
**FACULTY OF SCIENCE**

**DEPARTMENT OF ZOOLOGY**

**UGC-SAP and DST-FIST Sponsored**

**M.Sc. ZOOLOGY**

**(TWO YEARS PROGRAMME)**

**PROGRAMME CODE: SZOO 21**

**HAND BOOK**

# Regulations & Curriculum-2019

**2019-2020**

**(Onwards)**

# ANNAMALAI UNIVERSITY

## REGULATIONS FOR THE TWO-YEAR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculties of Arts, Science, Indian Languages, Education, Marine Sciences, and Fine Arts from the academic year 2019-2020 onwards.

### 1. Definitions and Nomenclature

**1.1 University** refers to Annamalai University.

**1.2 Department** means any of the academic departments and academic centres at the University.

**1.3 Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

**1.4 Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

**1.5 Course** is an individual subject in a programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by a course code.

**1.6 Curriculum** encompasses the totality of student experiences that occur during the educational process.

**1.7 Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

**1.8 Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

**1.9 Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

**1.10 Choice Based Credit System** A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

**1.11 Core Course** is mandatory and an essential requirement to qualify for the Degree.

**1.12 Elective Course** is a course that a student can choose from a range of alternatives.

**1.13 Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.

**1.14 Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

**1.15 Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

**1.16 Programme Outcomes (POs)** are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

**1.17 Programme Specific Outcomes (PSOs)** are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

**1.18 Learning Objectives also known as Course Objectives** are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

**1.19 Course Outcomes (COs)** are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

**1.20 Grade Point Average (GPA)** is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

**1.21 Cumulative Grade Point Average (CGPA)** is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

**1.22 Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

## 2. Programme Offered and Eligibility Criteria

| Faculty of Science | |
|---|---|
| M.Sc. Zoology | A pass in B.Sc. Zoology (or) B.Sc. (Hons) with Zoology as subject with not less than 50% of marks under Part–III. |

**2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme.**

## 3. Reservation Policy

Admission to the programme will be strictly based on the reservation policy of the Government of Tamil Nadu.

## 4. Programme Duration

4.1 The Two Year Master's Programme consists of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

## 5 Programme Structure

**5.1** The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental) and Project.

### 5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

### 5.3 Elective courses

5.3.1 **Departmental Electives (DEs)** are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 **Interdepartmental Electives (IDEs)** are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

**5.3.3 Students shall take a combination of both DEs and IDEs.**

### 5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.4.3 Experiential learning is categorised as Core.

### 5.5 Project

5.5.1 Each student shall undertake a Project in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

### 5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

### 5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

### 5.8 Credit Distribution

The credit distribution is organised as follows:

| | **Credits** |
|---|---|
| Core Courses | 65-75 |
| Elective Courses | 15 |
| Project | 6-8 |
| Total (Minimum requirement for award of Degree) | **90-95*** |

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 90-95 credits.*

### 5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) per week over a semester.

## 6 Attendance

**6.1** Each faculty handling a course shall be responsible for the maintenance of *Attendance and Assessment Record* for candidates who have registered for the course.

**6.2** The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organisation of lesson plan of the Course Instructor.

**6.3** The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

**6.4** At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

**6.5** The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

**6.6** Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

**6.7** Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

## 7 Mentor-Mentee System

**7.1** To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

**7.2** The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

**7.3** The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

## 8 Examinations

**8.1** The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

**8.2** There will be two CIA Tests and one ESE in each semester.

**8.3** The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

### 8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

### 8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

## 9 Evaluation

### 9.1 Marks Distribution

9.1.1. Each course, Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 40% and the ESE 60% of the marks.

### 9.2. Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

| | Marks |
|---|---|
| Test-I & Test-II | 15 |
| Seminar | 05 |
| Assignment | 05 |
| Total | 25 |

**9**.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

| | Marks |
|---|---|
| Test-I | 15 |
| Test-II | 15 |
| Viva-voce and Record | 10 |
| Total | 40 |

### 9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

**9.4 Assessment of Project/Dissertation**

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

| Continuous Internal Assessment (25 Marks) | | End Semester Examination (75 Marks) | |
|---|---|---|---|
| Review-I 10 | Review-II: 15 | Project / Dissertation Evaluation | Viva-voce |
| | | 50 | 25 |

**9.5 Assessment of Value-added Courses**

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

**9.6 Passing Minimum**

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

**10. Conferment of the Master's Degree**

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

**11. Marks and Grading**

**11.1** The performance of students in each course is evaluated in terms Grade Point (GP).

**11.2** The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

**11.3** The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, $C_i$ is the Credit earned for the Course $i$ in any semester;

$G_i$ is the Grade Point obtained by the student for the Course $i$ and

$n$ is the number of Courses passed in that semester.

**11.4** **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

where, $C_i$ is the Credit earned for the Course $i$ in any semester;

$G_i$ is the Grade Point obtained by the student for the Course $i$ and

$n$ is the number of Courses passed in that semester.

$m$ is the number of semesters

**11.5** Evaluation of the performance of the student will be rated as shown in the Table.

| Letter Grade | Grade Points | Marks % |
|---|---|---|
| S | 10 | 90 and above |
| A | 9 | 80-89 |
| B | 8 | 70-79 |
| C | 7 | 60-69 |
| D | 6 | 55-59 |
| E | 5 | 50-54 |
| RA | 0 | Less than 50 |
| W | 0 | Withdrawn from the examination |

**11.6 Classification of Results.** The successful candidates are classified as follows:

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (*See Section 12 for details*).

11.6.2 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11. 6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

**11.7 Course-Wise Letter Grades**

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

**12. Provision for Withdrawal from the End Semester Examination**

**12.1** The letter grade W indicates that a candidate has withdrawn from the examination.

**12.2** A candidate is permitted to withdraw from appearing in the ESE for one course or courses in **ANY ONE** of the semesters **ONLY** for exigencies deemed valid by the University authorities.

**12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.**

**12.3** Application for withdrawal shall be considered **only** if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

**12.4** The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

**12.5** Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

**12.6** Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

**12.7** Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

**13. Academic misconduct**

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitised on issues of academic integrity and ethics.

**14. Transitory Regulations**

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

**15.** *Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.*

Annamalai University

## DEPARTMENT OF ZOOLOGY
### M.Sc. ZOOLOGY (2 YEAR PROGRAMME)

**Programme Code SZOO 21**

**Programme Structure**
**(For students admitted from the academic year 2019-2020)**

| | | Hours/ Week | | | Marks | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | **Course Title** | **L** | **P** | **C** | **Inter. Mark** | **Exter. Mark** | **Total** |
| **I SEMESTER** | | | | | | | |
| 19ZOOC101 | Structure and functions of Invertebrates and Vertebrates | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC102 | Developmental Biology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC103 | Cell and Molecular biology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOP104 | Core Practical –I<br>Pre lab Discussion ( 1 hour)<br>Practical I (11 hours)<br>(Covering ZOOC 101,102 & 103) | | 12 | 6 | 40 | 60 | 100 |
| | Elective 1: Interdepartmental Elective | 3 | | 3 | 25 | 75 | 100 |
| | **Total** | | | **21** | | | **500** |
| **II SEMESTER** | | | | | | | |
| 19ZOOC201 | Animal Physiology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC202 | Genetics | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC203 | Immunology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOP204 | Core Practical- II<br>Pre lab Discussion ( 1 hour)<br>Practical II (11 hours)<br>(Covering ZOOC 201,202 & 203) | | 12 | 6 | 40 | 60 | 100 |
| | **Elective- II –** Department Elective | 3 | | 3 | 25 | 75 | 100 |
| | **Elective III –** Interdepartmental Elective | 3 | | 3 | 25 | 75 | 100 |
| | **Total** | | | **24** | | | **600** |
| **III SEMESTER** | | | | | | | |
| 19ZOOC301 | Evolution | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC302 | Environment & Biodiversity conservation | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC303 | Animal Behaviours | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC304 | Biotechnology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOP305 | Core Practical -III<br>Pre lab Discussion ( 1 hour)<br>Practical III (11 hours)<br>(Covering ZOOC 301,302 , 303 & 304) | | 12 | 6 | 40 | 60 | 100 |
| | **Elective- IV –** Department Elective | 3 | | 3 | 25 | 75 | 100 |
| | **Elective- V –** Interdepartmental Elective | 3 | | 3 | 25 | 75 | 100 |
| | **Total** | | | **28** | | | **700** |

| IV SEMESTER | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19ZOOC401 | Bio-chemistry | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC402 | Endocrinology | 4 | | 4 | 25 | 75 | 100 |
| 19ZOOC403 | Core Practical- IV<br>Pre lab Discussion ( 1 hour)<br>Practical IV (11 hours)<br>(Covering ZOOC 401 & 402) | | 12 | 6 | 40 | 60 | 100 |
| 19ZOOPJ404 | Project<br>(Dissertation and Viva-Voce) | | 10 | 6 | 25<br>(Viva<br>-Voce) | 75<br>(Disser<br>-tation) | 100 |
| | **Total** | | | **20** | | | **400** |
| | **TOTAL CREDITS** | | | **93** | | | |
| | **Value Added Courses** | | | | | | |
| | Online Courses(SWAYAM, MOOC, NPTEL) | | | | | | |

**L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination**

**Note:**

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

## DEPARTMENT ELECTIVES

### II and III Semester

| Semester & Course Code | Course Title | L | P | C | Int. Ass. Marks 25 | End Sem. Exam Marks 75 | Total Marks |
|---|---|---|---|---|---|---|---|
| **II Semester Elective II**<br>19ZOOE215-1<br>(or)<br>19ZOOE215-2 | Entomology<br>(or)<br>Public Health and Hygiene | 3 | 0 | 3 | 25 | 75 | 100 |
| **III Semester Elective- IV**<br>19ZOOE315-1<br>(or)<br>19ZOOE315-2 | Fisheries & Aquaculture<br>(or)<br>Toxicology | 3 | 0 | 3 | 25 | 75 | 100 |

