।। सा विद्या या विमुक्तये ।।

# स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED**

"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)

Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade

## ACADEMIC (1-BOARD OF STUDIES) SECTION

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**Website: www.srtmun.ac.in** **E-mail: bos@srtmun.ac.in**

**प्रस्तुत विद्यापीठातील जैवतंत्रशास्त्र संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे आराखडा (Structure) बदलासह CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्याबाबत.**

# प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २९ सप्टेंबर २०२० रोजी संपन्न झालेल्या ४९व्या मा. विद्या परिषद बैठकीतील विषय क्र.१०/४९–२०२०** च्या ठरावानुसार **प्रस्तुत विद्यापीठातील जैवतंत्रशास्त्र संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे आराखडा (Structure) बदलासह** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्यात येत आहेत.

01. M.Sc.-I & II Year-Botany
02. M.Sc.-I & II Year-Microbiology
03. M.Sc.-I & II Year-Zoology
04. M.Sc.-I & II Year-Biotechnology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.

**जा.क्र.:** शैक्षणिक–१/परिपत्रक/पदव्युत्तर(संकुल)–सीबीसीएस अभ्यासक्रम/२०२०–२१/**१४६५**

स्वाक्षरित
**सहा.कुलसचिव**
शैक्षणिक (१–अभ्यासमंडळ) विभाग

**दिनांक :** १२.११.२०२०.

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, जैवतंत्रशास्त्र संकुल, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

# SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

Maharashtra State, India

PIN: 431606

(NAAC 'A' Grade)

## School of Life Sciences

**Department of Zoology**

SEMESTER PATTERN CURRICULUM UNDER

CHOISE BASED CREDIT SYSTEM (CBCS)

For

Post Graduate Program

Under

Faculty of Science and Technology

# M. Sc. First Year & Second Year

**(Semester- I, II & III, IV)**

# SUBJECT: ZOOLGY

**For The University Campus**

**With Effective from June, 2020**

## Introduction:

The University Grants Commission, New Delhi (UGC) has initiated some important measures to enhance academic standards in higher education in India, for the purpose improvement in curriculum is one of the important concern in this regard. Swami Ramanand Teerth Marathwada University, Nanded has already initiated reforms in higher education by implementing semester system for the continuous teaching and learning process using Choice Based Credit System (CBCS) as per the UGC guidelines. Revision and updating the syllabus is a continuous process as per the demand for the development of self reliable and useful human resource for the society and ready to work human resource for the country. The CBCS provides choice for students to select any particular subject from the same course or from the same discipline (DSE) and also from other sources and disciplines as open choice subject called Open Electives (OE). There is also choice for the students to choose NPTL, SWYAM, MOOC like online educational portals as an additional credit earning resources. In the new curriculum reform there is compulsory slot for Skill Enhancement/Development Courses (SDC) so as to provide skills for the students through this course. Therefore BOS in Zoology has prepared the curriculum for PG Course in subject Zoology, Department of Zoology at School of Life Sciences this University. The curriculum is designed to include updated contents on various branches of subject Zoology and animal sciences in general.

Already the comments and opinion from students, stakeholders, parents, research students and industries are considered positively to revise the syllabus and the suggestions are incorporated. Moreover the valuable suggestions for further improvement and quality enhancement in this regard are welcome.

Two Year (**Four Semester**) CBCS pattern teaching program M. Sc. Zoology at this University Campus has an intake of 20 students. The course curriculum also includes dissertation for the partial fulfilment of the Postgraduate degree in Zoology from third semester onwards. The medium of instruction and examination of this course is English. The M. Sc. Zoology course offers Dissertation as one of the important component. It is for those students who are interested in pursuing their career in research. There is an option against dissertation to write a scientific review on selected research topics. Based on the academic performance of a student in semester-I, Semester-II the Dissertation Allocation Committee (DAC) under the chairmanship of Head of the Department to advice the students whether to go for the dissertation or Research Review.

## Program Educational Objectives:

1. Exposure of students to animal diversity and to provide them systematic tools of traditional and modern types to acquire this knowledge and skill.
2. To update the syllabus essential for appearing in NET, SET, GATE, ASRB and other competitive exams of UPSC and MPSC.
3. To make aware the students to know the natural resources of country, to utilize by sustainable methods and conservation of living resources.
4. To develop trained and knowledgeable human resource for educational and research institutions and industries; to use this human resource for self reliant India.
5. To develop self employable ability and to apply knowledge for several agro-based industries like sericulture, Goat farming and Apiculture; it will also provide employment to other dependents.

## Program Specific Outcome (PSO):

1. The students will be acquainted to animal diversity, its present status and applied use.
2. Students will get the knowledge and skill from learning this course for self employment and will provide job for others for entrepreneurship development.
3. The students will get updated knowledge of basic and applied branches of Zoology so as to qualify for various state and national level competitive examinations to get employment.
4. The learned students of this course will be leaders in the educational and research institutions and for the industries in the country and abroad.
5. To develop self reliant human resource for entrepreneurship and employability to make our country self reliant.

## Prerequisite:

This Post Graduate Degree Course will be offered to the students having basic knowledge of Zoology and willing to gain additional knowledge in applied and research aspects of Zoology. Admission to this PG Program is given to the students who have studied Zoology subject as one of the optional subject or honours in subject Zoology at their graduation level.

**Prof. S. P. Chavan**,
Chairman, Zoology Syllabus Framing Committee &
Head, Department of Zoology; School of life Sciences,
S. R. T. M. University, Nanded – 431606. M. S.
Email: dr_spchavan@rediffmail.com

**Swami Ramanand Teerth Marathwada University, 'Dnyanteerth', Vishnupuri, Nanded, PIN – 431 603 Maharashtra State, INDIA.**

## SCHOOL OF LIFE SCIENCES

### Department of Zoology

The syllabus framing committee for the M. Sc. Zoology course at Department of Zoology, School of Life Sciences as autonomous department, the committee formulated by the Director, School of Life Sciences, SRTM University with the directives and approval from Hon. Vice Chancellor of SRTM University Nanded. From the inputs and academic planning the syllabus is formulated as details given under.

| Sr. No. | Name of the BOS Committee Member and Address details | Designation |
|---|---|---|
| 01 | Dr. S. P. Chavan<br>Professor and Head, Department of Zoology,<br>School of Life Sciences, SRTMUN<br>Email: dr_spchavan@rediffmail.com<br>Mob: 9421046372 | Chairman |
| 02 | Dr. Nanaware S. S.<br>Chairman, Board of Studies in Zoology, SRTMUN and Professor, Department of Zoology, Yeshwant Mahavidyalaya, Nanded<br>Email:snanware@rediffmail.com<br>Mob: 9423401227 | Member |
| 03 | Dr. Waykar B. B.<br>Professor Zoology,<br>Department of Zoology,<br>Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.<br>Email: bbwaykar@gmail.com<br>Mob: 9284553922 | Member |
| 04 | Dr. Yankanchi S. R.,<br>Associate Professor, Department of Zoology,<br>Shivaji University, Kolhapur<br>Email: sryankanchi@yahoo.co.in<br>Mob: 9579692348 | Member |
| 05 | Dr. Pardeshi Anilkumar,<br>Associate Professor and Head<br>Department of Zoology,<br>Devgiri Mahavidhyala, Aurangabad.<br>Email:pardeshianilkumar@gmail.com<br>Mob: 9511684676 | Member |

**Swami Ramanand Teerth Marathwada University, Nanded,**
**PIN : 431 603, Maharashtra State, INDIA.**

# SCHOOL OF LIFE SCIENCES

## Department of Zoology

**M. Sc. Zoology (First Year and Second Year) Syllabus- w. e. f. June, 2020**
**(CBCS Pattern)**

**OUTLINE OF THE COURSE STRUCTURE**

| Semester | Course Code | Title of the Course | No. of Instructional Hrs/ Week | Type of Course | Total Credits | Marks | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | | | MSA | ESA | |
| Semester-I | | **THEORY** | | | | | | |
| | ZOT-C101 | Animal Taxonomy and Evolution | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT-C102 | Non-Chordates and Proto-chordates | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT-C103 | Cell Biology, Genetics and Molecular Biology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT-E101 **OR** ZOT-E102 | Elective-I Apiculture **OR** Wild Life Biology | 04 | DSE | 04 | 50 | 50 | 100 |
| | | | 16/Week | 3-CC, 1-DSE | 16 | 200 | 200 | 400 |
| | **PRACTICALS** | | | | | | | |
| | ZOL- C101 | Lab Course in Animal Taxonomy and Evolution | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL-C102 | Lab Course in Non-Chordates and Proto-chordates | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL-C103 | Lab Course in Cell Biology, Genetics and Molecular Biology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL-E101 **OR** ZOL-E102 | Lab Course in Apiculture **OR** Lab Course in Wild Life Biology | 04 | DSE | 02 | 25 | 25 | 50 |
| | | | 16/Week | 3-CC, 1-DSE | 08 | 100 | 100 | 200 |
| | **Total Semester- I (Theory + Practical)** | | **32/Week** | **3 CC, 1 DSE** | **24** | **300** | **300** | **600** |
| Semester-II | | **THEORY** | | | | | | |
| | ZOT- C201 | Developmental Biology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- C202 | Chordate Structure and Function | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- C203 | Biochemistry and Immunology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- E201 **OR** ZOT- E202 | Elective-II Goat Farming **OR** Conservation Biology | 04 | DSE | 04 | 50 | 50 | 100 |
| | Open Elective | **Open Elective-I** (From Outside the School / NPTL / SWAYM / MOOC) | 02 | OE | 02 | 25 | 25 | 50 |
| | | | 18/Week | 3-CC, 1-DSE 1-OE | 18 | 225 | 225 | 450 |
| | | **PRACTICALS** | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ZOL- C201 | Lab Course in Developmental Biology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL-C202 | Lab Course in Chordates Structure and Function | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL- C203 | Lab Course in Biochemistry and Immunology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL-E201 **OR** ZOL- E202 | Lab Course in Goat Farming **OR** Lab Course in Conservation Biology | 04 | DSE | 02 | 25 | 25 | 50 |
| | | | 16 | 3-CC, 1-DSE | 08 | 100 | 100 | 200 |
| | **Total Semester-II (Theory + Practical)** | | **34/Week** | **3-CC, 1-DSE 1-OE** | **26** | **325** | **325** | **650** |
| **Semester-III** | | **THEORY** | | | | | | |
| | ZOT- C301 | Animal Physiology and Endocrinology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- C302 | Ecology, Ethology and Biostatistics | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- E301 **OR** ZOT- E302 | Elective- III Fish Biology **OR** General Parasitology | 04 | DSE | 04 | 50 | 50 | 100 |
| | ZOT-S301 | Microscopy | 02 | SDC | 02 | 25 | 25 | 50 |
| | Open Elective | **Open Elective-II** (From Outside the School / NPTL /SWAYM) | 04 or 02 + 02 | (OE) | 04 or 2 + 2 | 50 or 25 + 25 | 50 or 25 + 25 | 100 |
| | | | 18/week | 2-CC, 1-DSE, 1-SDC 1-OE | 18 | 225 | 225 | 450 |
| | | **PRACTICALS** | | | | | | |
| | ZOL- C301 | Lab Course in Animal Physiology and Endocrinology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL- C302 | Lab Course in Ecology, Ethology And Biostatics | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL- E301 **OR** ZOL- E302 | Lab Course in Fish Biology **OR** Lab Course in General Parasitology | 04 | DSE | 02 | 25 | 25 | 50 |
| | | | 12/Week | 2-CC, 1-DSE, | 06 | 75 | 75 | 150 |
| | **Total Semester-III (Theory + Practical)** | | **30/Week** | **2-CC, 1-DSE, 1-SDC 1-OE** | **24** | **300** | **300** | **600** |
| **Semester-IV** | | **THEORY** | | | | | | |
| | ZOT- C401 | General Entomology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- C402 | Applied Entomology | 04 | CC | 04 | 50 | 50 | 100 |
| | ZOT- E401 **OR** ZOT- E402 | Aquaculture, Fisheries Technology **OR** Medical and Applied Parasitology | 04 | DSE | 04 | 50 | 50 | 100 |
| | Open Elective | **Open Elective-III** (From Outside the Schools/NPTL/SWAYM) | 02 | OE | 02 | 25 | 25 | 50 |
| | ZOT- S401 | Ecological Techniques and Microtomy | 02 | SDC | 02 | 25 | 25 | 50 |
| | | | 16/week | 2-CC, 1-DSE, | 16 | 200 | 200 | 400 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1-OE, 1-SDC | | | | |
| | **PRACTICALS** | | | | | | | |
| | ZOL- C401 | Lab Course in General Entomology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL- C402 | Lab Course in Applied Entomology | 04 | CC | 02 | 25 | 25 | 50 |
| | ZOL- E401 | Lab Course in Aquaculture Fisheries Technology OR Lab Course in Medical and Applied Parasitology | 04 | DSE | 02 | 25 | 25 | 50 |
| | ZOL-C403 | Dissertation **OR** Scientific Review **OR** Industrial Training | 04 | CC | 04 | - | 100 | 100 |
| | | | 16/Week | 3-CC, 1-DSE | 10 | 75 | 175 | 250 |
| | **Total Semester-IV (Theory + Practical)** | | **32/Week** | 2-CC, 1-DSE, 1-OE, 2-SDC | **26** | **275** | **375** | **650** |

(**CC**: Core Course, **OE**: Open Elective, **DSE**: Discipline Specific Elective Course, **SDC**: Skill Development Course; **MSE:** Mid Semester Exam, **ESE:** End Semester Exam)

| | |
|---|---|
| **Discipline Specific Elective (DSE):** Elective paper for Zoology students. But they can opt either of these papers OR course (DSE) offered by other Programs (M. Sc. Micro., Bot., Biotech.) of the School of Life Sciences of the same semester. | **Open Elective Course (OEC**): Zoology students must opt for any Open Elective Course or **Skill Development Course (SDC)** offered by other Schools of this University Campus OR **MOOC, NPTL, SWAYAM, NPTL** courses. |

**Distribution of Credits for each Semester and Year for M. Sc. Zoology**

(1 Credit = 25 Marks)

**Total Credits of the Course = 100**
**Total Marks of the Course = 2500**

| **Sr. No.** | **Semester** | **Credits for Theory** | **Credits for Practical** | **Total No. Of credits** | **Credits for Core Papers** (Theory) **(CC)** | **Credits for Discipline Specific Elective Papers**(Theory) **(DSE)** | **Credits for Open Elective Papers** (Theory) **(OE)** | **Credits for Skill Development Course Papers** (Theory) **(SDC)** |
|---|---|---|---|---|---|---|---|---|
| 1. | Sem.-I | 16 | 08 | 24 | 12 | 04 | Nil | Nil |
| 2. | Sem. -II | 18 | 08 | 26 | 12 | 04 | 02 | Nil |
| 3. | **F. Y. Total** | **34** | **16** | **50** | **24** | **08** | **02** | **Nil** |
| 4. | Sem.- III | 18 | 06 | 24 | 08 | 04 | 04 / (2+2) | 02 |
| 5. | Sem. - IV | 16 | 10 | 26 | 08 | 04 | 02 | 02 |
| 6. | **S. Y. Total** | **34** | **16** | **50** | **16** | **08** | **06** | **04** |
| 7. | **Course Total** | **68** | **32** | **100** | 40 | 16 | 08 | 04 |

**Abbreviations Used and explanation**

| **Sr. No.** | **Abbreviations** | **Explanation** |
|---|---|---|
| 01 | CC | Core Course- Core Paper of the discipline (This PG Course) |
| 02 | DSE | Discipline Specific Elective – Elective paper of this PG Course |
| 03 | OE | Open Elective – Elective paper from any other School in this University or any papers from NPTL, SWYAM, MOC |
| 04. | SDC | Skill Development Course. |
| 05 | ZOTC | Zoology Theory Core Paper |

| | | |
|---|---|---|
| 06 | ZOTE | Zoology Theory Elective from Discipline Specific |
| 07 | ZOTS | Zoology Theory Skill Development Course |
| 08 | ZOLC | Zoology Practical Core Paper |
| 09 | ZOLE | Zoology Practical Elective from Discipline Specific |
| 10 | ZOLS | Zoology Practical Skill Dev. Course |

**Internal Assessment** = 50 %

- Two Internal Exams each of 15 Marks (based on MCQs and Theory) Assignment of 10 Marks, Seminar of 10 Marks for each paper is compulsory (15+15+10+10).

