatives, fixation of tissues	(1P)
5.	Mucopolysaccharide staining, AB pH 1.5, 2.5 <b>(Compulsory)</b>	(1P)
6.	Proteins and lipid staining by Sudan black <b>(Compulsory)</b>	(1P)
7.	Nucleic acid staining: methyl green, pyronine, feulgen stain <b>(Compulsory)</b>	(1P)

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Course Code and Course Name:  
23-ZOUP-244: Special Zoology Lab- IV

(2 Credits: 60 Hours)

After successfully completing this course, students will be able to:

### **Mammalian Reproductive Physiology**

CO1: Identify the histological slides of reproductive

organ/tissues.CO2: Explain the various types of placenta in mammals.

CO3: Comment on merits and demerits of contraceptive

devices/methods.CO4: Illustrate the technique of gonadectomy.

CO5: Perform vaginal smear technique to identify the phases of oestrous cycle.

CO6: Distinguish the male and female anatomical features of reproductive system in mammals.

### **Aquaculture**

CO1: Identify Indian oysters.

CO2: Identify the common freshwater fish used in culture farming.

CO3: Demonstrate the processing and storing methods for fish and

prawn.CO4: Test the freshness of fish/prawn by histological methods.

CO5: Test the freshness of fish/prawn by biochemical

methods.CO6: Prepare the culture of Daphnia and rotifers.

CO7: Estimate the productivity of water bodies.

### **Apiculture**

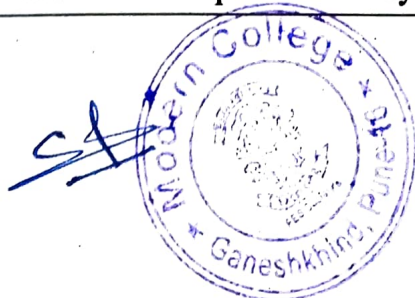
CO1: Identify the honey bees

CO2: explain the bee morphology and

behaviourCO3: Illustrate the bee enemies

CO4: Justify the rearing techniques and bee management

Sr. No.	Name of the Practical	No. of Practicals
	<b>Module- I : Practicals in Mammalian Reproductive Physiology</b>	
1.	<b>Anatomy of male and female reproductive system in rat/Mouse (Compulsory)</b>	1P



2.	Study of histological slides of male reproductive System-Testis, Vas deferens, Epididymis, Prostate, Seminal vesicle, Cowper's gland <b>(Compulsory)</b>	1P
3.	Study of histological slides of female reproductive System-Ovary, Uterus fallopian tube <b>(Compulsory)</b>	1P
4.	Vaginal smear technique in Rat	1P
5.	Study of placental types <b>(Compulsory)</b>	1P
6.	Study of Uterine smooth muscles	1P
7.	Study of contraceptive devices <b>(Compulsory)</b>	1P
8.	E-Demonstration of Vasectomy in rat/Mice	1P
9.	E-Demonstration of Ovariectomy in rat/Mice	1P
10.	Visit to artificial insemination Centre and family planning Centre.	
<b>Module- II : Practicals in Aquaculture</b>		
1.	To Study Physico-chemical parameters of fresh water -pH, Turbidity, Calcium, Nitrate, Ammonia. <b>(Compulsory)</b>	1P
2.	Determination of total alkalinity and total hardness of fresh water.	1P
3.	Determination of dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD) of fresh water. <b>(Compulsory)</b>	1P
4.	Study of conventional method for testing the soil of fresh water pond.	1P
6.	Study of induced breeding techniques by using pituitary extract.	1P
7.	Study of Indian major carps, prawns, and oysters. <b>(Compulsory)</b>	1P
8.	Study of fish disease (bacterial, fungal, protozoan), head and lateral line erosion and eye disease. <b>(Compulsory)</b>	1P
9.	Use of Geographic Information Technique (GIS) and Information and communication technology (ICT).	1P
10.	Visit to fish farm/ fish industry. <b>(Compulsory)</b>	1P

<b>Module- III : Practicals in Apiculture</b>		
1.	Study of Honey bee species, Castes and Bee morphology. <b>(Compulsory)</b>	(3P)
2.	Study of Beekeeping equipment: Bee box and tools. <b>(Compulsory)</b>	(2P)
3.	Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. <b>(Compulsory)</b>	(2P)
4.	Study of diseases and enemies of honeybee. <b>(Compulsory)</b>	(2P)
5.	Study of bee flora in the locality and observations on bee foraging Behaviour. <b>(Compulsory)</b>	(1P)
6.	A compulsory visit to an Apiary or Central Bee Research and Training Institute or a Beekeeper to gain a firsthand experience in handling bees.	(2P)