| INTERDEPARTMENT ELECTIVE COURSES (IDE) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.No | Course Code | Course Title | Department | L | P | Credits | Marks | | |
| | | | | Hrs | | | Int. Asses | End Sem. Exam | Total |
| 1. | 19SOSE 115.1 | Soft Skills | **English** | 3 | 0 | 3 | 25 | 75 | 100 |
| 2. | 19MATE 215.1 | Discrete Mathematics | **Mathematics** | 3 | 0 | 3 | 25 | 75 | 100 |
| 3. | 19MATE 215.2 | Numerical Methods | | 3 | 0 | 3 | 25 | 75 | 100 |
| 4. | 19MATE 315.1 | Differential Equations | | 3 | 0 | 3 | 25 | 75 | 100 |
| 5. | 19STSE 215.1 | Statistical Methods | **Statistics** | 3 | 0 | 3 | 25 | 75 | 100 |
| 6. | 19STSE 215.2 | Mathematical Statistics | | 3 | 0 | 3 | 25 | 75 | 100 |
| 7. | 19STSE 315.1 | Bio-Statistics | | 3 | 0 | 3 | 25 | 75 | 100 |
| 8. | 19PHYE 215.1 | Classical Mechanics and Special Theory of Relativity | **Physics** | 3 | 0 | 3 | 25 | 75 | 100 |
| 9. | 19PHYE 215.2 | Physics of the Earth | | 3 | 0 | 3 | 25 | 75 | 100 |
| 10. | 19PHYE 315.1 | Bio-Medical Instrumentation | | 3 | 0 | 3 | 25 | 75 | 100 |
| 11. | 19PHYE 315.2 | Energy Physics | | 3 | 0 | 3 | 25 | 75 | 100 |
| 12. | 19CHEE 215.1 | Applied Chemistry | **Chemistry** | 3 | 0 | 3 | 25 | 75 | 100 |
| 13. | 19CHEE 315.1 | Basic Chemistry | | 3 | 0 | 3 | 25 | 75 | 100 |
| 14. | 19CHEE 315.2 | Instrumental Methods of Analysis | | 3 | 0 | 3 | 25 | 75 | 100 |
| 15. | 19BOTE 215.1 | Plant Tissue Culture | **Botany** | 3 | 0 | 3 | 25 | 75 | 100 |
| 16. | 19BOTE 215.2 | Plant Science – I | | 3 | 0 | 3 | 25 | 75 | 100 |
| 17. | 19BOTE 315.1 | Gardening and Horticulture | | 3 | 0 | 3 | 25 | 75 | 100 |
| 18. | 19BOTE 315.2 | Plant Science – II | | 3 | 0 | 3 | 25 | 75 | 100 |
| 19. | 19GEOE 215.1 | Environmental Geosciences | **Earth Sciences** | 3 | 0 | 3 | 25 | 75 | 100 |
| 20. | 19GEOE 315.1 | Applied Geophysics | | 3 | 0 | 3 | 25 | 75 | 100 |
| 21. | 19 BIOE 215.1 | Basic Biochemistry | **Biochemistry & Biotechnology** | 3 | 0 | 3 | 25 | 75 | 100 |
| 22. | 19 BIOE 215.2 | Basic Biotechnology | | 3 | 0 | 3 | 25 | 75 | 100 |
| 23. | 19 BIOE 315.1 | Biochemical Techniques | | 3 | 0 | 3 | 25 | 75 | 100 |
| 24. | 19 BIOE 315.2 | Immunology | | 3 | 0 | 3 | 25 | 75 | 100 |
| 25. | 19 MIBE 315.1 | Microbiology | **Microbiology** | 3 | 0 | 3 | 25 | 75 | 100 |
| 26. | 19 CSCE215.1 | R Programming | **Computer & Information Science** | 3 | 0 | 3 | 25 | 75 | 100 |

**Elective Courses offered to the students of Other Departments in**

**II and III Semesters (Inter-Department Electives)**

| Semester & Course Code | Course Title | L | P | C | Int. Ass. Marks 25 | End Sem. Exam Marks 75 | Total Marks |
|---|---|---|---|---|---|---|---|
| **II Semester** 19ZOOX216-1 | Animal Culture Techniques | 3 | 0 | 3 | 25 | 75 | 100 |
| **III Semester** 19ZOOX316-1 | Environmental Science | 3 | 0 | 3 | 25 | 75 | 100 |

**Value Added Courses offered to Other Science Department**
**(Combinedly offered by Department of Physics and Zoology)**

| Course Code | Course Title | L | P | C | Int. Ass. Marks 25 | End Sem. Exam Marks 75 | Total Marks |
|---|---|---|---|---|---|---|---|
| | **Bio-Medical Instrumentation** | 3 | | | 25 | 75 | 100 |

**POs for Science Faculty**

| | |
|---|---|
| PO1: | **Domain knowledge**: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline. |
| PO2: | **Resource Utilisation.** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments |
| PO3: | **Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations. |
| PO4: | **Critical thinking and Problem solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions. |
| PO5: | **Project Management**: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources. |
| PO6: | **Individual and team work**: Exhibit the potential to effectively accomplish tasksindependently and as a member or leader in diverse teams, and in multidisciplinary settings. |
| PO7: | **Effective Communication**: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation. |
| PO8: | **Environment and Society**: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development. |
| PO9: | **Ethics**: Commitment to professional ethics and responsibilities. |
| PO10: | **Life-long learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline |

**Programme Specific Objectives (PSOs)**

| | |
|---|---|
| PSO1: | To ensure that the candidate after successfully completing the master's degree in Zoology is well versed in subjects related to the programme and are able to impart knowledge to the concerned sections of the society. |
| PSO2: | To acquire skills in utilizing the fundamental knowledge gained in various fields of biological sciences in teaching learning activities. |
| PSO3: | To analyze biological problems professionally with a scientific temperament and research attitude and also to think logically in a scientific way to solve biological issues that they may come across. |
| PSO4: | To critically evaluate and interpret biological data and to acquire skills in modern tools and techniques in biological field to take up jobs in teaching/research/clinical/Biotechnology/animal husbandry and environment related establishments. |
| PSO5: | To analyze environmental issues and contribute to words environmental protection, bio-sustainability and biodiversity and also to apply the scientific knowledge in guiding the society in maintaining public health and hygiene and thereby avoiding spreading of diseases. |

## FIRST YEAR : FIRST SEMESTER

## 19 ZOO C 101: STRUCTURE AND FUNCTIONS OF INVERTEBRATES AND VERTEBRATES

**LEARNING OBJECTIVES**

To understand and Structure and Functions of invertebrates and vertebrates

- To understand the organs of respiration and excretion and their functioning in invertebrates.
- To analyses the nervous systems if various groups if invertebrates
- To evaluate the larval forms of invertebrates to acquire knowledge on various organ system of vertebrates

**Unit-I: Respiration and Excretion of Invertebrates**

Organs of respiration: gills, lungs and trachea – Respiratory pigments – Mechanism of respiration – Excretion – Organs of excretion: coelom, coelomoducts, nephridia and Malphigian tubules – Mechanisms of excretion – Excretion and osmoregulation

**Unit II : Nervous System of Invertebrates**

Primitive nervous system: Coelenterata and Echinodermata – Advanced nervous system: Annelida, Arthropoda (crustacean and insecta) and Mollusca (cephalopoda) – Trends in neural evolution

**Unit III : Invertebrata larvae**

Larval forms of free living invertebrates – Larval forms of parasites – Strategies and evolutionary significance of larval forms – Minor Phyla – Concept and significance – Organization and general characters

**Unit IV : Skin and Skeletal System of Vertebrates**

General structure and functions of skin and its derivatives – glands, scales, horns, claws, hail, hoofs, featter and hairs. Skeletal elements of the body – account of jaw suspenrsorium, vertebral column – limbs and girdles

**Unit V : Respiratory system and Nervous system of Vertebrates**

Respiratory system – characters of respiratory tissue – Internal and external respiration – comparative account of respiratory organ. Nervous system – Anatomy of the brain and spinal cord in relation to their functions – Nerves -Cranial – peripheral and autonomous nervous system.

**PRACTICAL**

**1. Dissections:**

Dissection of Cockroach – Digestive and Nervous system,
Dissection of Prawn- Nervous system and mounting of appendages.
Dissection of Fish – Nervous system, Respiratory system and Digestive system.

2.Observation and Classification of the following Specimens by giving reasons: Paramecium, Sycon, Obelia, *Taenia solium*, Neries, Prawn, Freshwater mussel, Amphioxus, Hyla, Calotes, Rat.

3.Study of Adaptations to the mode of life: Trypanosoma, Corals, Ascaris, Wuchereria

4.Biological Significance of the following forms: Peripatus, Sea anemone, Anabas, Arius, Exocoetus, Eel, Amblystoma, Woodpecker, Anteater, Lingular, Sagitta and Phoronis.

5.Relate structure and function of the following forms: Taenia, Scolex, Nereis-Parapodium, Ctenoid and Quill feather of pigeon.

**TEXT BOOKS**


1. M. Ekambaranatha Ayyar, 1973. A Manual of Zoology – Part I, Invertebrata. S.Viswanathan (Printers and Publishers) Pvt., Ltd. Madras.
2. Jordon, E.L. and P.S Verma, 2013. Invertebrate Zoology. S.Chand and Co.Ltd., New Delhi.
3. M. Ekambaranatha Ayyar.1973. A Manual of Zoology Part – II: Chordata. S. Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
4. Jordan. E.L. and P.S Verma, 2017. Chordate Zoology and Elements of Animal Physiology, S. Chand & Co., Ltd., New Delhi.


**REFERENCE BOOKS**


1) Arumugam, N. 2014. Animal diversity Volume -1 – Invertebrata. Saras Publication
2) Arumugam, N. 2014. Animal diversity Volume -2 – Chordata. Saras Publication.
3) Barrington E.J.W. 2012.Invertebrate structure and function. Affiliated East West Press Pvt. Ltd., New Delhi.
4) Richard C. Brusca, Wendy Moore and Stephen M. Shuster. 2016. Invertebrates. OUP, USA.
5) Kent. 2015. Comparative Anatomy of the Vertebrates. McGraw Hill.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Understand the morphological features and physiological features like respiration and reproduction and nervous system of invertebrates and vertebrates

CO2: Understand the various salient features of higher invertebrates and vertebrates

CO3: Differentiate the patterns of functioning of various organ systems in invertebrates and Vertebrates

CO4: Know the structural organization and functioning of various organs in invertebrates and vertebrates

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | - | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | - | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | - | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | - | √ | - | - | √ | √ | √ | √ | √ | √ |

## 19 ZOO C 102: DEVELOPMENTAL BIOLOGY

**LEARNING OBJECTIVES**

- To understand the various concepts of development
- To study gametogenesis and process of fertilization
- To learn the processes of embryogenesis, organ formation and differentiation
- To analyse the embryonic induction and teratogenesis
- To critically explore assisted reproductive technologies for human welfare

**UNIT I: Introduction to Embryology**

Scope of embryology. Gametogenesis – spermatogenesis, oogenesis and egg membranes. Fertilization - mechanism of fertilization, capacitation, acrosomal reaction, cortical reaction and significance of fertilization. Cleavage – cleavage in frog and chick. Gastrulation – gastrulation in frog and chick. Fate map of amphibian aves and mammals.

**UNIT II: Embryonic adaptations and Parthenogenesis.**

Foetal membranes and their functions – Implantation – types and mechanism of implantation. placentation - placenta, structure, types and physiology of placenta. Parthenogenesis – types, mode of action of agents in artificial parthenogenesis – significance of parthenogenesis.

**UNIT III: Organogenesis and Differentiation**

Organogenesis - development of brain, eye and heart of mammals (Rabbit). Differentiation, types, chemical basis, selective action of genes, changing pattern of protein synthesis and sequence of gene action in development – stem cells, role of micro environments in differentiation.

**UNIT IV: Embryonic induction and Teratogenesis**

Embryonic induction- types, embryonic induction in amphibians, reptiles, birds and mammals. Neural induction, gene activation, mechanism of neural induction and chemical basis of neural induction. Teratogenesis - genetic teratogenesis- in human beings and animals, teratogenetic agents and mechanism of teratogenesis.

**UNIT V: Reproductive Technology for Human Welfare**

Causes of impotency and sterility in the male – causes of sterility in the female – Treatment of sterility – Artificial insemination in human beings - Infertility in men and women.

Sperm banking – Cryopreservation of gametes. Test tube baby: Techniques, Advantages and Disadvantages. Gamete Intra Fallopian transfer(GIFT). Cancer associated with male and female reproductive organs. IVF, embryo transfer and family planning.