**External Assessment** = 50%

At the end of Each Semester there will be External Examination for Theory and Practical Papers as per the University Examination Time Table.

## OPEN ELECTIVES IN ZOOLOGY FOR OTHER SCHOOLS

| Sr. No. | Course Code | Title of Open Elective Course | Number of Credits | Semester in which it is offered | Prerequisite for the course admission (Eligibility) | Course Instructor |
|---|---|---|---|---|---|---|
| **1.** | ZOT-OE101 | Fundamentals of Bee keeping | 02 | I/III | Any Graduate | Prof. S. P. Chavan |
| **2.** | ZOT-OE201 | Fundamentals of Goat Farming & Management | 02 | II/IV | Any Graduate | Prof. S. P. Chavan |
| **3.** | ZOT-OE301 | Fish Farm management | 02 | I/III | Any Graduate | Prof. S. P. Chavan |
| **4.** | ZOT-OE401 | Basics of Sericulture & Management | 02 | II/IV | Any Graduate | Prof. S. P. Chavan |

**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**
**Syllabus- Theory Paper,** Code: **ZOT- C101**
**Title of the Paper – Animal Taxonomy and Evolution**
(Core Course - CC)

**Credits:04** **Marks: 100** **Periods: 60**

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**Course Objective:** The paper is designed to make students aware not only of the great diversity which is being displayed by animals around us but also to prepare them theoretically and practically to study and arrange the Bio-diversity in scientific and natural manner.

**Course outcome:** The students will get basic and advanced knowledge about animal systematics and it will be useful to understand the animal world around them. The students may apply this knowledge in taxonomy related research and job opportunities.

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**UNIT – I**

1. Definition and basic concept of Biosystematics, taxonomy and classification, History of taxonomy, systematics, Taxonomic characters and their kinds and watage.
2. Trends in animal taxonomy: Chemo-taxonomy, Cyto-taxonomy, Molecular taxonomy, Immuno-taxonomy & Para-taxonomy.
3. Theories of animal classification, Hierarchy of categories in animal classification.
4. Importance and application of Taxonomy (biosystematics) in biological studies.
5. Systematics as a profession and its future perspectives,

**UNIT – II**

1. Species categories and species concept.
   a) Typological species concept. b) Nominalistic species concept.
   c) Biological species concept d) Evolutionary species concept.
2. Difficulties in application of Biological species concept.
3. Intra-specific categories & Taxons: a) variety, b) Subspecies c) super species d) Sibling species.
4. Origin of new species taxa and their delimitation.
5. Taxonomic Characters, Types of taxonomic characters, origin of reproductive isolation, biological mechanism of genetic incompatibility.

**UNIT – III**

1. Taxonomic procedures, Taxonomic collections. Preservations and process of identification of Insects, Helminth Parasites, Fishes.
2. Taxonomic keys: Different categories of taxonomy and their merits, demerits, Taxonomic publications.
3. International Code of Zoological Nomenclature (ICZN): Operative principles, interpretation and application of different rules, formation of scientific Name of various taxa.

4. Different types of camera for the field and laboratory studies.
5. Sound Recording and Echo-sound recording devices used in animal detection, Recording and Taxonomic studies.
6. Reference work in Taxonomy: Zoological Records, Biological Abstracts, Proto-zoological Abstracts, Entomology Abstracts, Agri-Index, Bibliography of Agriculture with Subject Index, Books and Journals, Latin Abbreviations, Linnaean Signs.

**UNIT – IV**

1. Neo-Darwinism and Population Genetics: Hardy-Weinberg law of genetic equilibrium,
2. Forces for destabilization in the process of organic evolution : Natural selection, mutation, genetic drift, migration and meiotic drive.
3. Origin and evolution of Fishes. Dinosaurs and their extinction.
4. Molecular Population Genetics: Gene mutation- Patterns of changes in nucleotide and amino acid sequences.
5. Ecological significance of molecular variations (Genetic Polymorphism), Micro-evolution and Macro-evolution.
7. Phylogeny: Cladistics, dendrogram, construction of Phylogenetic tree and analysis.

**SUGGESTED READINGS:**

2. Principles of Animal Taxonomy: Simpson George Gaylord. Columbia University Press, PP. 248, (1961)
3. Elements of Systematic Zoology (second Edition): Mayr Ernest and Peter D. Ashlock. McGraw-Hill Inc. US Pp. 416. (1991).
4. Biodiversity. Wilson E. O.
5. Evolutionary Biology (Vol. 2). Dobzahnskey, Theodosius, Hecht, Max K, Steere, William C. Springer Books. (1968)
6. Genetics and Origin of species. Dobzhanskey, Columbia University Press. (1987)
7. Theory and Practices in Animal Taxonomy: S. C. Kapoor (Oxford and IBH, New Delhi)
8. Evolution: Savage Jay M. Holt, Rinehart and Winston of Canada Ltd. Pp. 161. (1971).
9. Organic Evolution: Richard Swann Lull . Nabu Press . pp. 812, (Nov. 2011).
10. Evolution of Vertebrates. Edwin H. Colbert. Wiley, 1 January (2011)
11. Evolution and Genetics. Merrel D. J., Jones

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**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper** Code: ZOT- C102

**Title of the Paper – Non-Chordate and Proto-Chordates**

(Core Course – CC)

**Credits: 04** **Marks: 100** **Periods: 60**

**Course Objectives:**

1. To describe and explain the basic principles of animal classification, form and function among non-chordate phyla.
2. To describe the main elements of the biology and evolutionary relationships of the major groups of non-chordates
3. To describe the structure and function of vital organs among non-chordate phyla.

**Course outcome:** The students will get an idea about how the life processes goes on in the animals in their surrounding . Also the knowledge they use to monitor, manage, conserve and utilize these creatures. Also it gives an idea about how a Human being is evolved in sequential evolution process.

**UNIT – I**

1. Organization of Coelom : Acoelomata, Coelomata, Pseudocoelomata. Protostomia and Deuterostomia.
2. Food, feeding and reproduction in Protozoa.
3. Paramecium: Structure, Food and Feeding, Locomotion.
4. Spongocoel, Coelenteron.
5. Types of Cells and their functions in Sponges
6. Polymorphism, functions of zooids in Obelia Colony.

**UNIT- II**

1. Reproduction and Alternation of generation in Coelenterates.
2. Structure and working of respiratory organs in Insects, Scorpion, Prawn, Bivalve, *Pila globosa*.
3. Excretion – Structure and working of coelom, coelomoducts, flame cells, Nephridia and Malphigian tubules.
4. Primitive nervous system : Coelenterata and Echinodermata.
5. Advanced nervous system in Annelida, Arthropoda and Mollusca (Cephalopoda).

**UNIT – III**

1. Larval forms in Invertebrates (Porifera to Echinodermata) and their Evolutionary Significance.
2. General characters of Cephalochordates.
3. General characters of Urochordata
4. Affinities of Cephalochordates to Vertebrates and Origin of Vertebrates.
5. Introduction to Minor Phyla.

**UNIT – IV**

1. Cyclostomes: General characters; Classification and characters of Pertomyzon and Myxin.
2. Ostracoderms: Characters of Jawless fossil fishes.
3. Placoderms: Characters of fossil Placoderms.
4. Latimeria: Living fossil fish- occurrence and characters

**References:**

1. Modern Textbook of Zoology (12th Edition): R. L. Kotpal. Rastogi Publication. (2019).
2. Invertebrate Zoology: A Laboratory Manual: Alan R. Holyoak. Creatspace Independent publisher. Pp. 130. (2013).
3. Invertebrate Structure and Function. EJW BARRINGTON. E-book, (1967).

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**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology-First Year, Semester – I - (CBCS)- (w. e. f. 2020-21)**

**Syllabus- Theory Paper** Code: ZOT- C103

**Title of the Paper – Cell Biology, Genetics, Molecular Biology**

(Core Course- CC)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course Objectives:**

1. To study the structure and function of the basic unit of living organisms.
2. To study stages in cell cycle (including cell death and cancer), cell differentiation, and organelles and other cellular structures in the growth and functioning of the cell (including membrane transport and signaling).
3. To understand the basic concepts and processes in development of an organism.
4. The objective of this course is to provide a clear understanding of DNA so that they can manipulate and understand the basic tools and techniques involved in it. Strong foundation in genetics and molecular biology enables the students to familiarize themselves with genetic engineering.

**Course Outcome:**

The students will be able to apply the knowledge in education and research on molecular biology in various fields at industrial, institutional levels. Nationally as well as Internationally.

**Unit-1**

1. Introduction to basic concepts of cell Biology, Overview of Prokaryotic and Eukaryotic cells.
2. Types of cells in animals.
3. Nucleus, Mitochondria and its genetic organization, Structure and organization of Chromatin. Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments - structure, composition, functions.
4. Transport across cell membrane: Types of transport- Na & K ATPases, proton pumps, Bulk transport.

**Unit-II**

1. Cell interactions: cell adhesion, role of cell adhesion in inflammation and metastasis.
2. Cell Cycle: Major events during G1, S, & G2 phases, regulation of cell cycle, cell. cycle and apoptosis.
3. Cell signaling: Introduction to cell signaling, types of receptors, extra-cellular messengers and signal transduction with examples.
4. Cell Differentiation & differential gene activity, Biology of Cancer: Types and characteristics, Oncogenes & tumour suppressor genes and chemical carcinogenesis, biomarkers of cancer detection. Developmental genetics of *C. elegans* and *Drosophila melanogaster.*

**Unit III**

1. Overview of Mendelian Genetics, Fine structure of gene, types of mutations, UV and chemical mutagens; Ames test for mutagenesis; Retroviruses.

2. Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication,
3. Types & mechanism of DNA Repair, Process & types of Recombinations, Holiday junction, gene targeting, FLP/FRT and Cre/Lox recombination, Rec A and other recombinases.

**Unit IV**

1. Modifications in RNA: 5'-Capping, 3'-polyadenylation, and splicing, RNA editing, RNA stability, Process of Prokaryotic and Eukaryotic transcription, RNA polymerase,
2. General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing.
3. Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination.
4. Regulation of translation, co-and post-translational modifications of proteins. Synthesis of secretary and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes. Receptor mediated endocytosis.

**References:**


1. Molecular Cloning: a Laboratory Manual. J. Sambrook. E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York (2000).
2. Introduction to Practical Molecular Biology, P.D. Dabre, John wiley & Sons Ltd., New York, (1988).
3. Molecular Biology LabFax, T.A. Bown (Ed.) Bios Scientific Publishers Ltd., Oxford, (1991).
4. Molecular Biology of the Gene (4th Edition), J. D. Watson, N.H. Hopkins, J. W. Roberts, J. A. Steeitz and M. A. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and d. Baltimore, Scientific American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. d. Watson Garland publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998.
8. Molecular Biology and Biotechnology. A comparative desk reference, R. A. Meyers (Ed.) VCH Publishers, Inc., New York, 1995.
9. Cell and Molecular Biology – De Robertis.
10. Gene – IX, Benjamin Lewin, Oxford University Press..
11. Cell and Molecular Biology. – Gerald Karp, 5th Edition, John Willy and Sons. Inc. 2008.
12. Cell Biology – David E. Sadava, Jones and Bartlett Publishers, London, 1993.
13. Molecular Biology of Gene (V- Edition ) – J. D. Watson, Lania A. Raker, Stephan P. Bell, Alexander Gann, Micheal Eveni – Pearson Education and Publication.


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**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper-** Code: ZOT- E101

**Title of the Paper – Apiculture**

(Discipline Specific Elective – DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course Objectives:**

To introduce the students about potential of useful insect the Bees for getting Honey and other byproducts from their scientific culture methods.

To educate the students about conservation of bees to increase the production in agriculture duce to effective pollination.

**Course outcome:**

Students can start their own business of Apiculture/Bee farming, train others and will be able to enter in private, Govt sectors or in the research related to Apiculture/Bee keeping.

**Unit- I - Introduction of Modern bee keeping**

1.1. Importance of beekeeping
1.2. Scope of beekeeping
1.3. Bee species
1.4. Cast differentiation, Colony organization
1.5. Division of labour in honeybee
1.6. Life cycle of honeybee and nuptial flight

**Unit- II. Scientific bee keeping**

**2.1 Beekeeping equipment's**

2.1.1 Equipments for improving efficiency of honeybees
2.1.2 Equipments for improving efficiency of bee's keepers
2.1.3. Equipments for improving hygienic conditions
2.2. Methods of Swarm capturing. 2.2.1. Capturing a Swarm from a tree branch . 2.2.2. Capturing a Swarm from Ground
2.3. Inspection and Handling the Colony
2.4. Hiving by dividing an established colony.
2.5. Establishment, Seasonal Management of apiary and inspection of bee colonies.

**Unit III - Apiculture in Agriculture**

3.1. Bee plants and floral calendar- Importance and qualities of good bee flora.
3.2. Pollination, Need of bee pollination
3.4. Management of honeybees for pollination.
3.5. Migratory beekeeping
3.6. Honeybee products
3.6.1. Honey- Its constituents, methods of collection and uses.
3.6.2. Importance of other bee products to mankind
a) Pollen –Method of collection, constituents, uses.
b) Royal jelly- Method of collection, constituents, uses.
c) Propolis - Method of collection, constituents, uses.
d) Bee wax- Method of collection, constituents, uses.
e) Bee venom- Method of collection, constituents, uses.

**Unit-IV Problems of beekeeping industries,**

1. Natural Climate Condition,
2. Natural enemies, pest and diseases, human activities
3. Apiary and Hive Hygiene
4.Economics of beekeeping

## References:

1) Introduction to disease of bee –Bailey, L

2) World of honeybee –Butter C. G.

3) Beekeeping in India –Sardar Sing (ICAR)

4) The Principle of Insect Physiology-Wigglesworth, V.S.

5) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)

6) D. K. Belsare, Beekeeping for livelihood

**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology-First Year, Semester – I - (CBCS)- (w. e. f. 2020-21)**

**Syllabus- Theory Paper-** Code: ZOT-E102

**Title of the Paper – Wild life Biology**

(Discipline Specific Elective- DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

Man himself is a part of ecosystem. The ecosystems in the world are continuously under the pressure of anthropogenic activities and human mediated ecological changes. Several animal species are under the survival threats and accordingly they are categorized by IUCN. The aim of the contents of this course is to introduce and explain about various conservation issues of the ecosystem and animals. To introduce the students about wild life and wild habitats, about depleting wild life and human wild life conflict.

**Course outcome:**

The knowledge acquired from this course will be useful to work as nature conservationist, conservation, restoration, rehabilitation and research, extension programs on Wild Life in private and Govt sector,. NGOs.

**Unit-I. Introduction to Wildlife.**

1. What is Wildlife?. History of Wildlife in India and present status.
2. Why to protect and conserve the wildlife?. Values of wildlife: Ecological, Commercial, Aesthetic and tourism, Game, Scientific, ethical.
3. Causes of wildlife destruction : In past and present.
4. Protected wild life in India : Amphibians, Reptiles, Birds and Mammals.
5. Wild life along Indian sea coast.
6. Sanctuary? Criteria to establish a sanctuary. Sanctuaries in the World and protected animals.
7. What is National Park?. Criteria to establish National park. National Parks in India and in the World. Web search for National parks and sanctuaries.
8. Study of Important National Parks and Sanctuaries in India and world: Location, area, wild life, Administration and management.: i) Alberta national Park, Alberta-Congo- for Gorilla. ii) Corbett National Park- U. P.- -for Indian Tiger. iii) Gir National Park for Lion in Gujarat. iv) Kaziranga National Park, Aasam- One horned Rhino. v) Keoladev (Ghana) National Park, Bird sanctuary, Bharatpur, Rajasthan vi) Nandur Madhmeshwar Bird Sanctuary, Niphad near Nashik M. S. vii) Tadoba National Park, Chandrapur, M. S. viii) Desert National Park, Jaisalmer, Rajasthan.