**PRACTICAL**

1. Demonstration of male and female reproductive system in mammals (rat) - specimens
2. Dissection and mounting of chick blastodem to identify different stages in chick development.
3. Observation of early development of frog – two celled stage, 4 celled stage, 8 celled stage and sixteen celled stage, blastula, gastrula and yolk plug stage.
4. Regeneration in amphibian – frog tadpole.
5. Observation of metamorphosis in insects.
6. Observation of different types of placenta – slides.
7. Analysis of excretory products – chick embryo.
8. Histology of mammalian testis and ovary – slides.
9. Observation of uterine cycles in mammals – slides.

**TEXT BOOKS**


1. Verma, P.S., V.K. Agarwal and B.S. Tyagi, 2003. Chordate embryology. S. Chand & Company Ltd, New Delhi.
2. Arora, P. mohan, 1985. Embryology, Himalaya publishing House, New Delhi.
3. Gayathri Prakash, Reproductive Biology, 2007. Narosa Publishing House Pvt. Ltd., New Delhi.
4. Philip Grant 1977. Biology of development systems, University of Oregon
5. Berrill, N.J., and G. Karp. 1978. Development Biology, Tata McGraw Hill Publishing Co., Ltd, New Delhi
6. Balinsky, B.I. 1981. An Introduction to embryology, 4th Edition, Saunder's College Publishing Ltd, New York


**REFERENCE BOOKS**


1) Madhavan K.S. 2018. Developmental Biology. Arjun Publishing House.
2) Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias. 2015. Principles of Development. OUP, Oxford.
3) Jain P.C. 2013. Elements of Developmental Biology. Vishal Publishing Co.
4) Sastry K.V. and Vinita Shukal. 2012. Developmental Biology. Rastrogi Publication.
5) Berry A.K. 2016. An Introduction to Embryology. Emkay Publications.


**Course outcomes**

At the end of the semester students will be able to

CO1: Acquire knowledge on reproduction and development
CO2: Understand process of fertilization
CO3: Understand the whole process of embryogenesis
CO4: Acquisition of skills in common methods and practices followed in developmental biology related laboratory activities
CO5: Take up jobs in fertility clinics and research labs

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| **CO2** | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO5 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## 19 ZOO C 103: CELL AND MOLECULAR BIOLOGY

### LEARNING OBJECTIVES

- To understand the molecular basis of cell structure and functions
- To learn the structure and functions of various organization and cell membrane.
- To learn bioenergetic and biogenesis
- To learn structure and replication of DNA
- To learn various molecular techniques

**Unit–I: Cell structure and Cell membrane**

Cell Structure: Introduction – Structural organization of prokaryotic and eukaryotic cells; strcutral differences of prokaryotic and eukaryotic cells.

Cell membrane: Ultrastructure of plasma membrane – chemical composition of cell membrane, lipid bilayer – unit membrane concept – Fluid mosaic model; Functions of Plasma membrane; membrane transport- cell adhesion – cell recognition – antigen specificity - hormone receptors.

**Unit–II: Organelles of Endomembrane**

Golgi apparatus & secretion: Ultra structure – chemical composition - origin of golgi complex - process and mechanism of secretion – Type of secretion – Function of Golgi apparatus.

Lysosome: Characteristics of lysosomal membrane and enzymes -Polymorphism of lysosome – functions of lysosome.

Endoplasmic recticulam and ribosomes: morphology and functions of endoplasmic recticulam -Structure of ribosomes and rRNAs- - Organization of ribosomes – Role of ribosomes in protein synthesis.

**Unit–III: Organalles of Bioenergetics & Biogenesis**

Organalles of Bioenergetics: Mitochondria -Ultrastructure - respiratory chain complex; chemical composition and enzyme distribution – role in metabolism for cellular energetic- Anaerobic glycolysis, Pasteur effect - Kreb cycle – Formation of ATP. Chemical and conformation coupling hypothesis; shuttle system – Glycerophosphate and malate shuttle.

Organalle of Biognesis: Chloroplast – Ultrastructure- photochemical reaction in biogenesis - Light reaction and Dark reaction – Role of $CO_2$ and $H_2O$ in photosynthesis – 'Z' scheme.

**Unit-IV: DNA Structure and Replication**

Structure, Chemical composition- Types and their importance- Properties of DNA - Denarturatin, Renaturation and Hybridization.

**DNA replication:** Prokaryotic and eukaryotic DNA replication – Semi- conservative replication mechanism, enzymes and necessary proteins origin, initiation, Termination - DNA polymerases, telomerase and mode of action- replication factors

**Unit-V: RNAs Structure and Transcription**

Structural features of RNAs: Structure of rRNA in prokaryotes and eukaryotes – structure of tRNA and anti codon features – structure of mRNA in prokaryotes and eukaryotes.

Transcription and processing of RNA: Genetic code – Prokaryotic and eukaryotic transcription – RNA polymerases, general and specific transcription factors – regulatory elements – mechanism of transcription. Post transcriptional modifications. Translation – Prokaryotic and eukaryotic translation - translational machinery – mechanism of initiation, elongation and termination – regulation of translation. Post translational modifications.

**PRACTICAL**

1. Light Microscope – components , use and principles
2. Mounting of polytene chromosomes from salivary gland of Chironomus larva
3. Squash preparation of different stages of meiosis in grasshopper testis
4. Squash Preparation of mitosis in onion root tips
5. Study of Micrometry: a) Camera lucida b) Stage micrometer c) Ocular micrometer
6. Determination of Nucleo – Cytoplasmic index
7. Identification of drumstick chromosome from human blood smear preparation
8. Identification of Barr body from buccal smear preparation
9. Histochemical Localization of DNA and RNA
10. Estimation of DNA and RNA of the samples.

**TEXT BOOKS**


1. De Robertis E.D.D and De. Robertis E.M.F. 1980. Cell and Molecular Biology. Holt – Sunders International ($8^{th}$ Edition)
2. Gupta. P.K., 2003. Cell and Molecular Biology, Rastogi Publication, Meerut, India.
3. Lodish.H, Berk.A, Zipursky.SL, Matiudaira.P, Baltimore.D and Darnell J. 2000. Molecular Biology of the cell W.H. Freeman and company, New York.
4. Lewin.B, 2000. Gene VII, Oxford University Press, London.
5. Verma P.S. and V.K. Agarwal, 2015: Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company, New Delhi.


**REFERENCE BOOKS**


1) Verma P.S. and V.K. Agarwal. 2016. Cell Biology. S Chand & Co.
2) Geoffrey M.Cooper and Robert E. Hausman. 2013.The Cell: A Molecular Approach. Sinauer Associates Inc.
3) Arnold Berk, Chris A. Kaiser and Harvey Ledish. 2016. Molecular Cell Biology. WH Freeman.
4) Malathi. 2012. Essentials of Molecular Biology. Pearson Education, India.
5) Bruce Alberts, Alexander D. Johnson and Julian Lewis. 2014. Molecular Biology of the Cell. W.W.Norton & Co.


**Course outcomes**

At the end of the semester students will be able to

CO1: Aquire knowledge on cellular structure and functions.

CO2: Understand the process of energetic and genesis in cells

CO3: Interpret the structural and functional significances of DNA and RNA

CO4: Take up jobs in molecular biology labs and clinical labs

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## FIRST YEAR : SECOND SEMESTER

## 19 ZOO C 201: ANIMAL PHYSIOLOGY

**LEARNING OBJECTIVES**

- To learn the significance of food and physiology of diagram
- To understand the significance of excretory and osmoregulation system.
- To study the functioning of cardiovascular system
- To study respiratory and nervous systems including various receptors

**Unit–I: Food and Digestion**

Composition of food - classification of nutritive substances - comparative physiology of digestion - digestion in mammals - digestive enzymes – absorption - hormonal control of digestion –BMR – BMI.

**Unit–II: Excretion and Osmoregulation**

Excretion - Nitrogenous wastes and their formation – Patterns of Excretion in different animal groups – Mammalian excretory system – structure and function of vertebrate kidney - Mechanism of urine formation – Acid base balance – electrolyte balance - Hormonal control of kidney function in mammal. General concepts of osmoregulation – osmoregulation in invertebrates and vertebrates.

**Unit–III: Circulation**

Major types of body fluids - circulation of body fluids and their regulations - Composition of blood – blood groups – clotting mechanism –buffer system of blood - Circulation of blood in vertebrates - Open and Closed systems – Arthropod heart – Chambered hearts and booster pumps. Structure of mammalian heart, origin, conduction and regulations of heart beat – cardiac cycle and ECG.

**Unit–IV: Respiration**

Respiration in vertebrate – Respiratory organs and their ventilation – Integumentary respiration – bronchial respiration – lung respiration – mechanism of respiration in vertebrates – Regulation of breathing - Neural and chemical regulation – Transport of Oxygen - Respiratory pigments – Bohr's effect – Transport of $CO_2$ – Haldane's effect.

**Unit–V: Nervous system, Muscle and Sense organs**

**Neuron System:** Structure of neuron - Transmission of nerve impulse - axonal transmission - theories of excitation - synaptic transmission – nervous system (central & Peripheral) - neuroendocrine system - hormones and their functions.

**Muscle:** Types and Structure - chemical composition – mechanism of muscle contraction.

**Sense Organs** Mechanoreceptors – chemoreceptors - photoreceptors – phonoreceptors – equilibrium receptor - Bioluminescence.

**PRACTICAL**

1. Effect of enzyme concentration on the activity of salivary amylase
2. Effect of substrate concentration on the activity of salivary amylase
3. Effect of pH concentration on the activity of salivary amylase
4. Oxygen consumption of fish.- Unit metabolism
5. Effect of thyroxin on the respiratory metabolism of fish.
6. Counting of blood cells (RBC and WBC).
7. Quantitative estimation of haemoglobin.
8. Quantitative estimation of proteins.
9. Biochemical analysis of protein, Carbohydrates and Lipids (Qualitative).

**TEXT BOOKS**


1. P.S. Verma, B.S. Tyagi and V.K.Agarwal, 2005. Animal Physiology. S.Chand & Company Ltd, New Delhi.
2. Rastogi, S.T., 1988. Essentials of Animal Physiology. Wiley, Eastern Limited, Madras.
3. William S. Hoar, 1966. General and Comparative Physiology. Prentice Hall of India, New Delhi.
4. Wilson. A, 1979. Principles of Animal Physiology. Macmillan Publishing Co., Inc. New York.
5. Leon Goldstein, 1977. Introduction to Comparative Physiology. Holt, Rinehart and Winston, New York.
6. Prosser, L. and A. Brown, 1965. Comparative Physiology. Saunders Company, London.


**REFERENCE BOOKS**


**1)** Arumugam N. 2014. Animal Physiology. Saras.
**2)** Mohan P. Arora. 2018. Animal Physiology. Himalaya Publishing House Pvt. Ltd.
**3)** Tomar B.S. and Neera Singh. 2016. Animal Physiology. Pragati Prakashan.
**4)** Sobti R.C. 2011. Animal Physiology. Narosa Publishing House.
**5)** Sandeep Saxena. 2012. Animal Physiology. Oxford University Press


**Course outcomes**

At the end of the semester students will be able to

CO1: Understand the normal physiological functions and necessity to maintain a healthy Life

CO2: Get an opportunity to understand various factors that could lead to altered physiological functions and thereby health problems

CO3: Perform various physiological experiments and observations

CO4: Take up jobs in clinical labs and research institutes

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19 ZOO C 202: GENETICS

**LEARNING OBJECTIVES**

- To learn the fundamental concepts of genetics
- To study human health related genetic problems, quantitative traits and population genetics
- To learn the structure genes and their regulation
- To acquire skills in chromosomal alterations, gene mutations and cancer.
- To learn application of genetics concepts in microbial genetics and genetic engineering.

**Unit-I: Principles and Concepts of Gene and Gene mapping**

Mendelian principles: Dominance, Segregation extension of principles: Gene Interactions, dominant epistasis, Pleiotrophy: Penetrance and expressivity. Linkage and crossing over – concept, theories and example- linkage maps(X chromosome) gene mapping in drosophila, Coincidence and Interference – multiple allele – ABO and Rh blood group in man.

**Unit-II: Quantitative, Population and Human Genetics**

Polygenic inheritance: concept, mode of inheritance of skin colour in man – heritability and its measurements- normal karyotypes – Syndromes related to numerical variations of chromosomes – pedigree analysis – genetic counseling, Hardy-Weinberg law of genetic equilibrium.

**Unit-III: Fine Structure of Gene and Regulation of Gene action**

Fine structure of gene-regulation of gene action 'Lac and his' operon system- genes and metabolism – inborn errors of carbohydrate, proteins and lipid metabolism in man. One gene one enzyme concept – One gene one polypeptide concept.

**Unit-IV: Chromosomal Alterations, Gene Mutation and Oncogens**

Chromosomal aberrations – types and causes – point mutation – mutagens-chemical mutagens – molecular mechanism of gene mutation, mutant types – lethal, conditional biochemical lobs of function – oncogene and cancer.

**Unit-V: Microbial Genetics and Genetic Engineering**

Microbial genetics: Methods of genetic transduction – sex-duction – genetic engineering - restriction enzymes – recombinant DNA techniques – application of recombinant DNA technology.

**PRACTICAL**

1. Experiments on Mendelian inheritance
2. Experiments on polygenic inheritance
3. Human traits survey and data collection
4. Gene frequency calculations in population - Autosomal, multiple alleles and sex linked genes.
5. Testing the significance of genetic data - Chi-square test.
6. Human pedigree construction to study the inheritance of autosomal character.
7. Human pedigree for sex linked character and counseling
8. Culturing and maintenance of Drosophila in lab - Demonstration.
9. Identification of sex and mutant characters in *Drosophila*
10. Karyotyping of normal man using metaphase chromosomal plate.
11. Identification of human syndromes from karyotyping

**TEXT BOOKS**


1. Karvita B.Aluwalia, 1991. 'Genetics' Wiley Eastern Ltd., New Delhi.
2. Robert. H Tamirin, 2004. 'Principles of Genetics' Tata Mc. Graw-Hill Publishing Company Ltd. New Delhi.
3. Sarin,C., 1990. 'Genetics'. Tata McGraw-Hill Publishing Co. Ltd New Delhi.
4. Verma P.S. and V.K. Agarwal, 2015: Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company, New Delhi.
5. Mahabal Ram, 2010. Fundamental of Cytogenetics and Genetics.PHI learning Private Limited, New Delhi.


**REFERENCE BOOKS**


1) William S. Klug, Michael R. Cummings and Chariotte A. Spencer. 2016. Concept of Genetics. Pearson.
2) D. Peter Snustad and Michael J. Simmons. 2011. Genetics. John Wiley & Sons.
3) Gangane S.D. 2017. Human Genetics. Elsevier India.
4) Robert Tamarin. 2017. Principles of Genetics. McGraw Hill.
5) James D. Watson, A. Baker Tania and P. Bell Stephen.2017. Molecular Biology of the Gene. Pearson.


**Course outcomes**

At the end of the semester students will be able to

CO1: Interpret phenotypic expressions based on genotype

CO2: Understand and interpret genetically linked diseases

CO3: Perform blood group analysis and test metabolic disorders

CO4: Working clinical laboratories and take up researches

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## 19 ZOO C 203: IMMUNOLOGY

**LEARNING OBJECTIVES**

1. To learn the basic concepts, principles and mechanisms involved in Immunology
2. To develop awareness regarding the molecules, cells and organ system involved in immunological and their significances in up keeping the organism.
3. To learn the various types of antigen and antibodies
4. To acquire skills in the methodologies of antigen antibody interactions
5. To gain knowledge regarding the application of immunological techniques.

**Unit-I: Overview and Scope of Immunology**

Innate and acquired immunity. Humoral and cell mediated immunity. Clonal selection of lymphocytes. MHC/HLA system. Immunological significance of inflammation. Transplantation immunology: Cell mediated graft rejection- hyper acute, acute and chronic rejections.

**Unit-II: Molecules, Cells and Organs of Immune System**

Brief description of molecules of immunity (Lysozyme, interferon, complements, cytokines and chemokines). Haematopoietic stem cells: Myeloid and lymphoid progenitors and their derivatives – mononuclear phagocytes and granulocytic cells (monocytes, $T_H$ Cells, $T_c$ cells, B Cells, NK cells, mast cells, dendritic cells, neutrophils, eosinophils, basophils) and their immunological significance.. Primary lymphoid organs: thymus, bone marrow and bursa of Fabricious. Secondary lymphoid organs: lymph nodes, spleen and MALT.

**Unit-III : Immunogen and Antigen**

Definition of antigen and immunogen and classification. Properties of immunogen: Immunogenicity, antigenicity, allergenicity and tolerogenicity. Factors affecting immunogenicity: Contribution of immunogen-foreignness, molecular size, chemical composition & heterogenecity, degradability; contribution of biological system-genotype of recipient, dosage and route of administration; adjuvants, epitopes, heptens and mitogens.

**Unit-IV: Antibodies**

Basic structure of immunoglobulins. Classes of immunoglobulins (IgG, IgM, IgA, IgE, IgD), their structural modifications and biological activities. Monoclonal and polyclonal antibodies. Antigenic determinants on immunoglobulins: isotype, allotype and idiotype.Hyper sensitivity: Brief description of type I,II,III and IV. Autoimmune diseases :

Organ specific – insulin-dependent diabetes mellitus and Graves' disease; systemic – rheumatoid arthritis and multiple sclerosis.

**Unit-V Antigen – Antibody Interactions**

Strength of antigen – antibody interactions: Antibody affinity, antibody avidity;cross reactivity; precipitin reaction; agglutination reaction- haemagglutination, bacterial agglutination, passive agglutination and agglutination inhibition. Radial immuno diffusion, double immuno diffusion. Radio immuno assay(RIA). Enzyme linked Immunosorbant Assay (ELISA). Western blotting.

**PRACTICAL**

1. Demonstration of lymphoid organs
2. Cell imprinting of lymphoid organs
3. Histology of lymphoid organs
4. Study of bone marrow cells
5. Identifications of leucocytes in human blood smear.
6. Differential count of W.B.C. from blood smear preparation
7. Human blood grouping
8. Antigen antibody interaction- Demonstration
9. Rapid plasma reagent (RpR) test for syphilis

**TEXT BOOKS**


1. Kinndt, T.J. Goldsby, R. A.and Osborne, B.A . 2007. Kuby Immunology, 6 th Ed. W.H. Freeman and Company, Newyork.
2. Rao.C.V. 2011. Immunology, 2nd Ed. Narosa Publishing House, New Delhi.


**REFERENCE BOOKS**


1) Ramesh S.R. 2017. Immunology. McGraw Hill.
2) Abul K. Abbas, Andrew H. Lichtman and Shiv Pillai. 2017. Cellular and Molecular Immunilogy. Elsevier.
3) Peter J. Delves, Seamus J. Martin and Dennis R. Burton.2017. Roitt's Immunology (Essentials). Wiley Blackwell.
4) Raj Khanna. 2011. Immunology. Oxford.
5) Jenni Punt, Sharon Stranford, Patricia jones and Judith A Owen. .2018. Kuby Immunology. WH Freeman.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Analyse the various in immunological issues

CO2: Apply immunological procedures for various immunological testing procedures

CO3: To Interpret the results of immunological experiments

CO4: Carry out immunological investigation

CO5: Take up job s in clinical labs and related institution

CO6: Equip themselves for higher studies

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | -. | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO5 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO6 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## SECOND YEAR : THIRD SEMESTER

## 19ZOOC301: EVOLUTION

Learning Objectives

- To gain awareness about the origin of life
- To understand the roles of variations, polymorphisms, and polyploidy in evolution
- To familiarize the role of isolation and speciation in evolution
- To understand the various types of adaptations and mimicry
- To learn the evolution of mankind

**Unit I: Origin**

i. Environment:- nature and origin of life-proteins nucleic acids- Container membrane – Molecular interactions- Pool origin – Volcanic origin- Metaoric origin – Chemical Evolution

**Theories**

i Theories of organic evolution: Lamarck's Evolutionary propositions- Critical analysis of Lamarck's prepositions- Neo –Lamarckism.

ii. Theory of natural selection : Darwin – Wallace theory of natural selection- Critical analysis of Darwinism – Neo-Darwinism- Modern synthetic theory

**Natural Selection and process :**

i) Process of evolutionary change: Two –Step process Random mating – the Hardy – Weinberg Law and its Application- Migration- Random. Genetic Drift- founder effect and bottlenecks- Genetic Assimilation – Genetic Homeostasis.

ii) The concept of natural selection- Darwinism Fitness –Selection against recessive homozygotes- selection against dominants and selection without dominance.Selection and mutation – Estimation of mutation rates- selection against hetorozygotes- Frequency – Dependent selection

**Unit II : Mechanism**

**i) Variation and evolution**

Basic units of variability – effect and types. Geni mutations-chromosomal rearrangements –change in chromosome number chromosome segregation and recombination- crossing over- mutation and its role in evolution.

The mechanism of natural selection by internal characters- selection by environmental factos.

Direction of selection – centripetal selection –Centrifugal selection .

**ii) Polymorphism and evolution:**

Transient polymer-phism and industrial melanism- Balanced and neutral polymorphism-genetic polymorphism- chromosomal polymerphism-criticism of the polymorphism concept-Evolutionary significance of polymorphism

**iii)Polyploidy and evolution**

Polyploidy in animal and plants- types of polyploids- direct effect of Polyploidy-origin – polyploidy and the origin of higher categories in plants – practical significance.

**Unit III**

**i)Isolation and evolution:**

Premating isolation mechanism- Geographical- Ecological seasonal- ethological – physiological and mechanical isolation.

Postmating isolation mechanism- Gametic –zygotie mortality- hybrid inviability- hybrid break down – genetic basis of reproductive isolation- origin – significance .

**ii)Speciation and evolution:**

Species concept morphological- Genetic- Sterility based – Biologcial – sibling concepts-Monotypie and polytypic – Sub-species categories .

Types of speciation: Mechanism of speciation-allopatric speciation sympatric-speciation-quantum evolution- evolutionary significance.

**Unit IV**

**i)Adaptation Mimicry and colouration:**

Mimicry – Protective-aggressive- conscious sound and scent mimicry- Batesian and Mullerian mimicry- Experimental proof of mimicry – evolution of mimicry- significance.

.Colouration:Chemical colours- physical colours- indifferent colours- valuable colours-Symoathetic- cryptic ot conceling colouration- standard faunal colours – warning or revealing colours- mimetie colouration – confusing and sexual colouration.