**Unit-II. Wild Life Assessment and Management.**

1. Total count method: Basic concept and application of sample count.
2. Direct count: Block count, Transect method, Point count, visual count, Waterhole survey.
3. Indirect count: Call count, Track count, Pellet count, Pag-mark and footprints.
4. Use of different camera in wildlife census: Wild life photography, Trap camera, GPS and GIS used in Wildlife, Radio-collars: structure and application.
5. Population estimation of birds.
6. Wildlife diseases and management.

**Unit-III**. **Wildlife –Human conflict**.

1. Damage caused, reasons, control measures on : Elephants, Tiger, Leopard, Lion, Deer, Wild Boar, Peacock, Gaur, Monkeys.
2. Translocation of wildlife: Traps for various animals and their use.
3. Rescue of animals and importance: rescue of snakes, deer, monkeys and other creatures entered in human habitation, agro-farms etc.
4. Tranquilization: equipments, methods, importance and precautions.
5. Poaching of wildlife and prevention.
6. Manipulation of habitat for conservation: Food, water, shelter, shed. Microhabitat for birds, mammals, amphibians.

**Unit-IV. Conservation methods and Wild Life organizations, education and research**.

1. Establishment, Headquarter, working structure, objectives and motto, rules and regulations, legal rights: a) U. I. C. N., b) W.W.F., c) BNHS, d) Wildlife preservation e) society, Central Zoo authority of India, f) National Board for wild life
2. Institutes for wildlife research, conservation and management.
3. Methods of wildlife conservation.
4. Anti-poaching operations and Village Forest councils.
5. Role of Govt. and NGO's in wild life conservation.
6. Government administration in Wildlife protection and conservation: MOEF, State Biodiversity Board, State Forest Department.
7. Introduction to Wildlife Protection Act: Rules, regulations, legal rights of the Government and its implications.

**References:**


1. **Saharia, V. B. 1982** Wildlife in India, Nataraj Publishers, Dehra Dun.
2. **Seshadri, B. 1986**. India's Wildlife reserves , Sterling Pub'rs Pvt. Ltd., New Delhi 3.
3. **Giles, R. H. Jr. (Ed) 1984**. Wildlife Management Techniques 3rd edition. The wildlife Society, Washington. D.C. Nataraj Publishers, Dehradun. India
4. **Dasmann, R. f. 1964,** Wildlife Biology. John and Wiley and sons Newyork. Pp231.
5. **Robinson, Wl. and Eric, G. Bolen, 1984**. Wildlife Ecology and Management Mac Millan Publishing Co, Ny. Pp 478.
6. **Rodgers, W. A. 1991**. Techniques for Wildlife census in India – A Field manual technical Manual – Wildlife Institute of India, Dehra Dun. 7. Sukumar. R. 1989. Ecology and management of Asian elephants. Oxford University Press.


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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**
**Practical Paper Code-ZOL- C101,**
**Lab Course in Animal Taxonomy and Evolution**

**Credits: 02** **Marks: 25**

1. Equipments and collection methods for the invertebrates and vertebrates from terrestrial and aquatic habitats: Protozoa, Helminthes, Arthropods, Fishes.

2. Photo, Audio, Sonogram of animals for taxonomic studies.

    a. Use of still camera and Video-camera, Use of Infrared night vision camera, Sound recording in animals & Underwater camera. Sound recording of Birds, Frog, Mammal.

3. Taxonomy of local fauna for the distribution and conservational status and their preservation: Phytoplankton/Zooplankton, Gastropod/Bivalve, Ants, Spiders/Scorpion Mosquito, snakes, Birds. Use of specimen/Photo/Video/Audio

4. Studies on fossils, living fossils and connecting links Archaeopteryx, Peripatus, Limulus, Nautilus, *Latimeria* using models, photo.

5. Structure, types, management and maintenance of Museum and aquarium.

6. Problems and exercises in phylogeny of model organisms.

7. Molecular systematics of Fishes/Helminths and phylogenetics.

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**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**
**Practical Paper Code-ZOL- C102,**
**Lab Course in Nonchordates and Protochordates**
**Credits: 02** **Marks: 25**

1. Museum study- based on Photo and /or models of the animals: minimum any two from each Class/Phyla given below. (Use of Photo, Model, Video, Audio, Sketches/Specimen)
   Protozoans- for the structural differences and habitat specificity, locomotory structures; Porifera spicules; Typical colony of Coelenterata; Arthropoda; Echinoderms; Cestodes, Trematodes, Nematodes and Molluscs, Amphioxux, Belanoglossus.
2. Study of various types of spicules and canal systems in sponges using specimen, slides, e-resources.
3. Larval forms in Helminths.
4. Larval forms in Arthropods.
5. Permanent mounting and specimen study of various zooids in coelenterate colony/Phytoplankton/Zooplankton.
6. Participation of students in One study tour: long distance/1-4 Days preferably to the sea coast, Sanctuary, National park etc. to observe the animals in their natural habitat and report writing/Seminar.

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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology-First Year, Semester – I - (CBCS)- (w. e. f. 2020-21)**
**Practical Paper Code-ZOL-C103,**
**Lab Course in Cell Biology, Genetics and Molecular Biology**
**Credits: 02** **Marks: 25**

1. Study of Osmotic stress on cell membrane.
2. Cell organelle separation by Centrifugation: Nucleus. Mitochondria, Chloroplast
3. Cell division study- Mitosis and Meiosis,
   Onion/Garlic root tip, Grasshopper testis, snails.
4. Preparation, characterization, identification and submission of five slides of cells isolated from different organs of invertebrate and vertebrate animals.
5. Isolation of genomic DNA/RNA from Bacteria, animal and plant cells.
6. Isolation of plasmid DNA by using alkaline lysis method.
7. Study of in-vitro transcription and translation using PCR.
8. Genetic recombination (Conjugation, transformation, transduction) in bacteria.
9. Restriction fragment Length Polymorphism in DNA (RFLP)
10. Random amplified Polymorphic DNA (RAPD).
11. Study of Southern hybridization.
12. Cloning in plasmid vectors and analysis of gene products.
13. Blotting and Hybridization techniques.
14. Restriction, digestion and ligation of DNA.
15. Preparation of competent cells and transformation by CaCl2 method.
16. Agarose Gel Electrophoresis (PAGE) by using DNA markers for molecular weight determination.

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**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology-First Year, Semester – I - (CBCS)- (w. e. f. 2020-21)**
**Practical Paper Code-ZOL- E101,**
**Lab Course in Apiculture**

**Credits: 02** **Marks: 25**

1) Study of external morphology of honeybee: Difference between Queen, Drones and Worker bees.

2) Study of Indian species of honeybee (External morphological features, comparative differences and special identification features)

3) Study of life cycle of honeybee

4) Study of architecture of honey comb

5) Study of diseases, pests, parasites and predators of the honeybee

6) Study of bee keeping equipments and their uses.

7) Microscopic study of morphology of bee sting.

8) Visit to an apiary to study bee-crop relationship and management practices of honeybees for Pollination.

9) Chemical analysis of honey: test for pure honey. Assessment for the adulteration in honey.

10) Identification and uses of various products and by-products from Apiculture: Honey, Proposlis, Bee wax, Pollen, Royal Jelly, Bee Bread, Bee venom.

11) Maintenance of honeybee colony (Rearing of live colony) in University campus.: Demonstration and setting of various parts of Bee Box.

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**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology-First Year, Semester – I - (CBCS) - (w. e. f. 2020-21)**
**Practical Paper Code-ZOL-E102,**
**Lab Course in Wild Life Biology**

**Credits: 02** **Marks: 25**

1. Foot-print studies in Wildlife. Pellet shape and structure based identification of Wild animals. Make a plaster cast of domestic animals: Goat, Cat, Dog, cattle and its measurements and Compare the foot prints (Pagmarks) using photo, sketch of deer, Rohi, wolf, Jackle, Tiger, Lion, Leopard, wild boar.

2. Equipments for rescue of snakes, Birds, Mammals: Structure and application.

3. Habitat manipulation for conservation of wildlife: Nesting sites for birds: Artificial nesting in Birds.

4. Microscopic observation of fecal pellets/wastes of Hare, Deer, Monkeys, wild Boar, Wild cats, Birds for parasites and their infective stages.

5. Structure and working of traditional traps and netting methods used in wild life hunting and trapping.

6.Make a video, Audio, Documentary on wild animal, habitat, nest, mating calls, feeding calls etc. and its submission during examination.

7.Study of tracks, dung mounts, fecal pellets, hair, scats, burrows, nests, feathers.

8. DNA Fingerprinting in wildlife studies.

9. Trap camera use in wild life study. Collor Tags and GPS application in wild life study.

10. Visit to wildlife Sanctuary/National Park and submission of Report. Population estimation of Wild Life using statistical methods.

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**M. Sc. Zoology-First Year, Semester – II - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper** Code: ZOT- C201

**Title of the Paper – Developmental Biology**

(Core Course - CC)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course objectives:**

1. To study the structure and function of the basic unit of living organisms.
2. To study steps in animal development.
3. To determine the modern trends and tools, techniques in Animal embryology and development.

**Course Outcome:**

After learning the development of life from cell to multicellularity complex and coordinated systems in organisms the students can apply this knowledge for research, and education, to solve the problems related to development in animals through research.

**Unit I. Gametogenesis, fertilization and early development:**

1. Production of gametes-

1.1. Spermatogenesis in mammals, structure of sperm, Semen formation and composition.

1.2. Oogenesis in mammals, Structure of egg and types.

2. Cell surface molecules in sperm-egg recognition in animals;

**Unit II Zygote formation in animals**

1.1. Capacitation

1.2. Prevention to polyspermy (Fast block and slow block)

1.3. Acrosome reaction.

1.4. Activation of Egg metabolism.

2. Type of eggs, Cleavage and patterns of embryonic cleavage.

3. Blastula formation and fate map of blastula .

4. Gastrulation and formation of 3 germ layers in animals (Ex. Frog and Chick)

5. Extra embryonic membrane formation.

**Unit III Basic concepts of animal development:**

1. Potency.

2. Commitment.

3. Specification.

4. Induction.

5. Competence.

6. Determination and differentiation.

7. Morphogenetic gradients.

8. Cell fate and cell lineages.

9. Stem cells.

10. Imprinting; mutants and transgenics in analysis of development.

**Unit IV Morphogenesis and organogenesis in animals:**

1. Cell aggregation and differentiation in *Dictyostelium*;

2. Axes and pattern formation in *Drosophila*,

2.1. Segmentation genes, 2.2. Homeotic genes

3. Nuclear transplantation and cloning in mammals.

4. The concept of totipotency embryonic stem cells.

5. Differentiation of neurons,

6. Post embryonic development- 6.1. Larval formation, 6.2. Metamorphosis; 6.3. Environmental regulation of normal development;

7. Sex determination.

## References:

1. Developmental Biology by Gilbert Scott

2. Molecular biology of the cell By Albert et al

3. Molecular biology of the Gene by Watson et al

4. Principle of Development by Wolpert

5. Genes VIII/ IX By Benjamin Lewin

6. Developmental Biology by Balinsky

7. Developmental Biology by Berril

8. Developmental Biology by Waddington

9. Chordate Embryology: Verma and Agarwal.

9. Readings are also assigned from journals and from Internet resources such as Medline( Http//www.ncbi.nlm.nih,gov/entrez/quey.fcgi) and bio Med Net ( http/www.bmn.com/) Wikipedia etc.

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**M. Sc. Zoology-First Year, Semester – II - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper** Code: ZOT- C202

**Title of the Paper – Chordates structure and function**

(Core Course – CC)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

To study the basic structure and function of Chordates. To determine the progress and complexity in the development and evolution of different chordate groups for their habitat selection, adaptation and regulation of the life processes.

**Course outcome:**

Students will get an idea about how the evolution process incurred, its sequences, adaptations and degenerations. It is a basic study can be useful for all kinds of application issues in animal science.

**UNIT-I**

1. Basic structure of Chordate animal and its characters.
2. Difference between Vertebrates and Chordates.
3. Adaptive Radiation in Vertebrates.
4. Distribution and characters of Lung fishes.
5. General structure and functions of Integument and its derivatives in vertebrates.

**UNIT-II**

1. Evolution of Heart and Aortic arches in Vertebrates.
2. Respiratory pigments in animals.
3. Structure of Gill and respiration in fishes.
4. Structure of lung and respiration in Mammals.
5. Integumentary respiration in Amphibia.

**UNIT-III**

1. Comparative structure of alimentary canal and associated digestive glands in vertebrates.
2. Structure of brain and spinal cord in Fishes and mammals. Cranial nerves and their functions in fishes and Mammals.
3. Comparative structure of heart in Elasmobranches, Teleost, Frog, Calotes and Typical Mammal. Single and double circulation of blood.
4. Structure and functions of Kidney in fishes and Mammals.

**UNIT-IV**

1. Jaw suspension in vertebrates.
2. Structure and functions of Brain and cranial nerves in fishes and Mammal.
3. Structure and working of Mammalian Ear and Eye.
4. Distribution and Characters of pouched mammals- Kangaroo, Aquatic mammals- Whales.
5. Introduction to Dugong, Seal and Walrus.
6. Classification and characters of Chiroptera.

**SUGGESTED READINGS**

1. Vertebrate Zoology – Prasad. 2. Vertebrate Zoology- Kotpal and Kshetrapal- Rastogi Publication, Meerut. 3. Invertebrate Zoology-Kotpal and Kshetrapal- Rastogi Publication, Meerut.
4. Chordate Zoology- Jordan and Verma
5. Vertebrate Body – Romer, W. B. Saunders and Co. Philadelphia.
6. Life of Mammals – Young J. Z., Oxford University Press, London.
7. Evolution of Chordate Structure – Smith H. S.
8. Chordate Zoology – Dhami and Dhami.

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**M. Sc. Zoology-First Year, Semester – II - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper,** Code: ZOT- C203

**Title of the Paper – Biochemistry and Immunology**

**(Core Course - CC)**

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course Objective:**

1. Objective of this course is to help the student to navigate the discipline of Biochemistry that explains how the collection of inanimate molecules.
2. To determine the biochemistry and biochemical reactions in the animals as their life processes.

**Course Outcome:**

1. The students may clear the NET/SET/GATE and other scientific screening tests conducted by various departments and agencies involved actively in research and development in science and technology.
2. There are opportunities for the students after completing this course in bioprocessing and biotechnological research institutes.

**Unit-I**:

1. Acids and bases, Buffer solutions, Physiological and Biological Buffers.
2. Introduction to Amino acids and proteins. Amino acid, structure and properties of Amino Acids. Non-standard, Modified Amino acids.
3. Biologically important peptides.
4. Structure of proteins, Ramchandran plot. Fibrous proteins, Globular proteins, collagen, elastin, keratins, myoglobins, haemoglobins, haemoglobin varients and pathological effects, Protein sequencing.

**Unit-II**

1. Nucleic acids: Structure and functions .
2. Double stranded DNA (A, B, Z DNA). Triple and quadraplex structures.
3. RNA Types and biological functions.
4. Glycolysis, Glycogenesis, Gluconeogenesis, Kreb's Cycle (TCA Cycle).
5. Introduction to Enzymes and their Classification. Enzyme action. Coenzymes.

**UNIT-III**

1. Acquired or adaptive immunity.
2. Active and Passive immunity.
3. Cells and organs related to immunity- (Generation, activation and differentiation) T-Cells and B-cells
4. Immunoglobulins- Classification, structure and functions.
5. Antigen-Antibody interaction and its applications.