**Unit V:**

**i)Trends and rated**

Evolutionary trends: Phylogenetic patterns, - Micro macro and mega evolution-adaptive radiation trend- convergent-parallel – orthogenetic- non adaptive and interactive trends in evolution.

Evolutionary rates: Morphological rate of evolution-Taxonomic rate- Molecular rate-the role of extinction in macro evolution-measuring of extinction rate.

**ii)Mankind evolution**

Past evolution: Fossil history of mankind- the of primate the apes-Hominid evolution, early and history middle phase of hominid ancestor- the earliest humans; towards modern human; modern humans.

Present evolution:Cultural and social evolution of hominids.

Future evolution:Biologica future of mankind-positive and negative eugenics-mankind and the organic world evolution – biochemical evolution.

**Text book:**


1. Bergstrom, Carl T. and Lee Alan Dugatkin, 2016. Evolution (Second Edition), w.w. Norton and compahy Newyork.
2. Verma P.S. and V.K. Agarwal, 2007: Evolution, S. Chand and Company, New Delhi.
3. Arumugam, N. 2014.Organic Evolution. Saras Publication. Nagercoil.
4. Verma P.S. and V.K. Agarwal, 2015: Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company, New Delhi.


**Reference:**


1. Darwin, C. The Origin of species,Te.Oup.Desmond Morries, 1990.Animal Watching (Field Guide), Crown Pup Co., London.
2. Dobzhansky,Th.:Genetics and the origin of species 1951, Columbia University.Press.
3. Dobzhansky,Th.Et Al:Evolution,Surjeet Pub., Delhi, Prakash M.Et Al.


**Practicals:**

1. Genetics drift in small and large population using dummy materials
2. Sexual selection(a) Secondary sexual characters ,e.g.Chimeroid fish(male) (b) Brooding organs- E.gSea Horse(male) (c) Sepecial sound producing organs E.g seale insect (male)(d) Special using Rhinoceros beetle (male).
3. Plymorphism- (a) Transient Polymosphism e.g. industrial melanism (b) Neutral Polymorphism e.g. Umbonium shells (c) Balanced Polymorphism
4. Genetic Assimilation – in Drosophila
5. Identification of male and female Drosophila
6. Mimicry and Colouration- Concealing mimicrying, e.g. Kallima butterfly, Geometrid moth.Stick insect, Le a insect.

   Warning mimicry-Viceroy and Monarch butterfly Batesian and Mullerian mimicry.
7. Palentology Invertebrate fossil- Trilobite, Vertebrate Fossil- Archaeopteryx.
8. Osteology: Evolution of reptilian skull and its interrelationship
9. Evolution of mankind- similarities and differences between apes and man. Evolution of human skull.

**Course outcome**

After successful completion of the course students shall be able to

CO1. Analyse the evolutionary history of biological organisms

CO2. Critically assess the evolutionary relationship among various phyla

CO3. Identify the role of natural selection in the survival of the species

CO4. Understand the various mechanism involved in evolution.

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | - | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | - | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | - | √ | - | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | - | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19ZOOC302: ENVIRONMENT & BIODIVERSITY CONSERVATION

Learning Objectives

- To gain awareness about the basic concepts of environment and ecology
- To create a mindset for conservation of biodiversity
- To familiarize the concept of environmental impact assessment
- To understand the significance of natural resources and sustainable development
- To create awareness about environmental pollution and its prevention
- To learn the phenomenon of global warming and its prevention

**Unit I: Basic concepts and environmental impact assessment**

Concept of ecosystem, environment and biosphere. Biogeochemical cycles- carbon, nitrogen and phosphorous cycles. Environmental impact assessment (EIA): Objectives; General operational procedures and process, places in EIA, environmental planning and decision making. Describe properties of EIA methods. General procedures for environmental audit.

**Unit II: Natural resource and sustainable development**

Non-renewable and renewable natural resources and their conservation. Forest resources and types of forests in India. Use and over exploitation of forests .Deforestation and afforestation, land degradation, landslides, soil erosion and desertification. Food resources, world food problems, effect of modern agriculture and overgrazing. Concept of sustainable development and brundt land report.

**Unit III: Environmental pollution and disaster management**

Cause, effects and remedial measures of air, water, noise thermal, radioactive and agriculture pollution. Disasters caused by floods, earthquake and cyclones and their management. Solid waste issues and its management

**Unit IV: Biodiversity and its conservation**

Types of biodiversity, species richness and heterogeneity and significance of biodiversity. Threats to biodiversity and biodiversity crisis.Socio economic and political causes of loss of biodiversity.Conservation of biodiversity: insitu and exsitu conservation and biodiversity hostpots. Endangered faunal species of India

**Unit V: Global warming and water conservation**

Global warming: Concept, causes and impacts, Green house effect, Green house gases, their sources and control measures of global warming. Acid rain and Ozone

depletion.Impact of over utilization of surface and ground water. Water conservation, rain water harvesting and watershed management,

**Practicals:**

**1**. Estimation of dissolved Oxygen content of water samples
2. Determination of Oxygen sag curve from river
3. Estimation of dissolved Carbon – Dioxide
4. Estimation of Hydrogen sulphide in water samples
5. Estimation of Residual chlorine in water samples
6. Estimation of total dissolved solids of water samples
7. Determination of sulphate in water samples
8. Determination of iron in water samples
9. Determination of silicate in water samples
10. Determination of nitrate/Nitrate in water samples
11. Field visits to areas of environmental and biodiversity significance
12. Behavioural changes of organisms in polluted environment
13. Food chain and bioaccumulation

**Text books:**


1. Prabhat Patnaik and Jayanath Bhattacharjee, 2012; Environmental Biodiversity, Wisdom Press, New Delhi.
2. Khitoliya,R.K. (2004). Environmental pollution: Managment and control for sustainable developments.S.Chand & company (p) Ltd., New Delhi,India
3. Saha,T.K. (2007) Ecology and environmental Biology. Books and allied(P) Ltd.Kolkata, India
4. Ambrose, Dunston P. 2004; The Insects: Structure, Function and Biodiversity, Kalyani Publishers, New Delhi.


**Reference Books:**


1. Krebs C.J. (2016) Ecology: The experimental analysis of distribution and abundance. Pearson India Educaiton service(p) Ltd. New Delhi, India
2. Arumugam A.and. Kumaresan V. (2016) Environmental studies. Saras Publication, Tamil Nadu, India
5. Mehta M (2010) understaning environmental science. Discovery publishing house, New Delhi, India
6. Agarwal K.C. (1999) Environmental Biology. Agro Botanica, New Delhi, India
7. Pandy S.N.and S.P. Misra (2011) Enviroment and ecology.Ane Books Pvt. Ltd New Delhi, India


**Course outcome**

After successful completion of the course students shall be able to

CO1. Analyse and appreciate the basic ecological concepts
CO2. Critically assess environmental disasters and suggest counter measures
CO3. Develop a mind set to safeguard natural resources and take forward the concept of sustainable development
CO4. Protect the environment by acting against pollution
CO5. Take up employment in environment related agencies and institution
CO6. Spear head the measure against global warming
CO7. Educate the public regarding the importance of rain water harvesting and water conservation.

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | - | - | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | - | √ | - | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19ZOOC303: ANIMAL BEHAVIOURS

**Learning Objects**

- To gain awareness about the basic concepts of animal behaviour
- To create a mindset for conservation
- To understand the genetic principles behind behavioral patterns
- To familiarize the concept of sociobiology
- To understand the significance of Territoriality

**Unit I: Introduction**

Introduction to ethology, Principles and mechanism of animal behaviour (Ethology) four propositions of Nikolaas Tinbergen-Adaptive values of behaviour – instinct verses learning – circadian and circadian rthymes in animal behaviour .

**Unit II: Communication behavirour**

Communication and programmed behaviour – Visual communication- Dance languages of honey bee- Melody dance of birds- Auditory communication - songs of birds and sounds of mammals – chemical communications- pheromones of insects – pheromones of mammals – migration of fishes and birds- mechanism of migration.

**Unit III: Behavioural genetics**

Fundamentals of behavioural genetics –Genetic basis of behaviour – Mutations – knockout genes- genetic mosaic fruitflies- multiple genes – polygenic effects on behaviour – genes effect on physiological – Feeding behaviours of animals

**Unit IV: Social behaviour**

Introduction to Sociobiology, Social organization in animals –social behaviour - habitat selection – Advantages of social behaviour - conflict- situations. Conflict behaviours. Sexual selection- courtship behaviour - mechanism of courtship – courtship in fishes- courtship- mating in amphibians, reptiles, birds and mammals- Parental care in insects, fishes, amphibians, birds and mammals.

**Unit V: Territoriality**

Territoriality – characters of territoriality- function of territoriality- group foraging – Game theory model and strategies. Effects of hormones on behaviour – aggression and aggressive behavior. Drugs and behaviour.

**Practicals**

1. Study of behavioural adaptations of Cursorial animals
2. Study of behavioural adaptations of Arboreal animals
3. Study of behavioural adaptations of Volant animals
4. Study of behavioural adaptations of Aquatic animals
5. Reflex behaviour in animals
6. Mimicry
7. Polymorphism

**Text Book**

1. K. Agarwal (2010)- Animal behaviour - S. Chand& Co.Ltd New Delhi- 110055.
2. Aubery Manning (Latest edition- 2015) An Introduction to Animal Behaviour– Wedley publishing Co.London.
3. Hoshang S. Gundevia and Hare Govind Singh, 2016. A text book of Animal Behaviour. S. Chand company.

**Reference Books**

1. Recent Advances in Animal behaviour, 1994, 7 Vols. Anmol. Publishers.
2. Reena Mathur (2007), Animal behaviour, Rastogi & Co, Meerut.

**Course outcomes**

At the end of the semester students shall be able to

CO1: Master the theoretical as well as practical knowledge in the field of animal behaviour

CO2: Interpret the genetic basis of behavioral patterns

CO3: Appreciate the socio-biological elements in the behavior of various animal groups and their significance.

CO4: Understand the impact of hormones in the manifestation of various behaviours

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | - | √ | √ | √ | - | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | - | - | √ | √ | - | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | - | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19ZOOC304: BIOTECHNOLOGY

**LEARNING OBJECTIVES**

- To learn the basic concepts in biotechnology
- To learn the various techniques used in biotechnology
- To acquire biotechnological knowledge related to medical, agricultural and environmental disciplines

**Unit–I: Basic Biotechnology**

Definition – Scope – Achievements of Biotechnology – Enzymes in genetic engineering - Restriction Enzymes, DNA ligases, DNA polymerase of Cloning vectors – Plasmids- Bacteriophage, Cosmids, Yeast plasmids- Genomic DNA libraries, cDNA libraries.

**Unit–II: Techniques in Biotechnology**

Southern blotting, Northern blotting, Western blotting, In-situ hybridization, DNA sequencing, PCR, DNA finger printing, DNA probes, site – directed mutagenesis, particle gun, microinjection, electroporation.

**Unit–III: Medical Biotechnology**

rDNA Technololgy- Insulin, Somatotrophin, Somatostatin-hormone production, vaccines, interferons, gene therapy, monoclonal antibodies, Prenatal diagnosis, In-vitro Fertilization Technology (IVF) in Human beings, Human Genome Project (HGP).

**Unit–IV: Agricultural Biotechnology**

Micropropagation, protoplast culture, Biofertilizers- Symbiotic and Non symbiotic nitrogen fixation, Biofertilizers- Mass - production of BGA, VAM Rhizobium. Biopesticides - Trangenic plants and animals. Mushroom culture. single cell protein-Bio control of insect pests.

**Unit–V: Microbial and Environmental Biotechnology**

Bioreactor, Growth curve, primary metabolites – Vitamins, alcohols, Secondary metabolites – Antibiotics, Toxins, Microbial enzyme production – amylase. Biomass as a source of energy. Biogas production, Bioremediation, Microbial leaching-Vermicomposting. Ethical issues and Biosafety regulations, Intelluctual Property Right (IPR) and Protection (IPP).

**PRACTICALS**

1. Methods of sterilization
2. Preparation of culture media
3. Preparation of Agar slants
4. Estimation of microflora of milk by MBR test
5. Estimation of microflora of milk by RESAZURINE Test.
6. C.S. of stem and root nodule of leguminous plants
7. Isolation , Identification and enumeration of bacteria from soil
8. Isolation , Identification and enumeration of fungi from soil
9. Isolation , Identification and enumeration of actinomycetes from soil
10. Counting of soil microbial population by Quebec colony counter
11. Gram staining of Bacteria
12. Identification of algal Bio-fertilizers
13. Identification of bacterial bio-fertilizers
14. Agarose Gel Electrophoresis - Demonstration
15. Study of Biogas Plant- Demonstration

**TEXT BOOKS**


1. Dubey. R.C., 2004. A Text Book of Biotechnology. S.Chand & Co. Ltd. New Delhi.
2. Gupta. R.K., 1996. Elements of Biotechnology. Rastogi & Company, Meerut.
3. Purohit S.S. 2000. Biotechnology, Fundamentals and Applications. Agrobios.


**REFERENCE BOOKS**


1) William J. Thieman and Michael A. Palladino. 2014. Introduction to Biotechnology. Pearson.
2) Singh B.D. 2015. Biotechnology: Expanding Horizons. Kalyani.
3) Dubey R.C. 2014. Advanced Biotechnology. S Chand & Co.
4) Bernard R. Glick and Chery L Patten . 2017. Molecular Biotechnology. Taylor & Francis.

5) Pratibha Nallari and V. Venugopal Rao. 2010. Medical Biotechnology. Oxford University Press.

**Course outcomes**

At the end of the semester students shall be able to

CO1: Master the theoretical as well as practical knowledge in various field of biotechnology

CO2: Perform various experiments related to biotechnology

CO3: Carry out biotechnological applications in the fields of medicine, agriculture and environmental fields

CO4: Equip the students to take up jobs in various biotechnological companies and labs

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## SECOND YEAR

## FOURTH SEMESTER

## 19ZOOC401: BIOCHEMISTRY

**LEARNING OBJECTIVES**

- To learn classification and metabolism of carbohydrates
- To understand the structure and metabolism of protein
- To learn the structure and functions of lipids
- To acquire knowledge about various enzymes and hormones and their actions
- To acquire knowledge about the significance of vitamins

**Unit I:Buffers and Carbohydrate.**

i). *PH* and buffers – Water, carbondioxide and oxygen, properties, outlines of Biochemical energies.

ii). Carbohydrates:
Methods of study of intermediary metabolism of Carbohydrates;

A general account of classification – Structure and properties of mono and polysaccharides- metabolism of carbohydrates glycolysis,Citric acid cycle Gluconeogenesis ; defect in carbohydrated metabolism.

**Unit II : Proteins:**

Classification and isolation - The fundamental physiochemical principles and structure of amino acids, peptides and proteins- protein metabolism – Metabolism of amio acids in general.

**Unit III: Lipids:**

Classification of lipids- Structure and chemistry of single and compound lipids; metabolism of fats and fatty acids- Defects in lipid metabolism

**Unit IV: Enzymes and Hormones**

i).Enzymes :

Classification – Enzyme kinetics-Effects of substrate concentration –Inhibition and mechanism of enzyme action- Co-enzymes.

ii).Hormones:

Classification, biosynthesis and function – Pancreatic and thyroid hormones

**Unit V: Nucleic acids and Vitamins**

Composition and structure of nucleic acids; RNA and DNA - Major pathways in the synthesis of RNA and DNA

Vitamins – occurrence- grouping- deficiency diseases.

**Text books**


1. Firley, Jems, L. and Gardon L. Kilgour. 1971 Essentials of Biological chemistry, affiliated east west press
2. Agarwal, R.A., Anil K.; Srivastava and Kaushal Kumar, 2014. Animal Physiology mand Biochemistry. S. Chand and Company.
3. Sastry, K.V. 2011. Animal Physiology mand Biochemistry. Rastogi Publications, Meerut.
4. Annie, 2010. Biochemistry and Biotechniques. Saras Publications.


**References:**


1. Voet,D.And J.G.Voet. 2005 Biochemistry John Wiley & Sons.
2. Freifelder,D 2007.Physical Bochemistry W.H.Freeman & Co
3. Segal,I.H 2015 Biochemical Calculations John Wiley and Sons
4. Creighton, T.E 2012 Protein Structure and Molecular properties W.H. Freeman & Co


**Practicals:**

Preparation and use of buffers.

1. Qualitative tests for carbohydrates, Amino acids, proteins lipids and nucleic acids; amines urea;( thiourea).
2. Determination of the molecular weight of a mococarboxylic aminoacid by soresson formal titration
3. Determination of isoelectric pH of a protein.Estimation of glycogen, phosphate,cholesterol and protein in tissues.
5. Determination of protein digestion by trypsin. Fractionation and estimation of serum proteins.
6. Estimation of RNA and DNA in tissues.
7. Kinetics or enzyme action-effect of substrate concentration (Calculation of M), temperature (calculation of energy of activation)
8. Enzyme concentration and pH on enzyme activity.Determination of $AC_h$ E activity in brain.
9. Paper chromatography of sugars and amino acids-column chromatography of separation of amino acids

10. Paper electrophoresis of proteins.

11.Colour reactions of urine composition.

**Course outcomes**

At the end of the semester students shall be able to

CO1: Able to understand various micro and macro molecules and their signinficance

CO2: Able to discriminate various metabolic disorders

CO3: To take up jobs in clinical labs

CO4: To analyze biological samples of bio-chemical importance

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## 19ZOOC402: ENDOCRINOLOGY

**LEARNING OBJECTIVES**

- To learn general concepts of hormones and pituitary gland
- To understand structure and functions of thyroid and parathyroid gland
- To learn the structure and functions of pancreas and adrenal glands
- To acquire knowledge in the endocrinological basis of vertebrate reproduction
- To understand endocrinology of insects and crustaceans.

**Unit–I: General concept of Hormones and pituitary Gland**

General characteristics of hormones – concept of hormone secretion – hormones as messengers –classification of hormones- steroid hormones – peptide hormones – mechanism of hormone action- Cell signaling – Signal transduction.

Pituitary gland – structural organization – anterior pituitary, Pars intermedia and neurohypophysis - Hypothalamic control of pituitary function. Pituitary hormones – functions - neurohormonal peptides-diuresis and antidiuresis-

**Unit- II: Thryoid gland and parathyroid gland**

Thryoid gland – structural organization – Biosynthesis of thyroid hormones- biological function of thyroid hormones – Thyroid dysfunction

Parathyroid – structure and functions of parathyroid hormone – hormonal regulation of calcium and phosphorus metabolism.

**Unit–III: Pancreas and adrenal glands**

Structure of pancreas – function of insulin – Biosynthesis and regulation of the secretion of insulin – Biological action of insulin – function of glucagon – Biological action of glucagon.

Adrenals – structural organization - synthesis of adrenocortical hormones – Mineralocorticoids – Glucocorticoids - functions – regulation of cortisol secretion- abnormalities of adrenocortical secretions – hormones of adrenal medulla and its biological actions.

**Unit-IV: Vertebrate Reproductive Endocrinology**

Structure of mammalian testis and ovary – male, female sex accessory organs – hormones of testis and ovary – estrus and menstrual cycle – hormones of pregnancy – parturition – hormonal control of lactation.

**Unit-V: Insect and Crustacean Endocrinology**

The concepts of neurosecretion – Endocrine systems in crustacean – endocrine control of moulting and metamorphosis – Neuroendocrine system in insects- endocrine control of development – thorocotrophic hormones - ecdysone- Juvenile hormone functions – moulting in adult insects.

**PRACTICAL**

1. Dissection of endocrine organs in vertebrates
2. Dissection of reproductive systems in vertebrates
3. Histological study of pituitary, adrenal, testis, ovary, corpus luteum, pancreas and thyroid gland
4. Dissection of reproductive systems in insects.
5. Dissection of neuroendocrine complex in insects.
6. Histology of ovary, accessory glands, corpus allatum and brain in insects
7. Dissection of parabiosis in cockroach
8. Dissection of ovariectomy in cockroach
9. Vaginal smear showing various stages of estrus cycles.
10. Study on influence of insulin in blood glucose level.

**TEXT BOOKS**


1. Turner C.D. 1996. General endocrinology. 4th Ed, W.B. Saunders Co., London.
2. Bentley P.J. 1998. Comparative Vertebrate Endocrinology. Cambridge University Press.
3. Barrington E.J. W., 1968. An Introduction to General and comparative endocrinology. Academic press, London.
4. Williams. R.H. 1974, Text book of endocrinology 5th Ed. W B Souanders & co. Philadelphia


**REFERENCE BOOKS**


1) Yadav B.N. 2011. Mammalian Endocrinology. Vishal Publishing Co.
2) Pandey B.N. 2019. Endocrinology. Atlantic Publishers.
3) Lawrence I. Gilbert. 2011. Insect Endocrinology. Academic Press.
4) Bruce A. White and Susan P. Porterfield. 2013. Endocrine and Reproductive Physiology. Elsevier, India.

5) Larry Jameson J. 2016. Harrison's Endocrinology. McGraw Hill.

**Course outcomes**

At the end of the semester students shall be able to

CO1: Master the theoretical and practical aspects of endocrinology across various phyla

CO2: Apply the endocrinological methods and procedures for higher studies and research

CO3: To take up jobs in clinical labs

CO4: To analyze biological samples of endocrinological importance

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

**ZOO PJ 416 : PROJECT**
**DISSERTATION AND VIVA-VOCE**

**ELECTIVE II - DEPARTMENT ELECTIVE**
**IN SECOND SEMESTER**

## 19ZOOE215-1: ENTOMOLOGY

**LEARNING OBJECTIVES**

- To learn various insects and their classification
- To learn the morphological, anatomical and physiological systems in insects
- To learn knowledge in agricultural entomology as well as beneficial insects
- To learn vector insects and their role in public health
- To learn knowledge on pest management

**Unit–I: Insect Morphology**

Insect taxonomy upto orders – Salient features with suitable examples of the insect orders – Thysanura, Odonata, Isoptera, Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera - Insects collection – Preservation – Identification- insect head – types of antennae – mouth parts and wing venation – Abdomen.

**Unit–II: Insect Physiology**

Structure and Physiology of integumentary, Digestive system: Foregut, Mid gut, Hind gut, Salivary gland and Physiology of digestion.