**UNIT-IV**

1. Hypersensetivity: Types and causing factors.
2. Immunodeficiency and AIDS.
3. Auto-immune diseases.
4. Hybridoma Technology: Monoclonal antibodies and polyclonal antibodies.
5. MHC (Major Histo-competability Complex) Structure and functions.

## References:


1. Biochemical calculations- Erwin, H. Segel. John Willy and Sons.
2. General Chemistry- Linus Pauling. W. H. Freeman and Company
3. Biochemistry-D. Voet and J. G. Wileymand Sons.
4. Physical Biochemistry- D. Frefilelder. W. H. Freemand and Company.
5. Laboratory Techniques in Biochemistry and Molecular Biology, Worh and Work.
6. Understanding Chemistry, CNR Rao, Universities Press, Hyderabad.
7. A biologists Guide to Principles and Practices in Biochemistry- K. Wilson and K. H. Coulding. ELBS, (1986).
8. Tools of Biochemistry- T. G. Cooper.
9. Biochemistry- G. H. Well.

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**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology-First Year, Semester – II - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper-** Code: ZOT- E201

**Title of the Paper – Goat Farming**

(Discipline Specific Elective – DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives of the course:**

1. To introduce the zoology students for applied education based courses like Goat Farming.
2. To promote the agro-based business like Goat-farming in the local farmers and unemployed youth for their self employment.
3. To introduce the business thought about Goat meat is highly demanded meat all over the world hence high need of goat farming.

**Outcome of the course:**

1. Students can start their own small scale or large scale business.
2. Students may get the jobs in the goat farms as scientific expert and manager of the farm.
3. There are research opportunities in the Goat research Institutes, Goat milk, meat and leather industries for those who complete the course successfully.

**Unit-I. Introduction and Planning**

1. Introduction to goat farming and support of goat farming for low income group.
2. Goat Breeds in the world: For meat, fur, milk, leather. Biography of commercially important goat species in India
3. Exotic goat species introduced in India: their success and failure.
4. Basic requirements, Planning for goat farming: Finance by self and bank loans, self help groups. Project formulation, Investment, income and profit in goat farming business.
5. Types of goat farming: success and problems in types of shelter.
6. Structure, engineering and basic requirements to establish a goat farm.

**Unit-II. Goat Health and Management**

1. External morphology of goat, commercial use of goat body parts: Skin-Leather, Hairs, Hooves and horns, bones, Muscles and organs, Blood.
2. Characters, composition and uses of Goat milk.
3. Nutritional value of Goat meat (Chevon) and its biochemical composition. Preservation and processing of meat. Desirable features of chevon.
4. Digestive system of goat. Basic, supplementary and nutritional food for goats.
5. Reproduction, estrus cycle, breeding and reproduction in Goats. Management and care of Bucks, doe and kids.
6. Diseases in Goat: Causative organism, symptoms, diagnosis and treatment and preventive measures. Vaccination against infectious diseases in goats. Disease management_ Bacterial, Viral, Fungal, Parasitic, Nutritional. Causes and mortality in goat.

**Unit-III. Goat products, by-products, marketing management**

1. Fodder plants for goat: Shrubs, trees, grass, agriculture waste.
2. Goat meat: slaughter of goat, separation of goat meat, preservation, processing, marketing, distribution and export.
3. Goat leather processing and uses.
4. Fecal waste, urine from goat farm and its management, goat manure.

**Unit-IV Farm management and Economics.**

1. Labor, office staff, instruments, transport vehicles, maintenance and management.
2. Goat market, Local Bazaars: processes and places.
3. Economics of goat farming.

4. Goat farming research and education institutes in India.
5. Wild goat species in India.

**References:**

**1)** Hand Book of Goat farming In India**.** Engineers India Research Institute (EIRI)

**2)** Kumar, Shalander : Commercialization of Goat Farming and Marketing of Goats in India.

**3)** Final Report of ICAR Ad-hoc Research Scheme 2004-07, Central Institute for Research on Goats, Makhdoom, Mathura. Agricultural Economics Research Review Vol.20 (Conf. Issue)

**4)** Birthal, P.S. and P.K. Joshi (2006) High Value Agriculture for Accelerated and Equitable Growth: Policy Brief. No. 24, National Centre for Agricultural Economics and Policy Research, New Delhi, December.

**5)** Dalgado, C., M. Rosegrant, H. Steinfedl, S. Ehui,and C. Courbois (1999) Livestock to 2020 — The Next Food Revolution. Food, Agriculture and Environment Discussion Paper 28, IFPRI, Washington.

**6)** Kumar, Shalander (2007) Commercialization of Goat Farming and Marketing of Goats in India. Final Report of ICAR Ad-hoc Research Scheme 2004-07, Central Institute for Research on Goats, Makhdoom, Mathura.

**7)** Kumar, Shalander (2007) Multi-disciplinary project on transfer of technology for sustainable goat production, Annual Report 2006-07, Central Institute for Research on Goats, Makhdoom, Mathura.

**8)** Kumar, Shalander and P.R. Deoghare (2002) Goat rearing and rural poor: A case study in south-western semiarid zone of Uttar Pradesh. Annals of Arid Zone, 41(1): 79-84.

**9)** Kumar, S., V.S. Vihan and P.R. Deoghare (2003) Economic implication of diseases in goats in India with special reference to implementation of a health plan calendar. Small Ruminant Research, 47: 159-164.

**10)** Singh, N.P. (2006) Technological advances for commercial goat production. In: Commercial Goat and Sheep Farming and Marketing: Farmer-Industry- Researcher Interface, Eds: N.P. Singh, S. Kumar, A.K. Goel and R.K. Vaid, Central Institute for Research on Goats, Makhdoom, Mathura, pp. 1-17.

**11)** Singh, N.P. and Shalander Kumar (2007) An alternative approach to research for harnessing production potential of goats. Proceedings of 4th National Extension Congress, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur,

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**M. Sc. Zoology-First Year, Semester – II - (CBCS) - (w. e. f. 2020-21)**

**Syllabus- Theory Paper-** Code: ZOT- E202

**Title of the Paper – Conservation Biology**

(Discipline Specific Elective – DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

Man himself is a part of ecosystem. The ecosystems in the world are continuously under the pressure of anthropogenic activities and human mediated ecological changes. Several animal species are under the survival threats and accordingly they are categorized by IUCN. The aim of the contents of this course is to introduce and explain about various conservation issues of the ecosystem and animals.

**Course outcome:** The knowledge acquired from this course will be useful to work as nature conservationist in private and Govt sector,. NGOs.

**Unit-I. Biodiversity:**

1. Definition of Biodiversity, Why to preserve and conserve the Biodiversity? Species diversity, ecosystem diversity. Habitat biodiversity: Alpha, Beta and Gama diversity. How biodiversity is estimated.
2. Biodiversity at global level: Arctic, Forests, Fresh water, Marine, Arid desert, saline marshes and brackish water. Wetlands, Montains, hillstreams, vallies. Grasslands.
3. Criteria for Biodiversity Hotspots. Importance of Biodiversity hotspots.
4. Biodiversity Hotspots in the world and India, and their specific features.
5. Importance and value of Biodiversity: Consumption value; Productive value; Social and ethical value.
6. Climate change and Biodiversity. Natural Resources, overexploitation and their conservation.

**Unit-II. Conservation-1**

1. Endemic plants and animals, causes of endemism.
2. Traditional knowledge for biodiversity conservation.
3. Cultural practices for biodiversity conservation.
4. Diversity and conservation of endemic cultivated crops and endemic animals in Maharashtra.
5. National and state animals in India. National animals of various countries in the world.

**Unit-III. Conservation - II**

1. Alien species and their role in biodiversity. Invasive species and their interaction with existing biodiversity.
2. Ex-Situ and In-Situ conservation. Captive Breeding and restoration.
3. Seed Bank, sperm Bank, cryo-preservation of animal gametes.
4. Sources of DNA from plant and animal tissue.
5. Radioactive Carbon dating of fossils.

**Unit-IV. Endangered species**

1. Various terms used under IUCN categories related to conservation of animals: LC, Rare, Vulnerable, Near threatened, Threatened, Endangered, Critically endangered, Extinct.
2. Vulnerability and extinction process. stochastic and density dependent demographic processes can affect extinction risk.
3. Fragmentation of habitat and Edges.

4. Keystone species, Ecosystem engineers.
5. Protected area and biodiversity conservation.
6. Community participation in biodiversity conservation.
7. Career and job opportunities in conservation.

**Reference Books:**


1. Principles of Conservation Biology. 2006. M. J. Groom, G. K. Meffe, C. R. Carroll, and contributors. Third edition. Sinauer Associates, Inc., Sunderland, MA.
2. Essentials of Conservation Biology, Fourth Edition, by Richard Primack
3. Wild Life Ecology: Aaron, N. M. W. H. Freeman and Company, USA(1973).
4. The Book of Indian Shells: Apte Deepak, Oxford University Press, Mumbai.
5. Dietary Husbandary of Wild Mammalia: Arora B. M. AIZ & W. V. Bareilly and CZA, New Delhi. (2001).
6. Reproduction in wild Mammals and Conservation: Arora B. M. AIZ & W. V. Bareilly and CZA, New Delhi. (2002).
7. A Texbook of Agriculture Statistics: Chandel S. R. S., Achal Prakashan Mandir, Kanpur (1999).
8. A Texbook of Indian Reptiles and Amphibians: Daniel J. C. Natraj Publishers Dehradun (1999).
9. Concepts on Wild Life Management: Hosetti B. B., Daya Publishing House Delhi (1997).
10. Biodiversity and its Conservation in India: Negi S. S., Indus Publishing Co. , New Delhi (1993).
11. Mannual of Wild Life Management in India: Negi S. S., Indus Publishing Co. , New Delhi (1993).


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**M. Sc. Zoology-First Year, Semester – II - (CBCS) – (w. e. f. 2020-21)**
**Practical Paper Code-ZOL- C201,**
**Lab Course in Developmental Biology**

**Credits: 02** **Marks: 25**

1. Microscopic study of structure of sperms.
2. Study of semen for sperm motility and abnormalities.
3. Micro techniques for histology and histo-chemistry of tissue preparation.
4. Study of developmental stages in fertilized egg of hen (Various Hrs. stages of Embryonic Development) and demonstration of organogenesis in chick embryo.
5. Study of regeneration in earthworms and cultivable fishes.
6. Preparation and submission of five slides of cells isolated from different organs of invertebrate and vertebrate animals.
7. Techniques of cryopreservation of Ova and sperms in fish/Cattle.
8. Computer simulated experiments in animal embryology and cell biology.

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**Practical Paper Code-ZOL- C202,**
**Lab Course in Chordates Structure and Function**

**Credits: 02** **Marks: 25**

1. Virtual dissection of Rat and Frog for various systems. (Computer Simulated demonstrations and Problems)

   *a.* Pisces- Photo/models/specimen- *Zygaena*, Stingray, Electric Ray, *Channa sp. , Catla catla, Wallago attu, Notopterus sp., Mastacembellus armatus, exocoetus, Echenius, Diodon, Hippocampus, Puntius sp*.

   b. Amphibians- Photo/Model based study of *Ichthyophis sp., Rhacophorus sp., Hyla sp*.

   c. Reptiles- Photo/Model based study of Chameleon sp., *Phrynosoma* sp., Varanus sp., Viper sp., Rat snake sp., Cobra sp., Turtle sp.

   d. Aves- Photo/Model based study of Bubo, Duck, Vulture, Pigeon, Sparrow, Crow.

   e. Mammals- Photo/Model based study of Loris Sp. Bat sp., Funambulus sp., Duckbill platypus, Echidna, Kangaroo.

2. Mounting of scales in fishes for the structural differences: Cycloid, Ctenoid, Placoid.
3. Comparative Microscopic study of structure of scales in fishes and reptiles.
4. Model or Photo based study of Horns in mammals; Feathers, beak and claws in birds.

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**Practical Paper Code-ZOL- C203,**
**Lab Course in Biochemistry and Immunology**

**Credits: 02** **Marks: 25**

1. Separation of amino acids by paper chromatography method.
2. Separation of antigen, antibody by gel electrophoresis.
3. Solution Preparation, understanding Molarity, Normality, buffer, pH Meter
4. Amplification of DNA by using PCR Tools.
5. Experiments on enzyme activity ( Amylase, Protease, Lipase, inhibitors)
6. Estimation of Reducing/Non-Reducing sugars by colorimetry/Spectrophotometry and applications of the study.
7. Separation and identification of sugars by Thin Layer Chromatography (TLC). Introduction to Gas Chromatography (GC).
8. Separation of amino acids and proteins from blood samples by polyacrylamide Gel Electrophoresis ((PAGE).
9. Introduction and uses of HPLC

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**M. Sc. Zoology-First Year, Semester – II – (CBCS) – (w. e. f. 2020-21)**
**Practical Paper Code-ZOL- E203,**
**Lab Course Practical in Goat Farming**

**Credits: 02** **Marks: 25**

1. Goat species in India used for Goat Farming: Morphological special features used in identification. Important characters useful for goat farming using the models and photo.
2. Identifications of Goat farming equipments and their uses: Feeders, Horn and Hoof cutters
3. Identification of Goat farm Models: Characters, Advantages and disadvantages.
4. Types of Goat Fodder plants : Plant species and Importance in goat feeding.
5. Supplementary nutrients: Identification and importance.
6. Goat Diseases: Diseases of adults, kids: Photo and Models.
7. Characters of a sick goat and healthy goat: Demonstration by Photo, models, visits to Goat farm.
8. Collection and characterization of goat parasites from Intestine, fecal pellets.
9. Ectoparasites of goats and remedies: Collection and identification.
10. Management of Goat farm. Vaccination in Goat (Study of vaccine chart)
11. Economic and commercial value of goat products and byproducts: Meat, Horn, Hooves, Bones, Blood., Goat Urine and Manure.
12. Visit to a goat farm and report writing on economics of Goat farming.

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**Practical Paper Code-ZOL- E203,**
**Lab Course in Conservation Biology**

**Credits: 02** **Marks : 25**

1. Use of camera for close-up photograph of the head of an Insect: Cockroach, Housefly, compound eye, antennae of ants, head of ants.
2. Record and interpret sonogram of bird calls and identification of bird species.
3. Sonogram study of Insects, Frogs. Study of audio records of deer, wild boar, forest bear, Deer species from e resources.
4. GPS and its applications in fields to record coordinates of the habitat.
5. Use of Maps me app for marking GPS coordinates on map.
6. Preparation of field maps, vegetation maps.
7. Use of various marker pens on spiders and other insects like scorpion or other suitable model insects for capture and recapture studies to enumerate the population size.
8. Using Photographs, Models, diagrams identify and study the applications of various ringing and tagging devices in birds and other animals.
9. Study Tour assignment: Prepare a systematic plan, itinerary and a brochure to visit a sanctuary, Wild Life Reserve for 2-3 days and 2-3 nights (excluding travel days). Indicating purpose (Aim), objectives, expected outcome. Observe the habitat and record the biodiversity. Suggest environmental awareness.
10. Visit a village and survey the anthropogenic impact on natural resources, wild life and biodiversity in general: Record the dependence of community, pattern of use of resource and suggestions for the conservation, sustainable use. Use statistics for the qualitative and quantitative analysis; tabulation, evaluation, representation of data. Interpret the results.

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**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Syllabus – Theory Paper,** Code: ZOT- C301
**Title of the Paper – Animal Physiology and Endocrinology**
(Core Course-CC)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

1. To understand the fundamental principles of animal physiology.
2. To understand the physiology and functions of animal systems.
3. To understand the body functions and adaptations in respect to its external & internal environments related to nervous integration, sensation, metabolism & reproduction in animals..

**Course Outcome:**

1. Students are able to understand the physiology at the cellular and system level.
2. Able to understand the types and mechanism of nerve cells.
3. Able to understand the nature endocrine glands and their secretion,
4. Possible to determine the role and functions of different systems. That can be applied in various required fields in career development.

**UNIT – I. Body fluids:**

1. General Organization of alimentary canal – Role of salivary glands, liver, pancreas & intestinal glands in the process of digestion.
2. Digestion and Absorption of proteins, carbohydrates and lipids and its hormonal regulation. Pancreatic hormones and their role in digestion. Details on Diabetes.
3. Body fluids, formed elements of blood (Composition of blood), Coagulation of blood and theories of coagulation.
4. Nitrogenous and non-nitrogenous excretory products in animals. Urea cycle.

**UNIT – II. Study of different systems:**

1. Structure of mammalian heart and it's working. Closed system of circulation in Mammals.
2. Lymphatic system and its physiology.
3. Structure of mammalian kidney–Urine formation- acid base regulatory mechanisms. Endocrine regulation of water & mineral balance. Osmoregulation and mechanisms.
4. Types of muscles – Ultra-structure-Mechanism of contraction of skeletal muscles.
5. Nerve conduction- Synapse-Neurotransmitters- Nervous co-ordination-Coding information to sensory organs.
6. Male and female reproductive system in a Mammal and hormonal control of sex and reproduction.

**UNIT – III. Hormonal regulation in Mammals:**

1. Hormones, Neurohormones, Neurotransmitters. Physiology of Hormone action.
2. Pituitary gland, Thyroid gland, Parathyroid gland and Adrenal gland: Structure, hormones and their functions.
3. Thyroid hormone synthesis and its regulation, Physiology of Goiter.
4. Hormones and calcium metabolism in vertebrates.

**UNIT- IV. Hormonal regulation in animals:**

1. Endocrine system in a Crustacean. Hormones and color changes in Crustacea.

2. Endocrine glands, hormones and their functions in fishes. Hormones and color changes in Fishes.
3. Structure of endocrine system and hormones in insects.
4. Hormonal regulation of reproduction, molting and development in insects
5. Parthenogenesis.

**References:**

1. Ganong, H, Review of Medial Physiology, 1989. 14th edition, Appleton &Lange publisher, New York
2. Physiology: A regulatory system approach, Fleur, and Strand, (1978). Macmillan Publishing Company, New York; Collier Macmillan Publishers, London.
3. Shier, D., Butler, J. And Lewis, R., Hole"s Human Anatomy and Physiology, (10th edition) 2003. WCB/McGraw Hill, Boston. 2003.
4. Human Physiology- Gyton. (Elsvier Publication).
4. Animal Physiology, EcKert, R (5th edition), 2002. W.H.Freeman.
5. Williams S. Hoar (1991) General and Comparative Physiology 3rd edition. Prentice Hall of India- New Delhi.
6. Neilson, K.S. Animal Physiology, 1997. Cambridge University Press, Pergamon Press, Oxford.
7. Prosser, C.L. and Brown-Jr. F.A.: Comparative Animal Physiology, 1961. W.B. Saunders, Philadelphia.
8. A Text Book of Comparative Vertebrate endocrinology – P. J. Bentley – S. Chand and co. New Delhi.
09. Comparative vertebrate Endocrinology – Gorbman and Ber n – ELBS Publishers, London, New York.
10. Comparative Vertebrate Endocrinology – Turner – ELBS Pub.
11. Endocrinology of Reproduction – Nalbandhu.
12. A Text Book of Animal Physiology – Nagbhushnam, Kodarkar and Sarojini – Oxford and IBH Co. New Delhi.
13. Fish Endocrinology – J. M. Matty.
14. Invertebrate Endocrinology – Hyman L. H.
15. Fish Endocrinology Vol. – I- VI, Hoar and Randall.
16. Invertebrate Endocrinology by Hyman & Hill

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**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)

**Syllabus- Theory Paper,** Code: ZOT- C302

**Title of the Paper – Ecology, Ethology and Biostatistics**

(Core Course-CC)

**Credits: 04** **Marks: 100** **Periods: 60**

## Course Objectives:

1. To study higher levels of the organization of life on the earth and the interrelations between organisms and their environment.
2. To study the ecological and evolutionary basis for animal behaviour and its role in enabling animals to adapt to their ecological niches.

**Course Outcome:** The student will get idea about the ecological process in its surrounding and at national, global level and the use of his/her knowledge on ecology , behaviour and Biostatics can be applied in education, research and extension programs in his further career.

**UNIT – I. Ecological process:**

1. Introduction to Ecology and its various branches, Concept and Introduction to Limnology and Hydrobiology.
2. Biogeochemical cycles: Oxygen, Water and Carbon cycles.
3. Concept of Productivity and Food web in reservoir and Forest ecosystem and energy flow concept.
4. Nests in Birds: Types and Structure. Gender involvement and parental care.

**UNIT – II. Habitat ecology:**

1. Concept of habitat and ecological niche.
2. Mangrove Ecosystem and importance of Mangroves.
3. Population Ecology. Population Explosion and Population Control.
4. Ecological Succession.
5. Introduction to Ecosystems: (Occurrence, Physical characters, Flora and Fauna, Food chain) Grassland, Tropical forests, Arctic and Antarctic.

**UNIT-III. Ethology:**

1. Introduction to Ethology.
2. Innate Behaviour: a) Taxis b) Reflexes c) Instincts
3. Acquired Behaviour and its neural basis- a) Learning b) Reasoning c) Memory
4. Colonial structure/Social Behaviour in Termites and Honey Bees.
5. Mimicry in animals. Pheromones in Animals.

**UNIT-IV. Biostatistics:**

1. Primary and Secondary Data. Tabulation of Data.
2. Graphical presentation of Data. Use of Excel program for presentation of data.
3. Mean, Mode, Median and its application in Zoological studies. Standard Deviation (SD), Standard Error (SE), testing of hypothesis. Probability and T-test, Chi-Square Test.
4. Coefficient of correlation and its application. Regression analysis and its application.
5. Analysis of Variance (ANOVA) and its application. Common software's of Biostatistics used in Zoology.

## SUGGESTED READINGS

1. Ecology – Odum
2. Ecology and Environment – P. D. Sharma – Rastogi Pub., Merrut
3. Concept of Ecology - Edmond Cormondy, Himalaya Publishing house, Mumbai.
4. Ecology – M. P. Arora, Himalaya Publishing house, Mumbai.
5. Environmental Pollution, H. Loggen, - Holt Reinholt, Winston.
6. Noise Pollution and its control – T. N. Tiwari, V. P. Kudesia, Pragati Prakashan, New Delhi.
7. Environmental Relation, Thermal Pollution and Control – G. R. Chatwal, M. C. Mehera, Amol Publication, New Delhi.
8. Animal Behavior – Vinod Kumar, Himalaya Publishing House, New Delhi.
9. A Text Book of Animal Behavior – H. S. Gundevia, H. G. Singh. S. Chand and Co. Ltd.
10. Animal Behavior, An Evolutionary Approach – Alcock, Sinauer Assci. And Co. Ltd.
11. Animal Behavior – Boulanger
12. A text book of Animal Behavior – Harjinder Singh, - Amol Pub. Pvt. Ltd, New Delhi.
13. P.S.S. Sundar Rao, P. H. Richard, An Introduction to Bio-statistics, Prentice Hall of India (P) Ltd. New Delhi,2003.
14. Gupta S. P., Statistical Methods, sultan Chand and Sons, New Delhi,2005.
15. Jerrold H. Zar, BioStatistical Analysis, Asia Publishing Co., New Delhi, 1962.
16. David W. Mount, Bioinformatics: Sequence and Genome Analysis 2nd Edition,CSHL Press, 2004.

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**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Syllabus- Theory Paper** Code: ZOT- E301
**Title of the Paper – Fish Biology**
(Discipline Specific Elective-DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course Objectives:**

1. To equip and train the students to understand about fish biology and processes,
2. To determine the importance of culture practices and processes involved in preservation and marketing of fish and other edible organisms.
3. To determine the uses of fishes to prepare fish products and biproducts.

**Course outcome:**

Student can apply his knowledge to pursue his career in private, Government sector related to fisheries, fish culture and may enter in this particular field as entrepreneur. The students may join to the research institutes as research fellow, project fellow and researcher.

**UNIT – I. Fish Taxonomy, Anatomy and physiology**

1. General Characters and Classification of Fishes up to important orders.
2. Morphometric and Meristematic Characters in fishes and importance in Taxonomy. Introduction and applications of www.fishbase.org
3. Structure and functions of Weberian ossicles in fishes.
4. Structure and functions of Air Bladder in fishes.
5. Osmoregulation in Teleosts and Elasmobranchs and its Hormonal control. Osmoregulatory adjustments by fishes during migration.

**UNIT-II. Physiology and processes.**

1. Introduction to Food, feeding habits, gill rackers and digestive system in Teleosts.
2. Structure of heart and blood circulation in teleost.
3. Structure and functions of electric organs in fishes.
4. Coloration in fishes and mimicry.
5. Types of scales and functions in fishes.

**UNIT – III. General Biology.**

1. Weight length relationship study, Ponderal Index.
2. Gonado-somatic Index.
3. Gut content analysis in fishes.
4. Scale method for assessment of fish age and growth. Other structures useful in age determination.
5. Deep sea, fishes and their adaptations.

**UNIT- IV. Biology of Respiration and Reproduction.**

1. Accessory organs of respiration in fishes.
2. Luminous organs in fishes.
3. Endocrine glands, hormones and functions in fishes.
4. Reproductive system and reproduction in fishes.

5. Assessment of spawning periodicity by Ova-diameter measurement,

**Reference Books:**


1. Bardach, et al. Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
2. Stickney, R.R. Principles of Water Aquaculture. John Wiley & Sons, NY, 1979.
3. Chondar, C.L. Hypophysation of Indian major carps. Satish Book Enterprise, Agra, 1980.
4. Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.
5. Santhanam, R. et. Al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
6. Pilley, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990.
7. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990.
8. Janardhana Rao, K. & S.D. Tripathi. A Manual of Giant Freshwater Prawn Hatchery. CIFA, Kausalyaganga, Orissa, India, 1993.
9. Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd 1980.
10. Aquaculture and Aquarium keeping- S. P. Chavan, M. S. Kadam, S. D. Niture. Educational Books Publishers and Distributors, Aurangpura Aurangabad, MS
11. A Manual of Fresh Water Aquaculture, Santhanam. Oxford and IBH Publishers and Distributors New Delhi.
12. Introduction to Fishes – S. S. Khanna, Central Book Depot, Allahabad
13. Taxonomy of fishes – Jhingran and Talwar
14. Physiology of fishes – Hoar and Randall.
15. Fish Biology and Indian fishes – R. P. Parihar, - Central publishing house, Allahabad.
16. A text book of fish, fisheries and Technology, Biswas – Narendra Publishing House, New Delhi.
17. Aquaculture and Aquarium Keeping – Chavan S. P., Kadam M. S. and Niture S. D., - Educational Books and Publishers, Aurangabad, M. S.
18. Fishery Science and Indian Fisheries – C. B. L. Shrivastava - Kitab Mahal, New Delhi.
19. Aquaculture Principles and Policies – T.V.R. Pilley – Daya PublishingHouse, New Delhi
20. Aquaculture and Practices a selected review – FAO
21 Aquaculture Project Formulation – FAO
22. Bacterial Diseases of Fishes – Veleri Englis Ronald – Daya Publishing House New Delhi.
23. Taxonomy of Fishes Vol I, Vol II – Francis Day (Narendra Publishing House New Delhi)
24. Marine Fisheries – Bal and Rao.

**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Syllabus- Theory Paper** Code: ZOT- E302
**Title of the Paper – General Parasitology**
(Discipline Specific Elective-DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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## Course Objectives:

1. To study the major types of parasites of medical & veterinary importance.
2. To understand the basics of identification of common parasites of humans and animals.
3. To design and evaluate an intervention to control food and waterborne diseases.
4. To understand and evaluate epidemiological studies in different disease.

**Course outcome:**

The students after completing this course based on the expertise he may join the parasitological research institute, may be a scientist in the WHO, UN Parasitological researcher, scientist. May join as Parasitologist in the state and central government public health programs as officer. My get job opportunities in the pathological labs as parasitologist.

**UNIT- I. General topics in Parasite study.**

1. Introduction to Parasitology, Parasitism- Definition & concept. Types of Parasites. Factors influencing Parasitism; Influence of season, host age and other phonological factors on parasitic population (prevalence, intensity etc).
2. Inter-specific biological relationships phoresis, symbiosis, Commensalisms and parasitism.
3. Origin and evolution of parasites and adaptation in parasites. Advantages and Disadvantages in parasitic life.
4. Types of hosts- Definitive and intermediate, primary and secondary specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors, Host specificity.
5. Introduction to Immunology of Parasitic infections. Natural & acquired immunity. Immunodiagnosis.

**UNIT-II**. **Parasites as global problem.**

1. Parasite and global public health. Global burden of infectious diseases.
2. Parasitic zoonosis.
3. General principles of immunization and Hypersensitivity reactions.
4. Strategies in designing parasitic vaccines and Limitations.
5. Life cycle and pathogenecity of malarial parasites and control on malaria.

**UNIT-III. Protozoan Parasites.**

1. Study of coccidian parasites in vertebrates.
2. Study of class Piroplasma to special reference to *Theleria* and *Babesia.*

3. General organization of the parasitic Protozoa occurring in oral cavity, urinogenital tract, muscles and blood.
   i) *Trichomonas vaginalis* ii) *Trichomonas foetus* iii) *Trypanosoma gambiense* iv) *Trypanosoma cruzi* v) *Leshmania donovani vi) Leshmania tropica vii) Giardia lambiia. Viii) Entamoeba gingivalis ix) Toxoplasma gondii x) Balantidium coli.*

**UNIT-IV. Morphology life history, diseases/ harm caused and the control of following-**

1) Introduction to Parasitic Acanthocephala and Annelida (Any one example each)
2) Parasitic Siphonoptera, Anupleura, Mallophaga.
3) Parasitic Diptera . d) Parasitic Hemiptera and Pentastomidea
4) Parasitic Crustacean and Acarids (any one example).

## References:


1. 'Infectious Disease Epidemiology: theory and practice' 2nd edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth=2
3. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
4. Reingold, A.L. Outbreak Investigations – A Perspective. Emerging Infectious Diseases 1998; 4(1): 21-27.
5. Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993.
6. The Trematode - Dausese B
7. Taxonomy of Cestode Parasites of vertebrates: Khalil and Bray (CABI Publication, London)
8. An introduction to Nematodology -Chitwood
9. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
10. Laboratory methods of work with plant and soil nematodes -Southey
11. Human helmintology Munual for Clinicals, Sanitarians Medical Zoologists –Faust, Emerest Caroll
12. Practical exercise in Parasitology -Halton, Behave, Marshall.
13. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
14. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
15. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
16. Text book Medical Parasitology of Jaypee Brothers, - Panikar C.K.J (1988)
17. Medical Publishers, New York. - Panikar C.K.J (1988)
18. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
19. The Zoology of Tapeworm. - Wardle and Mcleod (1952)
20. The advances in the Zoology of tapeworm from - 1970- Wardle and Mcleod
21. Systema Helmenthum Vol. II Cestoda. - Satyu Yamaguti (1959)
22. The Physiology of Cestodes. - J.D Smyth

**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – III (CBCS),** (w. e. f. 2020-21)
Paper Code: ZOT- S301
**Title of the Paper – Microscopy**
(Skill Development Course-SDC)

**Credits: 02** **Marks: 25** **Periods: 30**

**UNIT – I - Types of Microscope** (Use of Photo / Video / Demonstrations)

1) History of Microscope and Importance of Microscopy
2) Types of Microscope and their applications.
3) Structure and various components of following microscopes and their functions:
   a) Simple, dissecting mirror reflector Microscope
   b) Paper Foldscope
   c) Compound Monocular Microscope
   d) Compound Binocular Microscope
   e) Inverted compound microscope
   f) Phase Contrast Microscope
   g) Florescent Microscope
4) Trinocular Microscope with Micro-camera and microphotography using computer softwares.
5) Scanning Electron Microscope (SEM)
   a) Structure, components and applications of SEM
   b) Preparation of biological sample for SEM (Plant Tissue and Animal Tissue)
   c) Fixation and preservation of sample for SEM
   d) Sputtering of sample by copper or gold nano particles.
   e) Micro-photography of sample using computers
6) Transmission Electron Microscopy (TEM)
   a) Structure, components and applications of TEM
   b) Preparation of biological sample for TEM (Plant Tissue and Animal Tissue)
   c) Fixation and preservation of sample for TEM
   d) Ultra sectioning of sample for TEM
   e) Micro-photography of sample using computers

**UNIT – II – Fixation and Staining (Use of photo/ Video/ Demonstration)**

1) Fixatives and preservatives used for biological samples for microscopy
   a) Bacteria
   b) Plant parts: spores, pollen grains, flowers, fruits, seeds, roots, stems
   c) Animal body parts and components: Blood, Epithelium, Gonads, Muscle cells, Hair, Teeth, Bones, nails and claws, Horns and Hooves, Scales, Feathers, stings
   d) Plankton: Phytoplankton and Zooplankton
   e) Protozoans, Helminth Parasites, Insects
   f) Large animals: Fishes, Amphibians, Reptiles, Birds and Mammals.
2) Types of stains and their uses in microscopy
3) Maintenance of Microscopes.

**References:**


1) Complete Book of Microscope: Rogers Kirsteen. Usborn Publishing Ltd. Pp 96. (2018).
2) Fundamental of Light Microscopy and Electronic Imaging: D. B. Murphy. John Wily and Sons. Ltd. PP 384. (2018).
3) Optical Imaging and Microscopy: Techniques and advanced Systems. : Peter Torok, Fu-Jen-Kao. Springer Pub. (2020).
4) Modern Microscopies: Techniques and Applications. Edt. By- P. J. Duke and A. G. Michette. PP. 272. Spronger-Verlag, New York Inc. (2016).
5) The Principles and Practices of Electron Microscopy: Ian M. Watt. Pp. 500. Cambridge Univ. Press. (2018)
6) A Practical Guide to Transmission Electron Microscopy: Zhiping Luo. Momentum Press Engineering. Pp. 180. (2018).
7) Principles of Microscopy: Wright Almroth. Palala Press. Pp. 322. (2019).
8) Sample Preperation Handbook for TEM: Ayache, J. Beaunier, L. Boumendil, J. Ehret G., Laub, D.: Springer. (2020).
9) A Beginners Guide to SEM: Anwar Ul_Hamid. Springer (2018).
10) SEM and X-Ray Microanalysis: A Textbook for Biologists, Materials Scientists and Geologists: David C. Joy, Dale E. Newbury, Charles Fiori, Eric Lifshin. (1981). Google Books. Springer (C.)(1992).


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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Practical Paper Code-ZOL- C301,**
**Lab Course in Animal Physiology and Endocrinology**

**Credits: 02** **Marks: 25**

1. Influence of PH on salivary amylase activity.
2. Quantitative estimation of carbohydrates, proteins and fats from edible fish/poultry tissue.
3. Measures of Blood pressure in Human.
4. Estimation of serum, bilirubin (Direct and Indirect methods).
5. Oral glucose tolerance test.
6. Physiology experiments based on computer simulations.
7. Demonstration of endocrine glands in edible teleost/Crab
8. Effect of eye-stalk ablation on oxygen consumption in edible crab/prawn
9. Effect of Hormonal injections on coloration in edible fish.
10. Preparation of pituitary gland extract and injection to fishes to study the coloration and locomotory behavior in a teleost.

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**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Practical Paper Code-ZOL- C302,**
**Lab Course in Ecology, Ethology and Biostatistics**

**Credits: 02** **Marks : 25**

1. Collection, preservation and identification of fresh water plankton; Isolation of biota from coastal zone of a reservoir by sieve method.
2. Qualitative and quantitative measurement of plankton, comparative Primary production estimate. Sidgewick Rafter Counting chamber Method.
3. Determination of water quality parameters (BOD, COD, DO, CO2, acidity and alkalinity, Carbonates and bicarbonates, Phosphates in water samples.
4. Identification of LC 50, LD 50 studies and histopathological lesions due to toxic effects by microscopy and Microtomy. (Exposure of Fish/Mollusc to Chemical pollutant: Cuso4, Formalin or Plant extract).
6. Computer simulated experiments on behaviour in animals.
7. Collection and identification of mimicry in Insects (Photo based study). Video recording on animal behaviour from nature and its behavioural explanation.
8. Adaptive behavior, mimicry, predation, mating calls, nest building in birds, rodents and submission/demonstration during examination. Preperation of audio/video
9. Zoology related Problems on Mean, Mode and Median.
9. Problems on application of SD and SE for zoological studies and its representation using computer Excel program.
10. Estimation of animal population structure using biostatistics- Similarity Index, Diversity Index, Richness, Evenness for Insects, Birds, Mammals.
11. Bio-statistical calculation of reproductive indices in various animals using online programs and apps.
12. Graphical representation of data generated related to zoological studies using Bar diagram, Pie charts, line diagram, histograms etc.
13. Use of ANOVA method and its application by using a suitable example, representation of results using computer.
14. Introduction and uses of Bio-statistical soft-wares used in zoological studies.

**S.R.T.M. UNIVERSITY, NANDED**
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**M. Sc. Zoology, Second Year- Semester – III (CBCS) -** (w. e. f. 2020-21)
**Practical Paper Code-ZOL- E301,**
**Lab Course in Fish Biology**

**Credits: 02** **Marks: 25**

1. Types of scales, fins, types of teeth, structure of alimentary canal, gill rakers, age determination in fishes. Morphological variations in scales of teleosts.
2. Taxonomy and biology of fishes from fresh water and marine water using computer assisted learning aids/specimen /model. *Labeo rohita, b. Catla catla, c Cirrihina mrigala, d. Cyprinus carpio, e. Labeo calbasu. F. Ctenopharyngodon idella g. Hypopthalmychthys molitrix, h. Tilapia sp. I) Notopterus kapirat j) Wallago attu k) Mastacembelus armatus l) Chimaera sp. M) Acipensor sp. N) Torpedo sp. O) Puntius ticto, p) Horpodon neherius q) Oil sardine, r) Mackeral s) Sole t) Pomfreet.*
3. Fish identification by Morphometrics and meristics.
4. Molecular Taxonomy of fishes.
5. Determination of growth, length and weight relationship and fecundity in fish.
6. Demonstration / Use of computer assisted digital programs/models/edible fish for determination of anatomical features of the following organs in fishes:
   a) Air Bladder
   b) Weberian ossicles
   c) Mouth
   d) Gill rakers
   e) Teeth and their locations
   f) Gonads
   g) Heart
   h) Ventral aorta and its branches brain and cranial nerves

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**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology, Second Year- Semester – III (CBCS),** (w. e. f. 2020-21)

**Practical Paper Code-ZOL- E302**

**Lab Course in General Parasitology**

**Credits: 02** **Marks : 25**

1. Preparation of stains: Haematoxylin, Acetocarmine, Borax caramine and Bouins fluid.
2. Parasitological examination of fecal waste of poultry and wild birds, Mammals for protozoan parasites, helminth eggs, larvae and adult worms. Parasite population indices and its uses.
3. General principles of Collection, Preservation, Staining and Mounting of Trematodes and Cestodes.
4. Collection of Trematodes and Cestode parasites from locally available different hosts.
5. Preparation and identification of collected helminth parasites (Trematodes and cestodes) at least ten.
6. Standard reference books, literature and e-sources used in Taxonomy of Parasitic Protozoa, Parasitic Arthropods, Trematodes, Cestodes and Nematodes.
7. Fixation of Helminth parasites for SEM and TEM studies and its importance in modern Taxonomy.
8. Molecular techniques for identification of Parasitic infection.
9. Study of permanent mounts of Trematodes and cestodes viz.
    - *a) Gyrodactylus*
    - *b) Paramphistomum*
    - *c) Fasciola hepatica*
    - *d) Fasciolopsis buski*
    - *e) Schistosoma Japonicum*
    - *f) Schistosoma mansoni*
    - *g) Paragonimus wetermani.*
    - *h) Taenia solium& Taenia saginata*
    - *i) Moniezia expansa*
    - *j) Railletina*
    - *k) Cotugnia*
    - *l) Echinococcus granulosus*
    - *m) Diphyllobothrium latum*
    - *n) Dipylidium caninum*
    - *o) Hymenolepis nana*
    - *p) Gyrocotyle*

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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – IV (CBCS) -** (w. e. f. 2020-21)
Theory Paper Code: ZOT- C401
**Title of the Paper – General Entomology**
(Core Course)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Course Objectives:**

1. To determine the basics of Insect morphology, anatomy, physiology, reproduction and endocrinology, Taxonomy and behaviour was main aim behind the design of this course.
2. To use the basic studies in entomology for human welfare and nature conservation.

**Course Outcome:**
The students will get an idea about what an Insect is, what is physiology, anatomy and reproduction in Insects as a basic study, that can be used in agriculture and research and human life.

**Unit-I. Insect Taxonomy, Diversity and Distribution.**

1. What is insect? Classification of Insects. E-content and websites for Insect classification.
2. General Characters of insect orders with examples:
   a) Apterygote Orders: Entognathus- Collembola; Ectognathus- Thysanura.
   b) Pterygot Orders: Odonata, Embidina, Phasmida, Diptera, Hemiptera, Hymenoptera, Coleoptera, Lepidoptera, Orthoptera, Hemiptera
3. Distribution of Insects; Role of insects in ecosystem regulation.
4. Insect Migration. Swarming in Insects.
5. Insects and their food value.

**Unit-II. Insect Morphology.**

1. External characters of Insects: Head- Types and segmentation; Cervix; Thorax- Skeleton, segmental regions, sternum and pleuron
2. Types of legs and their importance in Insects.
3. Types of mouth parts in Insects. Abdominal appendages- pre-genital, genital and post-genital.
4. Thoracic appendages: Types of wings and wing venation in Insects. Flight in insects.
5. Coloration, shapes and mimicry in Insects

**Unit-III. Insect Anatomy and Physiology and Endocrinology.**

1. Structure of trachea and respiration in Insects. Structures for respiration in Insects.
2. Types of Food in Insects.
3. Endocrine system in an Insect and Hormones, functions of Hormones.
4. Structure of Eye in insects. Skeleton in Insects.

5. Communication in insects. Mechano-receptors, Chemo Receptors and Thermo-receptors in Insects

**Unit-IV**. **Insect Reproduction and its physiological regulation.**

1. Types of reproduction in Insects. Physiological regulation of reproduction.
2. Reproductive system in Grasshopper
3. Reproductive system and reproduction in Mosquito
4. Metamorphosis in Insects
5. Moulting in Insects.

**Suggested Readings:**

1. A Text Book of Applied Entomology: Vol. II. K. P. Srivastava.
2. Elements of Entomology. Rajendra Singh.
3. A Text Book of Forest Entmology. T. V. Sathe
4. Sericulture and Pest Management. T. V. Sathe and A. D. Jadhav.
5. Agricultural Pests of South East Asia and India. A. S. Atwal.
6. 6. Bee Keeping in India. ICAR New Delhi. S. Singh.
7. Principles of Insect Morphology. R. E. Snodgrass.
8. Insect Structure and Function. R. F. Chapman.
9. Entomology. Gillot C.
10. General Entomology. Mani M. S. Oxford IBH Pub.
11. Modern Entomology. Tembhre D. B. Himalaya Pub.
12. A Textbook of Agricultural Entomology. Dhruti S. H. ICAR New Delhi
13. Insect Physiology and Anatomy. Pant N. S. and Ghai S. L.
14. Ericulture in India. Sarkar D. C. CSB Benguluru.
15. Sericulture for rural Development. Hanumappa. Himala

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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – IV (CBCS) -** (w. e. f. 2020-21)
Paper Code: ZOT- C402
**Title of the Paper – Applied Entomology**
(Core Course)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

1. To educate the students about applied aspects of insects.
2. To determine the role of insects as causative agents for various diseases and damages in agriculture crop, stored grains and mosquito like insects as important vectors for human and veterinary diseases.
3. To determine insect diversity and control measures, useful and harmful insects in the world.
4. Application of knowledge on Insects for the livelihood, agriculture protection and protection of health. To determine the importance of forensic entomology.

**Course Outcome:**
The students will get an idea about what are common Insect pests in agriculture and grain stores, their control and management.

**Unit-I. Insect Pests of Cotton and sugarcane and vegetable crop.**

a) External Characters, Classification, Mouthparts, Food and feeding, Reproduction, Crop damage and control of Insect Pests (3 species) infecting Cotton and Sugarcane.
b) Cabbage caterpillar, Potato tuber moth, Onion thrips, Brinjal fruit and stem borer, Mealy bug, Chilli Thrips, Coconut weevil and Rhinoceros Beetle.

**Unit-II. Insect Pests of Wheat and Rice and Pulses crop**
External Characters, Classification, Mouthparts, Food and feeding, Reproduction, Crop damage and control of Insect Pests (3 species) infecting Wheat, Rice and Pulses.

**Unit-III. Insect Pests of Stored grains, Insect pest control and Management.**
External Characters, Classification, Mouthparts, Food and feeding, Reproduction, Grain damage and control of Insect Pests (3 species) infecting stored rice, wheat, Pulses and Oil seeds.

**Unit-IV. Insects of Public Health, Veterinary and Forensic importance.**

1. Role of Mosquito species in human diseases.
2. Parasitic insects and their biology, Parasitoides in Insects.
3. Insect species as vectors for diseases to Human and other Bovines.
4. Species diversity and Morphology, pathology and control of Ticks.
5. Species diversity, morphology, pathology and control of Mites.

6. Introduction to Forensic entomology: Flesh flies species and their host specificity, reproduction. Species specificity in larvae of flesh flies and its forensic importance.
7. Methods of insect control. Insect traps, types and applications.

**Suggested Readings:**

16. A Text Book of Applied Entomology: Vol. II. K. P. Srivastava.
17. Elements of Entomology. Rajendra Singh.
18. A Text Book of Forest Entmology. T. V. Sathe
19. Sericulture and Pest Management. T. V. Sathe and A. D. Jadhav.
20. Agricultural Pests of South East Asia and India. A. S. Atwal.
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23. Insect Structure and Function. R. F. Chapman.
24. Entomology. Gillot C.
25. General Entomology. Mani M. S. Oxford IBH Pub.
26. Modern Entomology. Tembhre D. B. Himalaya Pub.
27. A Textbook of Agricultural Entomology. Dhruti S. H. ICAR New Delhi
28. Insect Physiology and Anatomy. Pant N. S. and Ghai S. L.
29. Ericulture in India. Sarkar D. C. CSB Benguluru.
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**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – IV (CBCS) -** (w. e. f. 2020-21)
**Syllabus- Theory Paper** Code: ZOT- E401
**Title of the Paper – Aquaculture and Fisheries Technology**
(Discipline Specific Elective –DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

1. To understand about fish biology and processes,
2. To determine the importance of culture practices;
3. To determine processes involved in preservation, processing and marketing of fish and other edible organisms and the products derived from them.

**Course outcome:**

1. Students will apply the knowledge on aquaculture methods, problems and techniques they learned to operate a fish culture/aquaculture farm.
2. They may work for the development of either private or Government or their own farm.

**Unit-I. Induced Breeding, Chinese Hatchery and Carp Culture.**

1. Indian Major Carps, Exotic Carps (External characters, fish formula, food feeding and reproduction, Gonadal development and breeding season).
2. Carp Breeding: Bundh Breeding, Happa Breeding and Breeding in Chinese Hatchery system.
3. Structure and working of various components in Chinese Hatchery unit.
4. Induced breeding in Fishes: Pituitary hormones and breeding in fishes. Synthetic hormones and dosage for induced breeding in fishes. How to subject the fish for induced breeding.
5. Management of spawn and Incubation tank. Management of fry and fingerling. Management of Brood fish.
6. Structure, components and managements of Ideal fish farm:
   Construction, structure and management of Nursery, Rearing and Stocking pond

**Unit-II. Aquaculture methods.**

1. Semi-intensive and intensive methods for aquaculture.
2. Air-breathing fish culture.
3. Cage Culture. Raceway culture. Pen Culture. Monoculture.
4. Reservoir fishery: Types and classification of reservoirs. Lease of reservoir for fishery activities. Fish seed stalking, management and harvesting the fish.
5. Fish market and marketing: market structure, Marketing trends, Export of fish and fish products in India and abroad.

**Unit-III. Fishing and Fish Culture.**

1. Traditional methods of fishing and equipments.
2. Types of fishing methods, nets and gears used and their limitations.
3. Fishing crafts, Mechanized and non-mechanized Fishing boats.

4. Structure and working of fish cooperative society in inland fisheries and marine fisheries. Indian EEZ, International fishing, Deep sea fishing.
5. Use of remote sensing, GPRS and fish finding devices in marine fisheries.
6. Culture and management of Tilapia, Thai Magur, Indian *Channa species* and *Macrobrachium rosenbergii* (fresh water prawn)
7. Government promotion and development plans for Inland fisheries development.

**Unit-IV. Fish Preservation, Processing, Marine Fisheries**

1. Biochemical composition and nutritional value of fish.
2. Traditional and modern methods of preservation and processing of fish.
3. Rigor Mortis changes and spoilage of fish. Determination and characterization of microbial contamination in fresh and preserved fish.
4. Fish products and byproducts. Introduction to some common and important fish dishes in India and World.
5. Marine fisheries in India: Bombay Duck, Mackeral, Sole, Oil Sardine, Hilsa, Molluscs. Current trends and dynamics in Marine fisheries of India. Shrimps, Molluscs and Lobsters of edible importance.

**Suggested Readings:**


1. Introduction to fishes. S. S. Khanna.
2. Bardach, et. Al. Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
3. Stickney, R.R. Principles of Water Aquaculture. John Wiley & Sons, NY, 1979.
4. Chondar, C.L. Hypophysation of Indian major carps. Satish Book Enterprise, Agra, 1980.
   Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.
5. Santhanam, R. et. Al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
6. Pilley, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990.
7. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990.
8. Janardhana Rao, K. & S.D. Tripathi. A Manual of Giant Freshwater Prawn
9. Hatchery. CIFA, Kausalyaganga, Orissa, India, 1993.
10. Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd 1980.
11. A Manual of Fresh Water Aquaculture, Santhanam. Oxford and IBH Publishers and Distributors New Delhi.
12. Introduction to Fishes – S. S. Khanna, Central Book Depot, Allahabad
13. Taxonomy of fishes – Jhingran and Talwar
14. Physiology of fishes – Hoar and Randall.
15. Fish Biology and Indian fishes – R. P. Parihar, - Central publishing house, Allahabad.
16. A text book of fish, fisheries and Technology, Biswas – Narendra Publishing House, New Delhi.
17. Aquaculture and Aquarium Keeping – Chavan S. P., Kadam M. S. and Niture S. D., - Educational Books and Publishers, Aurangabad, M. S.
18. Fishery Science and Indian Fisheries – C. B. L. Shrivastava - Kitab Mahal, New Delhi.
19. Aquaculture Principles and Policies – T.V.R. Pilley – Daya PublishingHouse, New Delhi
20. Aquaculture and Practices a selected review – FAO
21. Aquaculture Project Formulation – FAO
22. Bacterial Diseases of Fishes – Veleri Englis Ronald – Daya Publishing House New Delhi.
23. Taxonomy of Fishes Vol I, Vol II – Francis Day (Narendra Publishing House New Delhi)
24. Marine Fisheries – Bal and Rao.


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**S.R.T.M. UNIVERSITY, NANDED**

**School of Life Sciences, Department of Zoology**

**M. Sc. Zoology, Second Year- Semester – IV (CBCS) -** (w. e. f. 2020-21)

**Syllabus- Theory Paper** Code: ZOT- E402

**Title of the Paper – Medical and Applied Parasitology**

(Discipline Specific Elective- DSE)

**Credits: 04** **Marks: 100** **Periods: 60**

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**Objectives:**

1. To acquaint the students about parasites of human health and veterinary importance to prevent huge economic and health losses due to parasitic infection to major parts of world population.
2. To educate the students on basics of Parasitology and its applied issues of ecological and human health importance.

**Course outcome:**

The students may join the parasitological research institute, may be a scientist in the WHO, UN Parasitological researcher, scientist.

The students May join as Parasitologist in the state and central government public health programs as officer. My get appointment in the pathological labs as Parasitologist.

**Unit I. Trematodes**

1. General organization of Trematodes and its classification up to family level.
2. Larval forms in Trematodes
3. Immunology, Basic concept, Antigen Antibody reaction, Innate and Acquired resistance.
4. Study of Morphology, Life cycle, Pathogenicity, Prophylaxis of following parasites:
   *a. Fasciolopsis buski b. Schistosoma Japonicum and Schistosoma mansoni.*
   *c. Clonorchis sinensis d. Paragonimus wetermani.*

**Unit II. Cestodes**

1. General organization of cestodes and its classification up to order level.
2. Structural organization of cestodarians.
3. General important features of the following orders: a) Proteocephalidea. b) Tetraphyllidea c) Davaineidea. d) Hymenolepidea
4. Study of following important parasites with respect to their geographical distribution, habitat, morphology, Life cycle, Pathogenicity, Diagnosis, Treatment and Prophylaxis.
   *a) Taenia Solium b) Echinococcus granulosus*
   *c) Diphyllobothrium latum d) Hymenolepis nana e) Dipylidium caninum*

**Unit III. Nematodes**

1. Classification of Nematodes.
2. Study of following important parasites with respect to their Geographical Distribution, Habitat, Morphology, Life-cycle, Pathogenicity, Diagnosis, Treatment and Prevention.
   *a) Ancylostoma duodenale b) Wuchereria bancrofti*
   *c) Dracunculus medinensis d) Trichinella spiralis,*
   *e) Strongyloides stercoralis. f) Enterobius vermicularis.*

**Unit IV. General Parasitology**

1. Nematode as models (Toxicity, Genetic, Parasitic, Genetic study models)
2. Plant parasitic Nematodes – symptoms of nematode injuries to plants. a) Above ground symptoms. b) Below ground symptoms.
3.Controlling on Nemic Diseases of Plants – Heat, fallow crop rotation, Biological control, organic matter and mulching, Root Diffusates, natural enemies. Chemical Control:
a) Nematicidal chemicals. b) Application of Nematicides. c) Procedure in soil fumigation.
4. Structure, Life cycle and Control of the following Nematodes.
*a) Anguina (Seed Gall- nematode)* *b) Meloidogyne (Root knot nematode)*
*c) Heterodera (cyst nematode)* *d) Tylenchulus (citrus nematode)*

5. Model Nematodes used in parasitological studies: *Caenorhabditis. eligans, Setaria cervi*

**References:**


15. 'Infectious Disease Epidemiology: theory and practice' 2nd edition. Nelson & Williams (Eds.). 2007.
16. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth=2
17. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
18. Reingold, A.L. Outbreak Investigations – A Perspective. Emerging Infectious Diseases 1998; 4(1): 21-27.
19. Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993.
20. The Trematode - Dausese B
21. Taxonomy of Cestode Parasites of vertebrates: Khalil and Bray (CABI Publication, London)
22. An introduction to Nematodology -Chitwood
23. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
24. Laboratory methods of work with plant and soil nematodes -Southey
25. Human helmintology Munual for Clinicals, Sanitarians Medical Zoologists –Faust, Emerest Caroll
26. Practical exercise in Parasitology -Halton, Behave, Marshall.
13. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
14. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
15. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
16. Text book Medical Parasitology of Jaypee Brothers, - Panikar C.K.J (1988)
17. Medical Publishers, New York. - Panikar C.K.J (1988)
18. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
19.The Zoology of Tapeworm. - Wardle and Mcleod (1952)
20. The advances in the Zoology of tapeworm from - 1970- Wardle and Mcleod
21. Systema Helmenthum Vol. II Cestoda. - Satyu Yamaguti (1959)
22. The Physiology of Cestodes. - J.D Smyth

**S.R.T.M. UNIVERSITY, NANDED**
**School of Life Sciences, Department of Zoology**
**M. Sc. Zoology, Second Year- Semester – IV (CBCS),** (w. e. f. 2020-21)
Paper Code: ZOT- S401
**Title of the Paper – Ecological Techniques and Microtomy**
(Skill Development Course-SDC)

**Credits: 02** **Marks: 25** **Periods: 30**

## UNIT – I . Ecological Techniques

1) Introduction to various ecological zones of River, Lake and Reservoir.
2) Distribution of various animals in ecological zones of River.
3) Introduction to various ecological zones in sea.
4) Distribution of various animals in ecological zones in sea
5) Coastal ecological zones of sea.
6) Sampling techniques for plankton from fresh water: Plankton nets, Fixation, preservation and identification.
7) Sampling Techniques for marine plankton, Nets used, Fixation, preservation and Identification.
8) Benthic Sampling: Trawling for fishery, Benthic samplers, Vanveen Grab, Benthic Waber sampler, Corers for Box Core, Multicorer. Grualing and Piston corer for deep sea
9) Roves and Scuba diving.

## UNIT –II – Microtomy

1) Introduction to Microtomy and importance in scientific study.
2) Types of microtome: Tissue sectioning, Ultra-microtome
3) Structure and functions of various components in a microtome.
4) Sectioning of biological sample for microtomy:
   a) Embedding in Wax
   b) Block preparation
   c) Various types of blades and sectioning adjustments for micron size
5) Ultra-microtome and mechanical sectioning.
6) Preservation and processing of microsections for micro-slide preparation and other forms of large size section.
7) Maintainance of microtome.

**References:**


1. Ecological Sampling: Welch (2001)
2. Freshwater Biology : Edited- Edmondson (1999)
3. Ecological Census techniques: Edited by Willian Sutherland. 446 pages. Cambridge University Press (2006)
4. Practical Methods in Ecology: Peter A Handerson. Blackwell Pub. 172 pp. (2003).

5. Essentials of Microtomy: Sidney John Gray. 70 pp. Butterworth & Co. Pub. Ltd (1972)
6. Practical approach to Histopathology: Punit Puri. Pp 128. Walnut Publication. (2020)
7. Histopathology Techniques and its management: Nayak Ramadas. Jaypee Brothers Medical Pub. Pp. 398. (2019).
8. Microtomy and Paraffin Section Preperation: Leica Microsystems Education Series (2020)

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology Second Year - Semester-IV**
(Choice Based Credit System), (w. e. f. 2020-2021)
Practical Paper Code: **ZOL- C401**
**Lab Course in General Entomology**

**Credits: 2** **Marks: 25**

1. Identification and characters of mouth parts in Insects
2. Identification of Types of legs and types of wing venation in insects and importance in Taxonomy.
3. Insect traps and insect collection methods: Collection of Insects from various habitats.
4. Practical methods for Processing and preservation of Insects.
5. Identification, Characters and control on household Insects: Mosquito, Bedbug, Cockroach.
6. Characters of Insects, eggs and their larvae of stored grains (any 05): Rice, Wheat, Pulses. Microscopic observation of grains for damage caused and control.
7. Insects pests of Agriculture crop (Any 02): Identification and characters of pests on Soybean, Cajanus Cajan, Cotton, Sugarcane, wheat and rice.

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**M. Sc. Zoology Second Year - Semester-IV**
(Choice Based Credit System), (w. e. f. 2020-2021)
Practical Paper Code: **ZOL- C402**
**Lab Course in Applied Entomology**

**Credits: 2** **Marks: 25**

1. Mounting and identification of Insect larvae: Mosquito, Mayfly, Chironemids; mounting of Trachea.
2. Identification of Scorpion and Spiders: 02 examples each.
3. Identification of Ants.
4. Identification of Butterflies and Moths.
5. External characters of economically important insects: Honey bees, Lac insect;
6. Collection, mounting and identification of plant gall flies.
7. Pheromone traps, Biological control agents of Insects.
8. Luminous organs in Insects: e-source demonstration.
9. Identification of flies of Carcass: eggs, larvae and adult of any two species
10. Collection, identification and control measure studies in insects of vegetable crops: Brinjal, Chile (02 examples each)

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**M. Sc. Zoology - Second Year – Semester - IV**
(Choice Based Credit System) (w. e. f. 2020-2021)
Practical Paper Code: **ZOL- E402**
**Lab Course in Aquaculture & Fisheries technology**

**Credits: 2** **Marks: 25**

1. Study of models of fishing nets crafts and boats-i) Gill Net ii) Cast Net iii) Bag Net iv) Plankton net v) Different kinds of traditional and modern crafts and rafts used in fresh water and marine water. Vi) Mechanized Boats, Trawls. Vii) Ship for fishing with advance technology- Echo sounder, light fishing, Electric fishing, GPs and Remote sensing applications in Fisheries.
2. Weight and length relationship and growth studies in fishes.
3. Assessment of spawning periodicity by Ova diameter measurement.
4. Biological analysis of fish samples for gut contents, maturity stages and fecundity.
5. Examination of normal and diseased fish - Thorough examination of external surface, Autopsy of the diseased fish.
6. Host examination – Collection of parasites, 4. Slide preparation - fixing - staining and mounting of parasites. Histopathology of organs of diseased fish (Sectioning – Staining and Mounting). Slides of fish parasites (Protozoan – Helminth and Copepod
7. Fieldwork: Visit to fish landing and processing centre, Visit to aquaculture farms, finfish and shellfish hatcheries, Visit to conventional aqua farm to see the management of used water. Survey on environmental impact nearby aquaculture farms; Setting model for sustainable aquaculture (organic farm, integrated farm).
8. Field Visits/ Excursion tour to visit the Circular Chinese Hatchery of fish seed production/ Fishing Centre/Fish Market and submission of Report.

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology - Second Year, Semester-IV**
(Choice Based Credit System) (w. e. f. 2020-2021)
Practical Paper Code-**ZOL- E401**
**Lab Course in Applied and Medical Parasitology**

**Credits: 2** **Marks: 25**

1.Preparation of stains: Haematoxylin, Acetocarmine, Borax caramine and Bouins fluid.
2.Parasitological examination of fecal waste of poultry and wild birds for protozoan parasites, helminth eggs, larvae and adult worms.
3. General principles of Collection, Preservation, Staining and Mounting of Trematodes and Cestodes.
4. Collection of Trematodes and Cestode parasites from locally available different hosts.
5. Preparation and identification of collected helminth parasites (Trematodes and cestodes) At least Ten.
6.Standard reference books, literature and e-sources used in Taxonomy of Parasitic Protozoa, Parasitic Arthropods, Trematodes, Cestodes and Nematodes.
7.Fixation of Helminth parasites for SEM and TEM studies and its importance in modern Taxonomy.
8. Molecular techniques for identification of Parasitic infection.
9. Study of permanent mounts of Trematodes and cestodes viz.
*1.. Gyrodactylus*
*2. Paramphistomum*
*3. Fasciola hepatica*
*4. Fasciolopsis buski*
*5. Schistosoma Japonicum*
*6. Schistosoma mansoni.*
*7. Paragonimus wetermani.*
*8. Taenia solium& Taenia saginata*
*9. Moniezia expansa*
*10. Railletina*
*14. Cotugnia*
*15. Echinococcus granulosus*
*16. Diphyllobothrium latum*
*17. Dipylidium caninum*
*18. Hymenolepis nana*
*20. Gyrocotyle*

10 . General principles of collection, preservation, staining and mounting of Animal parasitic Nematodes.
11.Collection of Animal and plant parasitic Nematodes from locally available different hosts/sources.
12. Preparation and identification of collected Animal parasitic Nematodes and plant parasitic Nematodes (At least Ten).
13. Morphology, taxonomy and their role as parasitic: Lice, Ticks, Mites, Flea and flies of

Human and veterinary importance.

14. Parmanant slides of protozoa: *Balantidium spp., Nyctotherus spp., Plasmodium spp, Trypanosoma spp., Entamoeba histolytica.*
15. Study of permanent slides of Animal parasitic and plant parasitic Nematodes viz.

*1. Ascaris lumbricoides*
*2. Oxyuris*
*3. Ancylostoma duodenale*
*4. Wuchereria bancrofti*
*5. Dracunculus medinensis*
*6. Trichinella spiralis,*
*8. Enterobius vermicularis.*
*9. Anguina (Seed Gall- nematode)*
*10. Meloidogyne (Root knot nematode)*
*11. Heterodera (cyst nematode)*
*12. Tylenchulus (citrus nematode)*
13. *Pratylenchus (Lesion nematode)*
*14. Ditylenchus dipsaci*
*15. Tylenchorhynchus*
*16. Radopholus similis*
*17. Xiphinema americanus*

16.Collection Techniques- Baerman's funnel technique., Oostenbrinks elutriator, Sieving, Fixation, Dehydration.
17.Parasitic Zoonosis: Examination of fecal waste of domestic animals (Cat, Dog) and wild animals, Rat, mice as reserves of parasites for occurrence of gravid eggs and embryonated stages, cysts and larval stages.

[Note-1) Demonstration of Animal Dissections through Models, Charts and Computer Aided Techniques as per U.G.C. Guidelines]
2) Essential animal material should collected from slaughter house.]

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology, Semester-I/III**
(Choice Based Credit System - CBCS) (w. e. f. 2020-2021)
Syllabus- Theory Paper, Code: **ZOT- OE101/301**
**Title of the Paper – Basics of Sericulture and Management**
(Open Elective Course for other Schools-OE)

**Credits: 02** **Marks: 25** **Periods: 30**

**Learning Objectives:**

To develop the knowledgeful human resource for the management of growing silk industry as agro-based business in India.

**Course Outcome:**

1.The students will get the knowledge about what is sericulture, types of sericulture and its importance as agrobased, employment generating industry.
2. The students will get knowledge about Life cycle of silk worm, Cocoon formation and Silk thread.
3. The students will acquire skill of how to manage a sericulture farm: Rearing shade, Mulbery garden, Silk and cocoon market and other value added and byproducts from sericulture.

**Unit-I INTRODUCTION TO SERICULTURE AND LIFE CYCLE OF SILK WORM**

a) Histry of sericulture, sericulture in India and importance of sericulture. Sericulture products and byproducts.
b) Silk producing species of insects and their food.
c) Mulbery silk worm: characters and life cycle.
d) Food and feeding to different stages of silk worm.
e) Methods of silk worm rearing.
f) Equipments and their uses in sericulture and its practical demonstration.

**Unit-II MANAGEMENT OF SERICULTURE UNIT**

a) Mulberry garden: Plantation, harvesting, irrigarion, disease management
b) Sericulture House: Various models, Ideal regional model and its construction.
c) Magement of Sericulture House/Shade: disinfection, control on insect pests, rodent pests and bird pests.
d) Management of bacterial, viral and protozoan diseases of silk worm.
e) Management and maintenance of cocoons, Cocoon markets and sale.
f) Economics of investment, expenditure, Sale and profit from sericulture.
g) Visit to sericulture farm and report writing.

**References:**

**Reference Books:**

1. Sericulture Manual. R. K. Patnaik
2. Silk Culture. Ananthnarayan
3. Silk Reeling. S. K. Ananthanarayan

4. Silk Worm Rearing. S. K. Ananthnarayan.
5. Silk Production and Export. Td. Koshey.
6. Sericulture and Pest Management. T.V. Sathe and A. D. Jadhav
7. Silk Reeling and Testing. Yong Woo Lee.
8. Textbook of Sericulture. S. K. Sehegal.
9. Tropical Wild Sericulture. P. K. Mohanty.
10. Silk and Sericulture. Chowdhary S. N.
11. Silk Culture: A Manual with complete Instructions in Sericulture. M. C. Buckner.
Principles of Sericulture. Hisao Aruga. CRC Press.

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology, Semester-II/IV**
(Choice Based Credit System - CBCS) (w. e. f. 2020-2021)
**(Open Elective for other Schools-OE)**
Syllabus- Theory Paper, Code: **ZOT- OE201/401**
Title of the Paper – Fundamentals of Goat Farming and Management

**Credits: 02** **Marks: 25** **Periods: 30**

## Course Objectives:

1) To intoduce about goat farming as an important agrobased small scale domestication agro-industry to the youth for self employment.
2) To educate the students on scientific methods of goat farming and its economics.

## Course Outcome:

1) The students will learn about scientific methods of Goat farming and its importance.
2) The students will get scientific knowledge and practical aspects by goat farm visit to decide about goat farming and its management. The learners may get job for Goat farm administration and management or may start their own business.

## Curriculum

**Unit: I . INTRODUCTION AND IMPORTANCE OF GOAT FARMING AND GOAT SPECIES.**

1) Histry of goat farming. Introduction to goat farming and its importance in India.
2) Goat species of domestication importance.
3) External characters of goat. Digestive system and Reproductive system of goat.
4) Products and their economic value from Goat farming;
   a) Goat Meat (Chevon) b) Goat leather. c) Goat manure d) Goat Milk.
5) Goat reproduction and management.

**Unit: II. MANAGEMENT OF GOAT FARM**

1) Types of goat shade and ideal models for goat shelter and their management.
2) Goat food and feeding: Main food and its composition, supplimentary food and its management. Food dependent Wait gain and reproduction in goat and its management.
3) Common diseases in goats: pathogens and parasites, infection, symptoms and treatment.
4) Goat marketing: Adults and slaughter size.
5) Economics of Goat farming: Investment, Income and profit.

## References and Suggested Readings:


1. Hand Book of Goat farming In India**.** Engineers India Research Institute (EIRI)
2. Kumar, Shalander : Commercialization of Goat Farming and Marketing of Goats in India. Final Report of ICAR Ad-hoc Research Scheme 2004-07, Central Institute for Research on Goats, Makhdoom, Mathura. Agricultural Economics Research Review Vol.20 (Conf. Issue)
4. Birthal, P.S. and P.K. Joshi (2006) High Value Agriculture for Accelerated and Equitable Growth: Policy Brief. No. 24, National Centre for Agricultural Economics and Policy Research, New Delhi, December.
5. Dalgado, C., M. Rosegrant, H. Steinfedl, S. Ehui,and C. Courbois (1999) Livestock to 2020 — The Next Food Revolution. Food, Agriculture and Environment Discussion Paper 28, IFPRI, Washington.

6. Kumar, Shalander (2007) Commercialization of Goat Farming and Marketing of Goats in India. Final Report of ICAR Ad-hoc Research Scheme 2004-07, Central Institute for Research on Goats, Makhdoom, Mathura.
7. Kumar, Shalander (2007) Multi-disciplinary project on transfer of technology for sustainable goat production, Annual Report 2006-07, Central Institute for Research on Goats, Makhdoom, Mathura.
8. Kumar, Shalander and P.R. Deoghare (2002) Goat rearing and rural poor: A case study in south-western semiarid zone of Uttar Pradesh. Annals of Arid Zone, 41(1): 79-84.
9. Kumar, S., V.S. Vihan and P.R. Deoghare (2003) Economic implication of diseases in goats in India with special reference to implementation of a health plan calendar. Small Ruminant Research, 47: 159-164.
10. Singh, N.P. (2006) Technological advances for commercial goat production. In: Commercial Goat and Sheep Farming and Marketing: Farmer-Industry- Researcher Interface, Eds: N.P. Singh, S. Kumar, A.K. Goel and R.K. Vaid, Central Institute for Research on Goats, Makhdoom, Mathura, pp. 1-17.
11. Singh, N.P. and Shalander Kumar (2007) An alternative approach to research for harnessing production potential of goats. Proceedings of 4th National Extension Congress, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur.

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology First Year, Semester-I/III**
(Choice Based Credit System - CBCS) (w. e. f. 2020-2021)
**(Open Elective for Other Schools- OE)**
Syllabus- Theory Paper, Code: **ZOT- OE101/301**
Title of the Paper – Fundamentals of Bee keeping

**Credits: 02** **Marks: 25** **Periods: 30**

**Course Objectives:**

1) To determine the basics in Apiculture or Bee keeping.
2) To determine the importance of bees to increase the agriculture production and social services of bees.

**Course Outcome:**

1) Understanding about Structure of Bee colony and division of Labour.
2) Understanding about Bee keeping in Bee boxes and Bee services.

**Curriculum:**

Unit-I . INTRODUCTION TO BEE KEEPING/APICULTURE

1) History of Bee keeping. Life Cycle of bees, Structure of bee colony and division of Labour: Queen, Drones and Workers. Characters and functions.
2) Strucure of Bee Box: Brooder, Super, Stand, Frames, Covers. Placement of Bee boxes.
3) Importance of flowring and bee keeping, Crops required for bee keeping, Floral calander of the region, Migratory bee keeping.
4) Collection of colonies from trees, cliffs and ground. Swarming.

Unit-II. PRODUCTS OF BEE KEEPING AND BEE SERVICES

1) Honey formation in the Bee Boxes and extraction of honey.
2) Composition and medicinal value of honey.
3) Other products in bee farming, economic value and medicinal importance, uses: Propolis, Pollen, Royal Jelly, Bee wax, Bee venom
4) Personal protective equipments for bee keeping: Bee dress, gloves, shoes etc.
5) Bee behaviour and personal protection. Economics of bee Keeping: Investment, Income and Profit.

**Reference Books**

1) Introduction to disease of bee –Bailey, L
2) World of honeybee –Butter C. G.
3) Beekeeping in India –Sardar Sing (ICAR)
4) The Principle of Insect Physiology-Wigglesworth, V.S.
5) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)
6) D. K. Belsare, Beekeeping for livelihood

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
M. Sc. Zoology, Semester-II/IV
**(Open Elective for other Schools- OE)**
(Choice Based Credit System - CBCS) (w. e. f. 2020-2021)
Syllabus- Theory Paper, Paper Code: **ZOT- OE201/401**
**Title of the Paper – Fish Farm Management**

**Credits: 02** **Marks: 25** **Periods: 30**

**Course Objectives:**
1) To determine what is fish culture.
2) To learn about various aspects of Fish farm management

**Course Outcome:**
1) Understanding about what is fish, culturable fish species, structure and components of a fish farm.
2) Knowledge and techniques of Management of a fish farm.

**Curriculum:**

Unit – I. INTRODUCTION TO FISH AND FISH CULTURE, FISH CULTURE METHODS

1) External characters of fish, culturable fish species in India.
2) Exotic fish species used in fish culture.
3) Pond culture: Structure of Pond for fish culture. Fish seed stocking (Spawn, fry and fingerlings)
4) Maintenance in pond water quality for fish culture.
5) Food of fishes in various systems of fish culture.

Unit – II. FISH CULTURE POND MANAGEMENT

1) Management of Fish diseases, Algal blooms, Weeds, Dissolved Oxygen, harmful gases and aquatic insects, fish predators.
2) Fishing nets and their operation for fish harvesting. Decomposition of fish and fish preservation.
3) Management of pond productivity.
4) Management of fish reproduction and breeding.
5) Fish market and fish price. Food value of fish. Economics of Pond Fish Culture.

**References** :

1. Bardach, et al. Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
2. Stickney, R.R. Principles of Water Aquaculture. John Wiley & Sons, NY, 1979.
3. Chondar, C.L. Hypophysation of Indian major carps. Satish Book Enterprise, Agra, 1980.
4. Jhingran, V.G. Fish and fisheries of India. Hindustan Publ. Corporation (India), 1982.
5. Santhanam, R. et. Al. A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
6. Pilley, T.V.R. Aquaculture – Principles and Practices. Fishing News (Books) Ltd., London, 1990.
7. Pandey, A.C. Air Breathing Fishes. Reliance Publishing House, New Delhi, 1990.
8. Janardhana Rao, K. & S.D. Tripathi. A Manual of Giant Freshwater Prawn Hatchery. CIFA, Kausalyaganga, Orissa, India, 1993.
9. Iso Matsui. Theory and Practice of Eel Culture. American Publishing Co. Pvt. Ltd 1980.
10. Aquaculture and Aquarium keeping- S. P. Chavan, M. S. Kadam, S. D. Niture. Educational Books Publishers and Distributors, Aurangpura Aurangabad, MS
11. A Manual of Fresh Water Aquaculture, Santhanam. Oxford and IBH Publishers and Distributors New Delhi.
12. Introduction to Fishes – S. S. Khanna, Central Book Depot, Allahabad

13. Taxonomy of fishes – Jhingran and Talwar
14. Physiology of fishes – Hoar and Randall.
15. Fish Biology and Indian fishes – R. P. Parihar, - Central publishing house, Allahabad.
16. A text book of fish, fisheries and Technology, Biswas – Narendra Publishing House, New Delhi.
17. Aquaculture and Aquarium Keeping – Chavan S. P., Kadam M. S. and Niture S. D., - Educational Books and Publishers, Aurangabad, M. S.
18. Fishery Science and Indian Fisheries – C. B. L. Shrivastava - Kitab Mahal, New Delhi.
19. Aquaculture Principles and Policies – T.V.R. Pilley – Daya PublishingHouse, New Delhi
20. Aquaculture and Practices a selected review – FAO
21 Aquaculture Project Formulation – FAO
22. Bacterial Diseases of Fishes – Veleri Englis Ronald – Daya Publishing House New Delhi.
23. Taxonomy of Fishes Vol I, Vol II – Francis Day (Narendra Publishing House New Delhi)
24. Marine Fisheries – Bal and Rao.

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**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
(CBCS, w. e. f. 2020)

# PRACTICAL EXAMINATION (Internal / External)

**Class : M. Sc. Zoology (First/Second Year)**
**Semester :_____**
**Practical Paper- No. : _____**
**Title of the Paper- Zoology Lab Course : _____**

Marks: 25 Time: 04 Hours Date:

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Q. 1. Major Question 10 Marks

Q. 2. Minor Question 08 Marks

Q. 3. Record Book and submission 03 Marks

Q. 4. Viva Voce 04 Marks

1. Signature of Internal Examiner----------

   Name, Address of the Examiner----------

2. Signature of External Examiner----------

   Name, Address of the Examiner----------

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology Second Year – Semester-IV**
**(Choice Based Credit System), (w. e. f. 2020-2021)**
**Practical Paper-ZOLC**
**Title of the Paper- Dissertation/Scientific Review**

**Marks-100** **Assessment Sheet** **Date:**

| Sr. No. | Exam. Seat Number | Objective of Research Problem and its Scope | Research Done | Conclusion drawn | Presentation | Total marks |
|---|---|---|---|---|---|---|
| Marks | | 10 | 60 | 20 | 10 | 100 |
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1. Signature of **External** Examiner: ----------
   Name, Address of the Examiner: ----------
2. Signature of **Internal** Examiner: ----------
   Name, Address of the Examiner: ----------
3. Signature of **Head of the D**epartment :----------

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED,**
**SCHOOL OF LIFE SCIENCES,**
**M. Sc. Zoology Second Year – Semester- IV**
**(Choice Based Credit System), (w. e. f. 2020)**
**Practical Paper- ZODL- 3**
**Title of the Paper- Dissertation/Scientific Review/Industrial visit and Report**

**Marks-100** **Final Assessment Sheet** **Date:**

| Sr. No. | Exam. Seat Number | Total Marks by Internal Examiner | Total Marks by External Examiner | Average of Marks | Final Total Marks Obtained | Remarks any |
|---|---|---|---|---|---|---|
| Maximum Marks | | 100 | 100 | 100 | 100 | |
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1. Signature of External Examiner----------
   Name, Address of the Examiner----------
2. Signature of Internal Examiner----------
   Name, Address of the Examiner----------
3. Signature of Head of the Department :----------