Circulatory system: Components of Circulatory system, Haemocoel –Haemolymph of – types of haemocytes, Functions of fatbody and Physiology of circulation.

Excretory system: - Types-excretory organs – accessory excretory organs – Physiology of excretion.

Reproductive system: Male reproductive system, Testis – Vasadeferens – Seminal vessicle - accessory glands and Female excretory system – Ovaries – Ovariole – types-oviduct –spematheca- accessory glands.

Respiratory system: Trachea – Spiracles-types – terrestrial respiration – Aquatic respiration – Endoparasitic respiration

**Unit–III: Agricultural Entomology**

Insect pest- pest outbreak – assessment of insect population- Identification, seasonal history, biology, nature of damage and control measures of major pests of paddy, sugarcane, Vegetables (Brinjal).

**Unit–IV: Principles and methods of Pest Management**

Principles of Insect control – Prophylactic measures – cultural, mechanical, physical methods – Genetic control and quarantine. Biological control: parasitoids, Predators and Microbial agents. Chemical methods: Pesticides- general classification – classification based on mode of action, mode of entry and Biopesticides: Integrated Pest Management (IPM) – definition, Integration of methods – potential components – need for IPM and uses.

**Unit–V: Beneficial insects and Vector insects**

Sericulture: Biology of silk worm, silk gland, cultivation of mulberry plants, rearing of silkworm and uses of silk – Apiculture: types of bees, bee colony, life history, Structural adaptions - Social organization - Beekeeping accessories - composition of honey and uses of honey. Useful insects - Biology and control measures of important insect vector – mosquitoes.

**TEXT BOOKS**

1. Temphare D.B. 1984. A Text Book of Insect Morphology, Physiology and Endocrinology. S.Chand and Co., New Delhi.
2. Chapman R.F. 1982. The Insect Structure and Functions. English Language Book society, Hooder Strongron.
3. Temphare, D.B., 2009. Modern Entomology, Himalaya publishing Mumbai.

**REFERENCE BOOKS**


1) Vasantharaj David B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology. Brillion Publishing.
2) Prasad T.V. 2019. Handbook of Entomology. New Vishal Publications.
3) Ashok Kumar Sharma. 2012. Anatomy and Physiology of Insects. Oxford Book Company.
4) Ganga G. and J. Sulochana Chetty. 2019. Introduction to Sericulture. Oxford and IBH Publishing Co. Pvt. Ltd.
5) Jayashree K.V., C.S. Tharadevi and N.Arumugam. 2014. Apiculture. Saras.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Identify insects based on morphological features

CO2: Start entrepreneurial activities in sericulture and apiculture

CO3: Take up jobs in vector control and public health departments

CO4: Take up integrated pest management activities

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19ZOOE215-2: PUBLIC HEALTH AND HYGIENE

**LEARNING OBJECTIVES**

- To learn important vector borne diseases of human being
- To understand diseases caused by protozoans
- To acquire knowledge in diseases caused by helminthes
- To learn common air, food and water borne disease.

**Unit-I: Introduction to Important Disease to Human Beings**

Mosquito borne diseases – malaria, filariasis and chikungunya – symptoms and treatments. Morphology, life cycle and control measures of vector mosquitoes - Anopheles, Culex and Aedes species and vector management.

**Unit-II: Vector borne Diseases to Human Beings**

Vector borne diseases – Kala - azar, typhoid, amoebic dysentery, cholera and sleeping sickness- Symptoms and treatments - Morphology, life cycle and control measures of sand flies, House flies and Tsetse fly.

**Unit-III: Protozoan Diseases to Human Beings**

Protozoan diseases – Trypanosomiasis, Leishmaniasis and Trichomoniasis symptoms and treatments - Morphology, life cycle and control measures of Trypanosoma, Leishmania and Trichomona.

**Unit-IV: Helminthes Diseases *to* Human Beings**

Helminthes diseases - Taeniasis, Schistosomiasis and Ascariasis – symptoms and treatments - Morphology, life cycle and control measures of *Taenia solium*, Schistosoma and Ascaris.

**Unit-V: Air, Food and Water – borne diseases**

Air – borne diseases – Tuberculosis, Diphtheria and pneumonia. Food and water – borne diseases – sources of water pollutants – cholera, botulism, shogellosis and typhoid fever. Cancer – sources, different types of tumors and treatment.

**TEXT BOOKS**


1. Rathinasamy G.K., 1974. A Handbook of Medical Entomology and Elementry Parastitology.S.Viswanathan Printers and Publication Pvt., Ltd.
2. Dubey, R.C. and D.K. Maheswari, 2005. A text book of Microbiology, S.Chand & Company Ltd., New Delhi.
3. Gupta, P.K and V.Rampraksh, 1985. Advance in Toxicology and Environmental Health. Jagmender Book GENCY, New Delhi
4. Jordon, E.L. and P.S.Verma, 2005, “Invertebrate Zoology”, S.Chand & & Company Ltd., New Delhi.
5. Parthiban, M. and B. Vasantharaj David, 2007. “Manual of Household & Public Health pests and their control”, Namrutha Publications, Chennai.

**REFERENCE BOOKS**


1) Mark F. Wiser. 2012. Protozoa and Human Disease. Garland Science.
2) Burton J. Bogitsh, Clint E. Carter and Thomas N. Oeltmann. 2012. Human Parasitology. Academic Press.
3) Ruth Leventhal. 2011. Medical Parasitology. F.A. Davis Company.
4) Sudhir R. Wagh and Vishnu K. Deshmukh. 2015. Medical Entomology. Success Publications.
5) Kenrad E. Nelson and Carolyn Williams. 2013. Infectious Disease Epidemiology. Jones and Bartlett Publishers.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Analyse various common vectors and diseases, causing organisms

CO2: Impart skills the general Public for public health and hygiene

CO3: Work in clinical labs

CO4: Take up research on issues related to public health and hygiene

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

**ELECTIVE IV - DEPARTMENT ELECTIVE**
**IN THIRD SEMESTER**

## 19ZOOE315-1: FISHERIES AND AQUACULTURE

**LEARNING OBJECTIVES**

- To learn the principles and practices followed in Inland fisheries and aquaculture
- To learn biology and fisheries potential of marine fisheries
- To acquire skills in culturing fin fishes
- To develop skill non fin fish culture
- To learn fish harvesting and post harvesting technology

**Unit- I: Inland fisheries**

Biology and commercial importance of major inland fishes of India: Indian major carps; air breathing fishes-Channa, Clarias, Common carp, grass carp, silver carp, trouts, mahaseer and English carp. Food and feeding habits of cultivable fishes. Age and growth determination: Scale reading, length-weight relationship.

**Unit-II: Marine Fisheries**

Brief out line of inshore, coastal, offshore and deep sea fishery potential of India. Biology of commercially importance fishes: Hilsa, oil sardine, Mackeral and Bombay duck. Crustacen fisheries: prawns, shrimps and crabs. Molluscan fisheries: edible oyster, mussels and cephalopodes (Sepia and Loligo)

**Unit-III: Fin Fish culture**

Types of culture, types of ponds, fish pond preparation, algal bloom and its eradication. Stocking of seeds, feeding. Predators and their control. Sampling and harvesting. Transport of fish seed. Major diseases, symptoms and treatment.

**Unit-IV: Shell fish and sea weed culture**

Culture of fresh water prawn - *Macrobrachium rosenbergii*. Culture of brakishwater prawn *Litopenaeus vannamei.* Culture of pearl oyster (P*inctada fucata*), green mussel (*Perna viridis*), lobster (*Panulirus homarus*). Culture of sea weed.

**Unit-V: Harvesting and Post harvest technology and Economics of Aquaculture**

Fish finding devices: Sonars and Echosounder. Fishing gears: Nets and seines –gill nets, fyke net, pound net, dip net, casting net; hooks and lines. Fish preservation: Common principles of fish preservation and major methods of fish preservation. Fishery products and by products: Fish liver oil, fish body oil, fish meal, fish flour, fish silage, fish manure and

guano, fish sausage, fish glue, isinglass, fish leather, fish macroni. Fish and prawn economics of aquaculture – Fish and prawn marketing – process.

**TEXT BOOKS**


1. Pillay, T.V.R., 1995. Aquaculture Principles and Practices. Fishing New Books, Blackwell Science Ltd., Oxford.
2. Jhingran,V.J., 1991. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
3. Santhanam,R., Sugmaran,N. and P.Natarajan, 1997. A Manual of Fresh Water Aquaculture. Oxford and IBH Pub.Co., Ltd., New Delhi.


**REFERENCE BOOKS**


1) Arumugam N. 2014. Aquaculture and Fisheries. Saras.
2) Singh B. and Dey A. 2017. Fish and Fisheries. Invicible Publishers.
3) Pillay T.V.R. and M.N. Kutty. 2011. Aquaculture: Principles and Practices. Wiley India Pvt. Ltd.
4) Rajendra Kumar Rath. 2011. Freshwater Aquaculture. Scientific Publishers.
5) Vishwas B. Sakhare. 2013. Inland Fisheries. Daya Publishing House.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Understand and analyse various issues related to fisheries and aquaculture

CO2: Take up jobs in fisheries and aquaculture sectors

CO3: Start aquaculture activities on their own

CO4: Take up jobs in marine product export sectors

CO5: Take up research activities in various fisheries institutions and Universities

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO5 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

## 19ZOOE315-2: TOXICOLOGY

**LEARNING OBJECTIVES**

- To learn the concepts and processes involved in toxicology
- To understand the various methods of absorption and distribution of toxicology
- To study the biotransformation and excretion of toxicants
- To learn the impacts of toxicants and human beings.
- To learn the application of anti dotes and Biomonitoring

**UNIT-I: Introduction to Toxicology**

Definition – Brief history of toxicology –– Disciplines of toxicology – Scope of toxicology – Toxicity methods – Acute toxicity tests – Sub-acute toxicity test – Chronic toxicity test – Bio-assay – Determination of $LC_{50}$ and $LD_{50}$ – Dose-Response relationship – Indices of toxicity – Threshold dose – Margin of safety and therapeutic index - Selective toxicity - Response of toxicity - Factors influencing toxicity – Chemical interaction – Types of interactions.

**UNIT-II: Exposure Route, Absorption and Distribution of Toxicants**

Route of exposure of Toxicants: Dermal route – Inhalation route – Ingestion route. Absorption of Toxicants**:** Introduction – Mechanism of absorption – Passive transport and carrier mediated transport – Factors affecting absorption. Distribution of Toxicants**:** Introduction **–** Factors determining the distribution **–** Binding of plasma protein – The storage depots – Liver, Kidney, Fat and Bone – Membrane barriers.

**UNIT-III: Biotransformation and Excreation of Toxicants**

Biotransformation: Introduction – Pattern of Biotransformation - Phase I reaction – Oxidation – Mixed Function Oxidase System – Reduction reaction – Hydrolysis – Phase II reaction – Biochemical conjugation – Glucuronidation – conjugation with Glutathione – Sulfate conjugation – Acetylation and Methylation – Aminoacid conjugation - Deactivation versus Bioactivation.

Excretion of Toxicants**:** Urinary excretion – Biliary excretion - Lungs and other routes.

**UNIT- IV: TOXIC EFFECTS ON HUMAN**

Categories of toxic effects – Local and systemic effects – Reversible and irreversible effects – Immediate and delayed effects – Effects on biomolecules - Effects on target organs: Neurotoxic effects – Hepatotoxic effects – Genotoxic effects –mutagenic – Teratogenic - carcinogenic effects.

**UNIT-V: Antidotes and Biomonitoring**

Antidotes: Classification of antidotes– Mechanism of action of antidotes-Specific antidotes for metals and pesticides.

Biomonitoring: Introduction – Objectives – Biological Monitoring Programme – Parameters for Biomonitoring – Bioindicators and Environmental Monitoring – Classification of Bioindicators – Criteria for Selection of Bioindicators – Traditional Bioassays – Biotechnology Based Bioassays – Microbial Indicators – Plant Indicators – Animal Indicators – Aeroallergens – Human System – Benefits and Disadvantages of Bioindicators.

**TEXT BOOKS**


1. Sharma, P.D., 1996. Environmental biology and toxicology. Rastogi Publication, meerut, India
2. Frank C. Lu 1985. Lu's Basic Toxicology. Hemispher Publication Corporation Washington, N.Y.London.
3. Gupta, P.K., and Salunka, D.K., 1985. Modern Toxicology.vol I and II, Metropolitan, New Delhi.
4. Kamleshwar Pandey and Jagdamba Prasad, 2000. Elements of Toxicology. Dominant publishers, New Delhi
5. Chris Kent (1998). Basics of Toxicology. John wiley & Sons.


**REFERENCE BOOKS**


1) Kamaleshwar Pandey, J.P. Shuikla and S.P. Trivedi. 2011. Fundamentals of Toxicology. New Central Book Agency.
2) VijaByung-Mu Lee, Sam Kacew and Hyung Sik Kim. 2017. Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment. CRC Press.
3) Stephen M. Roberts, Robert C. James and Phillip L. Williams. 2015. Principles of Toxicology: Environmental and Industrial Applications. Wiley Blackwell.
4) Frank A. Barile. 2017. Principles of Toxicology Testing. CRC Press.
5) Karen E. Stine and Thomas M. Brown. 2015. Principles of Toxicology. CRC Press.


**Course outcome**

At the end of the semester students shall be able to

CO1: Carry out toxicological analysis of various environmental samples

CO2: Make observations and biochemical analysis of biological samples

CO3: Carry out toxicological testing using live specimen to determine toxicity of toxicants

CO4: Take up jobs in toxicological research institutions and clinical labs

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ |

**INTERDEPARTMENTAL ELECTIVE**

**IN II SEMESTER**

**19ZOOE216-1 : ANIMAL CULTURE TECHNIQUES**

**LEARNING OBJECTIVES**

- To learn vermicomposting
- To understand epiculture
- To study sericulture
- To learn aquaculture

**Unit-I: Vermicomposting**

Composting earthworms, Indigenous and exotic - Method of composting - factors responsible for composting – vermicomposting – Applications of vermicompost - vermiwash.

**Unit-II: Apiculture**

Types of honey bees-bee colony-Structural adaptation and social life in honey bees - types of bee hives and other accessories - apiary -uses of honey.

**Unit-III: Sericulture**

Types of Silk worm - *Bombyx mori* - cultivation of mulberry plants-rearing of silkworms-silk production-composition -reeling of silk and uses of silk.

**Unit-IV: Fish culture**

Types of culture, types of ponds, general culture techniques - induced breeding - culture of edible fishes.

**Unit–V: Prawn culture**

Prawn culture: Cultivable species – characteristics – Types of culture, shrimp farming prawn culture – harvesting, marketing – indirect breading.

**TEXT BOOKS**


1. Vasantaraj David, B and Kumaraswamy, T., 2002. Elements of Economic Entomology. Popular Book Depot, Madras.
2. Pillay T.V.R., 1995 Aquaculture Principles and Practices Fishing. News Books Surverly, England.
3. Marry Christ Violet .A. 2014. Vermitechnology, MJP. Publisher, Chennai.


**REFERENCE BOOKS**


1) Manish Kumar Singh. 2014. Handbook of vermicomposting: Requirements, Methods, Advantages and Applications. Anchor Academic Publishing.
2) Kaliannan Durairaj, Arunachalam Manimekalan and Palaninaiker Senthilkumar. 2017. Production of Marine Prawn *Litopenaeus vannamei* in pond culture system. Lap Lambert Academic Publishing.
3) Chiranjib Chakraborty and A.K.Sadhu. 2013. Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Daya Publishing House.

4) William E. Meehan. 2018. Fish Culture: In Ponds and other Inland waters. Forgotten Books.
5) Francis Francis. 2015. Fish Culture: A Practical guide to the Modern system of Breeding and Rearing Fish. Sagwan Press.

**Course outcomes**

At the end of the semester students shall be able to

CO1: Start entrepreneurial activities involving solid waste management and Vermicomposting

CO2: Take up apiculture as a profession

CO3: Take up sericulture

CO4: Start aquaculture

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | - | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | - | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | - | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | - | √ | √ | √ | √ | - | - | √ | √ | √ | √ | √ | √ |

## III SEMESTER
## 19ZOOE316-1: ENVIRONMENTAL SCIENCE

**LEARNING OBJECTIVE**

- To study basic environment and its problems
- To understand natural resources and conservation
- To learn various aspects of biodiversity
- To understand biosphere degradation
- To learn EIA, Climate change and global warming.

**UNIT I: Basics of Environment**

Definition and subdivisions of environment: Physiological environment – brief description of lithosphere, hydrosphere, stratification of hydrosphere (Marine and fresh water), atmosphere and its stratification. Biotic environment – biosphere, structure of ecosystem and energy flow in ecosystem, food chain, food web, ecological pyramids and biomagnifications.

**UNIT II Natural Resources and Their Conservation**

Definition and classification of natural resources: Based on chemical nature, abundance, occurance and origin. Causes of depletion of natural resources - Uneven distribution, population growth, industrial development, over exploitation for economic development. Conservation of natural resources. Equitable use of resources and sustainable development.

**UNIT III : Biodiversity and its Conservation**

Concept and types of biodiversity: Genetic, species, ecosystem, point, alpha, gamma and epsilon diversity. Biodiversity hotpots of India. WCU (I.U.C.N.) Red Data Book- extinct, extinct in wild, critically endangered, endangered and vulnerable species. Factors contributing to biodiversity crisis. Conservation of biodiversity – *In- Situ* conservation and *Ex-situ* conservation

**Unit IV: Biosphere Degradation**

Environmental pollution: Sources, effects and control measures of air, water, noise and radiation pollutions. Issues and challenges of solid wastes and their management. Pollution case studies in India – Bhopal gas tragedy, Ganga river pollution and Tajmahal pollution issue.

**Unit V :EIA, Climate Change And Global Warming**

Need and objectives of environmental impact assessment, basic procedures of environmental impact assessment. Green house effect - green house gases and their impacts. Causes and impacts of global warming and its management. Ecological impacts of climate change.

**TEXT BOOKS**


1. Pandey, S.N. and Misra,S.P. , 2011. Environment and Ecology. Ane books Pvt.Ltd., New Delhi, India.
2. Singh,H.R., 2005. Environmental Biology, S.Chand & company Pvt Ltd., New Delhi, India.
3. Abbasi S.A, 2010. Environmental Pollution and its control. Discovery publishing house Pvt. Ltd., New Delhi, India.


**REFERENCE BOOKS**


1) Sharma P.D. 2017. Ecology and Environment. Rastogi Publications.
2) Botkin and Keller. 2012. Environmental Science. Wiley.
3) Arihant Experts. 2016. Environment and Ecology. Arihant Publications.
4) Pranav Kumar. 2017. Fundamentals of Ecology and Environment. Pathfinder Publication.
5) Daniel D. Chiras. 2014. Natural Resource Conservation. Pearson Education.


**Course outcomes**

At the end of the semester students shall be able to

CO1: Identify environmental issues

CO2: Appreciate wild life and natural resources

CO3: Develop talent to conserve nature

CO4: Provide basic environmental education to the society

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |

## VALUE ADDED COURSE

**(Combinedly offered by Department of Physics and Zoology)**

## BIO- MEDICAL INSTRUMENTATION

**LEARNING OBJECTIVE**

- To understand the basic structural and functional elements of human body
- To learn separation technique for biomolecules
- To learn bio-electric and biopotential
- To learn imaging instruments

**Unit –I : Basic Elements of human Body**

Cell: Structure and organelles – Functions of each component in the cell. Cell membrane- transport across membrane – origin of cell membrane potential –Action potential.

Human physiological systems of the body –Structure of heart – properties of Cardiac muscle-Conducting system of heart –Cardiac cycle- Structure of a Neuron – Types of Neuron –Synapses and types- conduction of action potential in neuron – Respiratory system –Components of respiratory system –Respiratory Mechanism- Types of respiration – Oxygen and carbon dioxide transport and acid base regulation – problems encountered in biomedical measurements.

**Unit II: Separation techniques for Bio-molecules**

Electrophoresis: Principles, methods and application of paper, Cellulose and immune electorophoresis, Poly Acrylamide. Gel Electphoresis.

Chromatography: Principles, methods and application of paper chromatography, thin layer chromatography (TLC), Gas chromatography (GC) Gas liquid chromatography (GLC), High performance liquid chromatography( HPLC), Ion-Exchange chromatography.

**Unit III: Bio-Electric Potentials**

Resting and action potentials – Propagation of action potentials – Bioelectric potentials – Electrocardiogram (ECG) – Electroencephalogram (EEG) – Electromyogram (EMG) Electroretinography (ERG) – Electrooculography (EOG).

**Unit IV: Bio- Potential Electrodes**

Biopotential Electrodes – Types of Electrodes- Microelectrodes – Body surface electrodes – Depth and Needle electrodes –Chemical electrodes –Distortion in measured bioelectric signals using electrodes – Electrode paste.

**Unit V: Imaging Equipments**

Ultrasonic imaging – Reflection –Scattering-A mode display-B mode display –T-M mode display-Ultrasonic imaging instrumentation – Biomedical applications. Magnetic Resonance imaging (MRI)- Principles – Instrumentation – Advantages of MRI over other medical imaging techniques – Thermography- Endoscopy.

**Text Books and References:**


1. Farr's Physics for Medical imaging, Penelope Allsiy, Rpberts, Jerry R.Villiams, Saunders, Elsevier,Second Edition, 2008.
2. Biomedical Instrumentation, T.Rajalakshmi, First Edition, 2008.
3. Bio medical Instrumentation, M.Arumugam , Fourth Reprint,2000.
4. Handbook of biomedical instrumnetion, R.S. Khandpur,2007.

5. The physics of Radiation Therapy,Fiaz M.Khan, 2006.
6. Nuclear Medicine physics, Ramesh Chandra, 5th Edition, Lea and Febiger.
7. P.S. Verma, B.S. Tyagi and V.K.Agarwal, 2005. Animal Physiology. S.Chand & Company Ltd, New Delhi.

**Course outcomes**

At the end of the semester students will be able to :

CO1: Understand the structure and physiological functioning of various organ systems of human body

CO2: Master the common bio-separation techniques used for clinical Applications

CO3: Operate various medical equipments working on the principles of bio-electric potentials

CO4: Understand the basic principles and operations of various imaging equipments used in the clinical field

CO5: Takeup jobs in various clinical labs, hospitals and related institutions

**Outcome Mapping**

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO2 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO3 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO4 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| CO5 | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |