



**FACULTY OF SCIENCE**

# **DEPARTMENT OF ZOOLOGY**

**M.Sc., ZOOLOGY**

**(FIVE YEARS INTEGRATED PROGRAMME)**

**PROGRAMME CODE : SZ0051**

**HAND BOOK**

**2019-2020**

**(Onwards)**

  
**ANNAMALAI UNIVERSITY**

**REGULATIONS FOR THE FIVE YEAR INTEGRATED POST GRADUATE PROGRAMMES  
UNDER CHOICE BASED CREDIT SYSTEM (CBCS)**

**DEPARTMENT OF ZOOLOGY  
M.Sc. ZOOLOGY (FIVE YEAR INTEGRATED) PROGRAMME  
PROGRAMME CODE: SZOO 51**

These Regulations are common to all the students admitted to the Five Year Integrated Master's Programmes in the Faculties of Arts, Science, Languages, Marine Sciences and Education 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 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 of 90 working 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 Experiential Learning** is a process of learning through experience. It is specifically defined as "learning through reflection on doing".
- 1.15 Extension activities** are the activities that provide a link between the University and the community such as lab-to-land, literacy, population education, and health awareness programmes. These are integrated within the curricula with a view to sensitise the students about Institutional Social Responsibility (ISR).
- 1.16 Credit** refers to the quantum of course work in terms of the 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.
- 1.17 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.
- 1.18 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.
- 1.19 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.
- 1.20 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.
- 1.21 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.
- 1.22 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.
- 1.23 Cumulative Grade Point Average (CGPA)** is a measure of the overall cumulative performance of a student in all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters.
- 1.24 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, and RA.

## 2. Programmes Offered and Eligibility Criteria

The Integrated Programme offered by the University and the eligibility criteria are detailed below.

M.Sc. Zoology	A pass in H.S.E. (10+2 level) OR Equivalent thereto with a minimum aggregate of 40% marks under academic stream in the following subjects viz. Physics, Chemistry and Biology or Zoology and Botany.
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**2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programme.**

### **3. Reservation Policy**

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

### **4. Programme Duration**

**4.1** The Five Year Master's Programme consist of five academic years and ten semesters.

**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 Five Year Integrated Programme consists of Language Courses, Core Courses, Allied Courses, Elective Courses, Soft Skills, Experiential Learning and Project. Students shall also participate in Extension Activities as part of their curriculum.

#### **5.2 Language Courses**

**5.2.1** Each student shall take two languages of four courses each, one in each semester for the first two years of the programme.

**5.2.2** Language-I shall be Tamil or another language such as Hindi or French.

**5.2.3** Language-II shall be English.

#### **5.3 Core courses**

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

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

#### **5.4 Allied Courses**

**5.4.1** Each student shall take courses in two disciplines allied to the main subject (Allied-I and Allied-II) of the programme in the first four semesters.

**5.4.2** In Arts, Languages, and Education, there will be three Theory Courses each for Allied-I and Allied-II.

**5.4.3** In Science and Marine Sciences, there will be two Theory courses and one Practical course each for Allied-I and Allied-II.

#### **5.5 Elective Courses**

**5.5.1 Departmental Electives (DEs)** are the electives that students can choose from a range of Electives offered within the Parent Department offering the Programme.

**5.5.2 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.

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

## **5.6 Soft Skills**

**5.6.1** Soft skills are intended to enable students to acquire attributes that enhance their performance and achieve their goals with complementing [hard skills](#).

**5.6.2** Soft skills include communication skills, computer skills, social skills, leadership traits, team work, development of emotional intelligence quotients, among others.

**5.6.3** Each student shall choose four courses on soft skills from a range of courses offered from the First to the Sixth Semester.

## **5.7 Value Education**

All students shall take a course on Value Education that includes human values, sustainable development, gender equity, ethics and human rights.

## **5.8 Experiential Learning**

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

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

## **5.9 Extension Activities**

**5.9.1** It is mandatory for every student to participate in extension activities.

**5.9.2** All the students shall enrol under NSS/NCC/YRC/RRC or any other Service Organisation in the University.

**5.9.3** Students shall put in a minimum attendance of 40 hours in a year duly certified by the Programme Co-ordinator.

**5.9.4** Extension activities shall be conducted outside the class hours.

## **5.10 Project**

**5.10.1** Each student shall undertake a Project in the final semester.

**5.10.2** The Head of the Department shall assign a Project Supervisor to the student.

**5.10.3** The Project Supervisor shall assign a topic for the project and monitor the progress of the student periodically.

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

## **5.11 Value Added Courses (VACs)**

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

**5.11.2** VACs enhance the students' employability and life skills. VACs are listed on the University website and in the Handbook on Interdepartmental Electives and VACs.

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

**5.11.4** Classes for VACs are conducted beyond the regular class hours and preferably in the VIII and IX Semesters.

**5.12 Online Courses**

**5.12.1** 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.

**5.11.2** Students who successfully complete a course in the MOOC platform shall be exempted from one elective course of the programme.

**5.12 Credit Distribution**

The credit distribution is detailed in the Table.

	<b>Credits</b>
<b>Semester I to VI</b>	
Language-I (Tamil or any other Language)	12
Language-II (English)	12
Core Courses	60-65
Allied-I	10
Allied-II	10
Electives	15
Soft skills	12
Environmental studies (UGC mandated)	2
Value Education	2
Experiential learning	4
Extension activities	1
<b>Total Credits (Semester I to VI)</b>	<b>140-145</b>
<b>Semester VII to X</b>	
Core Courses	65-75
Electives	15
Project	6-8
<b>Total Credits (Semester VII to X)</b>	<b>90-95</b>
<b>Total Credits Semester I to X (Minimum requirement for the award of Degree)</b>	<b>*230-240</b>

*\*Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 230-240 credits.*

### **5.13 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 students 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 should earn a minimum of 75% attendance in 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.

## **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 a 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 for 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 one 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 (ESEs)**

**8.5.1** The ESEs for the odd semester will be conducted in November and for the even semester in May.

**8.5.2** A candidate who does not pass the examination in any course(s) will be permitted to reappear in such course(s) 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, both 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	5
Assignment	5
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 Double Evaluation for the ESE is done by the University Teachers.

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 Review of literature, 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 of the Head of the Department, Project Supervisor, and a senior faculty.

9.4.7 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 VACs shall be evaluated completely by Internal Examiners.

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 candidate 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 of 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.

$$CGPA = \frac{\sum_{i=1}^m \sum_{j=1}^n C_i G_{ij}}{\sum_{i=1}^m \sum_{j=1}^n C_i}$$

where,  $C_i$  is the Credit earned for the Course  $i$  in any semester;  
 $G_{ij}$  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 to 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 candidate 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 completed successfully, 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 student has re-appeared.

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 or more 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), 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 (for which the student has secured RA Grade) 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) in the subsequent semester.

**12.7** Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the student 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 department library or computer resources, stealing other students' notes/assignments, 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 Five Year Integrated 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.*

## PROGRAMME OUTCOMES

- 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 tasks independently 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)

1. 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.
2. To acquire skills in utilizing the fundamental knowledge gained in various fields of biological sciences in teaching learning activities.
3. 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.
4. 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.
5. 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.



Annamalai University

Department of Zoology

M.Sc., Zoology ( Five years Integrated ) Programme

REGULATIONS (2019)

PROGRAMME CODE SZOO 51

Programme Structure

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SCHEME OF EXAMINATION

Code code	Course Title	Hours/ Week			Marks		
		L	P	C	CIA	ESE	Total
<b>Semester - I</b>							
19ITAC11	Language – I/Paper I	3		3	25	75	100
19IENC12	Language-II /Paper I	3		3	25	75	100
19ICEC13	Civics, Environment awareness and Health science	3		3	25	75	100
19IZOT14	Invertebrata I	4		4	25	75	100
19IBOA15	Ancillary I – Botany I	4		4	25	75	100
19IZE16.	Elective 1: Department Elective	3		3	25	75	100
	Total Credits			20			600
<b>Semester – II</b>							
19ITAC21	Language –I Paper II	3		3	25	75	100
19IENC22	Language-II Paper II	3		3	25	75	100
19ICAC23	Computer Applications I	4		3	25	75	100
19IZOT24	Invertebrata II Tutorial/ Group Discussion	4		4	25	75	100
19IZOA25	Ancillary I- Botany II	4		4	25	75	100
19IZOP26	Core Practical- I Pre-Lab Discussion (1 hour) Practical I (11 hours) (Covering IZOT 14 & 24)		6	5	40	60	100
19IZOP27	Ancillary-I practical I (Covering IZOA 15 & 25)		6	3	40	60	100
	Total Credits			25			700
<b>Semester -- III</b>							
19ITAC31	Language –I Paper III	3		3	25	75	100
19IENC32	Language-II Paper III	3		3	25	75	100
19IZOT33	Chordata I Tutorial/ Group Discussion	4		4	25	75	100
19IZOP34	Core Practical-II Pre-Lab Discussion (1 hour) Practical II (11 hours) (Covering IZOT 33)		6	5	40	60	100
19IZOA35	Ancillary II - Chemistry I	4		4	25	75	100
19IZOE36.	Elective 2 – Department Elective	3		3	25	75	100



				<b>21</b>			<b>500</b>
	<b>Total Credits</b>						
	<b>Semester - VIII</b>						
19IZOT81	Animal Physiology	4		4	25	75	100
19IZOT82	Genetics	4		4	25	75	100
19IZOT83	Immunology	4		4	25	75	100
19IZOP84	Core Practical-VII Pre lab Discussion ( 1 hour) Practical VII (11 hours) (Covering IZOT 81,82 & 83)		12	6	40	60	100
19IZOE 85.	Elective 5: Department Elective	3		3	25	75	100
	Elective 6: Inter-department Elective	3		3	25	75	100
	<b>Total Credits</b>			<b>24</b>			<b>600</b>
	<b>Semester - IX</b>						
19IZOT91	Evolution-II	4		4	25	75	100
19IZOT92	Environment & Biodiversity conservation	4		4	25	75	100
19IZOT93	Animal Behaviours	4		4	25	75	100
19IZOT94	Biotechnology	4		4	25	75	100
19IZOP95	Core Practical- VIII Pre lab Discussion ( 1 hour) Practical VIII (11 hours) (Covering IZOT 91,92, 93 & 94)		12	6	40	60	100
19IZOE 96.	Elective 7: Department Elective	3		3	25	75	100
	Elective 8: Inter- department Elective	3		3	25	75	100
	<b>Total Credits</b>			<b>28</b>			<b>500</b>
	<b>Semester - X</b>						
19IZOT101	Bio-chemistry	4		4	25	75	100
19IZOT102	Endocrinology	4		4	25	75	100
19IZOP103	Core Practical- IX- Pre lab Discussion ( 1 hour) Practical IX (11 hours) (Covering IZOT 101 & 102)		12	6	40	60	100
19IZOPJ104	Project (Dissertation and Viva-Voce)		10	6	25	75	100
					(Viva -Voce	(Disser- -tation)	
	<b>Total Credits</b>			<b>20</b>			<b>400</b>
	<b>Semesters I-X Total Credits</b>			<b>237</b>			
	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 Inter-departmental Electives (IDEs) from a range of choices available.
2. Students may opt for any Value-added Course listed in the University website.

## DEPARTMENT ELECTIVES

Semester & Course Code	Course Title	L	P	C	Int. Ass. Marks 25	End Sem. Exam Marks 75	Total Marks
<b>I Semester Elective 1</b> 19IZOE16-1 (or) 19IZOE16-2	Medical Entomology (or) Bio-Physics	3	0	3	25	75	100
<b>III Semester Elective 2</b> 19IZOE36-1 (or) 19IZOE36-2	Aquaculture (or) Pisciculture	3	0	3	25	75	100
<b>V Semester Elective 3</b> 19IZOE56-1 (or) 19IZOE56-2	Bio-informatics (or) Medical Laboratory techniques	3	0	3	25	75	100
<b>VIII Semester Elective 5</b> 19IZOE85-1 (or) 19IZOE85-2	Entomology (or) Public Health and Hygiene	3	0	3	25	75	100
<b>IX Semester Elective- 7</b> 19IZOE96-1 (or) 19IZOE96-2	Fisheries & Aquaculture (or) Toxicology	3	0	3	25	75	100

### Ancillary Courses offered to Other Science Department in I and II Semesters

Semesters & Code	Title	L	P	C	CIA	ESE	Total Marks
<b>I Semester</b> Ancillary I 19IZOA15	Ancillary Zoology-I Animal Diversity –I	4	0	4	25	75	100
<b>II Semester</b> Ancillary II 19IZOA25	Ancillary Zoology-II Animal Diversity-II	4	0	4	25	75	100
19IZOP27	Pre lab Discussion		1	1			
	Ancillary Practical Covering IBOA-15 & IBOA 25	-	6	2	40	60	100

**INTERDEPARTMENT ELECTIVE COURSES (IDE)**

S.No.	Course Code	Course Title	Department	L	P	Credits	Marks		
				Hrs			Int. Asses	End Sem. Exam	Total
1.	19ISOSE715.1	Soft Skills	<b>English</b>	3	0	3	25	75	100
2.	19IMATE815.1	Discrete Mathematics	<b>Mathematics</b>	3	0	3	25	75	100
3.	19IMATE815.2	Numerical Methods		3	0	3	25	75	100
4.	19IMATE915.1	Differential Equations		3	0	3	25	75	100
5.	19ISTSE815.1	Statistical Methods	<b>Statistics</b>	3	0	3	25	75	100
6.	19ISTSE815.2	Mathematical Statistics		3	0	3	25	75	100
7.	19ISTSE915.1	Bio-Statistics		3	0	3	25	75	100
8.	19IPHYE815.1	Classical Mechanics and Special Theory of Relativity	<b>Physics</b>	3	0	3	25	75	100
9.	19IPHYE815.2	Physics of the Earth		3	0	3	25	75	100
10.	19IPHYE915.1	Bio-Medical Instrumentation		3	0	3	25	75	100
11.	19IPHYE915.2	Energy Physics		3	0	3	25	75	100
12.	19ICHEE815.1	Applied Chemistry	<b>Chemistry</b>	3	0	3	25	75	100
13.	19ICHEE915.1	Basic Chemistry		3	0	3	25	75	100
14.	19ICHEE915.2	Instrumental Methods of Analysis		3	0	3	25	75	100
15.	19IBOTE815.1	Plant Tissue Culture	<b>Botany</b>	3	0	3	25	75	100
16.	19IBOTE815.2	Plant Science – I		3	0	3	25	75	100
17.	19IBOTE915.1	Gardening and Horticulture		3	0	3	25	75	100
18.	19IBOTE915.2	Plant Science – II		3	0	3	25	75	100
19.	19IGEOE815.1	Environmental Geosciences	<b>Earth Sciences</b>	3	0	3	25	75	100
20.	19IGEOE915.1	Applied Geophysics		3	0	3	25	75	100
21.	19BIOE815.1	Basic Biochemistry	<b>Biochemistry &amp; Biotechnology</b>	3	0	3	25	75	100
22.	19BIOE815.2	Basic Biotechnology		3	0	3	25	75	100
23.	19BIOE915.1	Biochemical Techniques		3	0	3	25	75	100
24.	19BIOE915.2	Immunology		3	0	3	25	75	100
25.	19IMIBE915.1	Microbiology	<b>Microbiology</b>	3	0	3	25	75	100
26.	19ICSCE815.1	R Programming	<b>Computer &amp; Information Science</b>	3	0	3	25	75	100

**Elective Courses offered to the Students of Other Department in  
VIII and IX Semesters**

<b>Semesters &amp; Code</b>	<b>Title</b>	<b>L</b>	<b>P</b>	<b>C</b>	<b>Int. Ass. Marks 25</b>	<b>End Sem. Exam Marks 75</b>	<b>Total Marks</b>
<b>VIII Semester</b> 19IZOX815	Animal Culture Techniques	3	0	3	25	75	100
<b>IX Semester Elective IV</b> 19IZOX915	Environmental Science	3	0	3	25	75	100

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

<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>P</b>	<b>C</b>	<b>Int. Ass. Marks 25</b>	<b>End Sem. Exam Marks 75</b>	<b>Total Marks</b>
19IPHYE915.1	<b>Bio-Medical Instrumentation</b>	3	0	3	25	75	100

**FIRST YEAR**  
**19 IZOT 14: INVERTEBRATA- I**

**SEMESTER I**

**Credit Hours:4**

**LEARNING OBJECTIVES**

- To learn lower invertebrate diversity
- To learn the classification of lower invertebrate upto orders
- To learn the morphological features, physiology, and reproduction in invertebrates

**Course outcome**

At the end of the semester students shall be able to

CO1: Understand the diverse forms of lower invertebrates

CO2: Identify common protozoans

CO3: Identify common coelenterates and ctenophore

CO4: Understand common parasitic platyhelminthes and nematodes and also Classify lower invertebrate upto orders based on morphological characters

**UNIT - I: Non- chordates**

Principles of classification – salient features and classification upto orders in non-chordates. Structural organization in different classes of non- chordates.

**UNIT - II: Protozoa**

Protozoa – salient features and classifications upto orders: Type study - *Amoeba* and *Paramecium* - Locomotion, osmoregulation, nutrition and reproduction.

**UNIT - III: Porifera**

Porifera – salient features and classifications upto orders: Type study – *Leucosolenia* and *Sycon* Sponge, Origin of metazoa – metamerism and symmetry.

**UNIT - IV: Coelenterata and Ctenophora**

Coelenterata – salient features and classifications upto orders: Type study - *Obelia* and *Aurelia* - alternation of generation – Polymorphism in Hydrozoa.

Ctenophora - salient features and classifications upto orders: Type study – *Pleurobranchia* and *Ctenoplana* and affinities.

**UNIT - V: Platyhelminthes and Nematelminthes**

Platyhelminthes – salient features and classification upto orders: Type study - Tapeworm – reproduction and parasitic adaptations.

Nematoda – **salient features and classifications upto orders**: Type study – *Ascaris*.

UNIT - VI: **Current Streams of Thought (Not for final exam)**: Advances in invertebrate - Invertebrate symbioses – social behavior of invertebrates – Reproduction strategies - invertebrate behavior .

### PRACTICAL

1. Examination of *Paramecium*, *Amoeba*, *Euglena*
2. Study of specimens: *Sycon*, *Hylonema* and *Spongilla* -
3. Study of Specimens: *Hydra*, *Obelia*, *Aurelia*, *Sea-Anemone*, *Gargonia*.
4. Study of Specimens: *Fasciola* and *Taenia*
5. Study of Slides and specimen of *Ascaris*

### TEXT BOOKS

1. Ekambaranatha Ayyar .M., 1973. A Manual of Zoology – Part I, Invertebrata. Viswanathan.S, (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. Adam Sedgwick, 1960. A student's text book of Zoology, Vol. I & III, General Book Depot, Allahabad.
4. Hyman, L.H. The Invertebrates, 1951. Vol. I, McGraw Hill Book Co., Newyork.
5. Kotpal.R.L., 2017. Modern Text book of Zoology-Invertebrata, (Animal Diversity- I). Rastogi Publications, New Delhi.

### REFERENCE BOOKS

- 1) Arumugam, N. 2014. Animal diversity Volume -1 – Invertebrata. Saras Publication
- 2) Fatik Baran. 2012. Invertebrate Zoology. PHI.
- 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) Clarkson E.N.K. 2011. Invertebrate Palaeontology and Evolution. Wiley India Pvt. Ltd.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2
CO3	3	3	2	3	1	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

## 19 IZOT 24: INVERTEBRATA- II

**SEMESTER II**

**Credit Hours:4**

### **LEARNING OBJECTIVES**

- To learn higher invertebrate diversity
- To learn the salient features of higher invertebrates
- To learn the classification of higher invertebrate upto orders
- To learn the various organ systems in higher invertebrates

### **Course outcomes**

At the end of the semester students shall be able to

CO1: Understand the diversity and significance of higher invertebrates

CO2: Identify higher invertebrates upto order based on morphological features

CO3: Understand the various salient features of annelids

CO4: Identify and explain onychopora and arthropods and also Identify and differentiate various echinoderms

### **UNIT - I: Annelida**

Annelida - Salient features - **Classification up to orders**: Type study - Earthworm, Nereis, Leech – Coelom and excretory system –adaptive radiation in polychaetes.

### **UNIT - II: Onychopora**

Onychopora – **Salient features – Classification upto orders**: Type study - *Peripatus* and affinities

### **UNIT - III: Arthropoda**

Arthropoda – Salient features – Classification upto orders: Type study - *Palaemon* and Grasshopper; *Limulus* and its affinities.

### **UNIT - IV: Mollusca**

Mollusca - Salient features – classification upto orders: Type study - Fresh water Mussel and Sepia; Torsion in Mollusca, Foot in Mollusca, Shells in Mollusca.

### **UNIT - V: Echinodermata**

Echinodermata – Salient features - classification upto orders - Type study – *Asterias* – Echinoderm larvae and significance.

### **PRACTICAL**

1. Dissection of Cockroach- Internal organs and mounting of mouth parts.
2. Dissection of Prawn- digestive system and Nervous system and mounting of appendages.

3. Dissection of Earthworm – Internal organs.
4. Pila –dissection of internal organs.
5. Transverse sections of Leech and Earthworm (slides).
6. Mounts of Radula, Ctenidium.
7. Echinoderm – specimen study.
8. Spiders, Ticks and Mites-specimen study.
9. Minor phyla - specimen study.

### TEXT BOOKS

1. Ekambaranatha Ayyar .M., 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. Adam Sedgwick, 1960. A Students Text Book of Zoology, Vol. I, II & III. General Book Depot, Allahabad.
4. Hyman, L.H. 1951. The Invertebrates, Vol I & II, McGraw Hill Book Co, Newyork, London.
5. Kotpal.R.L., 2017. Modern Text Book of Zoology, Invertebrata (Animal Diversity II). Rastogi Publications, New Delhi).

### REFERENCE BOOKS

- 1) Arumugam, N. 2014. Animal diversity Volume -1 – Invertebrata. Saras Publication
- 2) Fatik Baran. 2012. Invertebrate Zoology. PHI.
- 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) Clarkson E.N.K. 2011. Invertebrate Palaeontology and Evolution. Wiley India Pvt. Ltd.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	3	1	3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	1	2	3	3	3	3	3	2	3	3	2

## SECOND YEAR

### 19IZOT 33: CHORDATA – I

SEMESTER III

Credit Hours: 4

#### LEARNING OBJECTIVES

- To learn the origin, salient features of lower chordate
- To learn the classification of lower chordates
- To learn the structural organization of lower chordates
- To learn the classification of agnatha
- To study the general characters, behaviour and classification of fishes

#### Course outcomes

At the end of the semester students shall be able to

CO1: Understand the diversity of lower chordates

CO2: Learn the salient features and classification of lower chordates

CO3: Know the structural organization of protochordata and vertebrata

CO4: Understand origin of chordate and general characters of agnatha

#### UNIT - I: Protochordata

General characters and phylogeny of Hemichordata, Urochordata, Cephalochordata and their larval forms; **Significance of protochordates**, Type study: Balanoglossus, Herdmania and Amphioxus.

#### UNIT - II: Origin of Chordate

Theoris of origin of Chordates – Dipleurula concept – Echinoderm theory of chordates – Origin of Hemichordata, Urochoradata and Cephalochordata – **Barringtons hypothesis**.

#### UNIT - III: Vertebrate

**General characters of vertebrates and classification upto orders. Structural organization in vertebrates** – notochord – pharynx with pouches - slits – Nervous system – Vertebral column.

#### UNIT - IV: Agnatha

General characters of Agnatha and classification of cyclostomes upto orders – Type study'- *Petromyzon*. **Affinities and phylogenetic status of Cyclostomata**.

## UNIT - V: Pisces

General Characters of Chondrichthyes and Osteichthyes. Pisces and Classification upto orders. Comparison between Chondrichthyes and Osteichthyes. Types of Fishes, scales and accessory respiratory organs of fishes. Migration in fishes, osmoregulation and parental care.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Advances in chordate Zoology – Phylogenetic relationships – Medical uses – as food – Defense mechanisms – Life cycles – animal behavior – Animal diversity

## PRACTICAL

1. Protochordata
  - a) (Specimens and Slides): *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial *Urochordata*. *Ascidian*
  - b) Sections of *Balanoglossus* through proboscis and branchiogenital regions
  - c) Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
2. Agnatha (Specimens) *Petromyzon* , *Myxine*
3. Fishes (Specimens) : *Etrophus*, *Tilapia*, *Pristis*, *Torpedo*, *Chimaera*, *Notopterus*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Tetrodon*, *Diodon*, *Anabas*, Flat Fish.
4. Dissection: Fish digestive system and Reproductive system.

## TEXT BOOKS

1. Ekambaranatha Ayyar.M., 1973. A Manual of Zoology Part – II: Chordata. S. Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
2. Jordan. E.L. and P.S Verma, 2017. Chordate Zoology and Elements of Animal Physiology, S. Chand & Co., Ltd., New Delhi.
3. Young, J.N. 2004. The Life of Vertebrates. Oxford at the Clarendon Press, London.
4. Adam Sedgwick, 1960. A Student Text Book of Zoology Vol.III. General Book Depot, Allahabad.
5. Hyman, L.H. 1974. Comparative Vertebrate Anatomy. University of Chicago Press, New York, Chicago.
6. Edwin H Colbert, 1969. Evolution of Vertebrate. Wiley Eastern University Press, Ansari Road, New Delhi.
7. Hall, B.K. and Hallgrímsson, B., 2008. Strickberger's Evolution IV Edition, Jones and Barlett Publishers, U.S.A.India.

## REFERENCE BOOKS

- 1) Arumugam, N. 2014. Animal diversity Volume -2 – Chordata. Saras Publication, Nagercoil
- 2) Saxena R.K. and Sumitra Saxena. 2016. Comparative Anatomy of Vertebrates. Viva Books New Delhi.
- 3) Kent. 2015. Comparative Anatomy of the Vertebrates. McGraw Hill UK.
- 4) Edwin H. Colbert, Michael Morales and Eli C. MinKoff. 2011. Colbert's Evolution of the Vertebrates. Wiley USA
- 5) Kenneth Kardong. 2018. Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill. UK

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3

## 19 IZOT 43: CHORDATA – II

**SEMESTER IV**

**Credit Hours: 4**

### **LEARNING OBJECTIVES**

- To learn general characters and classification of higher chordates upto order
- To learn various types of snakes
- To learn various flying adaptations in birds and also flightless birds
- To learn various types of mammals and zoogeography

### **Course outcomes**

At the end of the semester students shall be able to

CO1: Identify different types of higher chordates based on their morphology

CO2: Differentiate poisonous and non poisonous snakes and other reptiles

CO3: Understand flying adaptations in birds

CO4: Understand origin, ancestry and adaptive radiation among mammals and also differentiate the anatomical features of various internal organs

### **UNIT - I: Amphibia**

Origin and evolution of amphibian, general characters and classification upto order – type study – Frog. Adaptive features of Urodela - Salamander and **Ichthyophis**. Parental care in amphibian.

### **UNIT - II: Reptilia.**

**Origin and evolution of reptiles**, general characters and classification upto order. Type study – Calotes. **Extinct reptiles**, Poisonous snakes in India, identification of poisonous and non-poisonous snakes – biting mechanism.

### **UNIT - III: Birds**

**Origin**, salient features and classification upto order. Type study – **Pigeon**. Principles, mechanism and flight adaptation in birds – flightless birds, **adaptive radiation** – bird migration- Archaeopteryx - a connecting link.

### **UNIT - IV: Mammals**

**Origin, ancestry of mammals**, salient features and classification upto order. Type study - **Rabbit**. Aquatic mammals – flying mammals – adaptive radiation in mammals. Dentition in mammals.

## UNIT - V: **Comparative anatomy**

**Comparative anatomy of vertebrates – integuments, lungs, heart, kidney, testis and ovary.**

### **PRACTICAL**

1. Amphibia: Amblystoma/Pipa-Pipa, Necturus, Bufo, Hyla, Alytes, Salamandra- Specimen study.
2. Reptiles:
  - i. Specimens: Krait, Hydrina, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Lycodon, Tomopterus, Vipera, Naja, Turtle, Phrynosoma, Crocodylus.
  - ii. Key for Identification of Poisonous and Non – Poisonous snakes.
3. Aves: Study of six common birds from different orders. Types of beaks and claws.
4. Mammals:  
Specimens: Raccoon, Bat (Insectivorous and Frugivorous) Scaly anteater, Loris, Otter
5. Dissection of Frog: Digestive system and reproductive system –Demonstration
6. Dissection of Calotes: Digestive system and reproductive system–Demonstration

### **TEXT BOOKS**

1. Ekambaranatha Ayyar M.,1973. A Manual of Zoology Part–II: Chordata. S.Vishvanathan Printers and Publishers , Pvt. Ltd.,Madras
2. Jordan. E.L. and P.S Verma, 2017. Chordate Zoology and Elements of Animal Physiology, S. Chand & Co., Ltd., New Delhi.
3. Young, J.N.2004. The Life of Vertebrates. Oxford at the Clarendon Press, London.
4. Adam Sedgwick, 1960. A Student Text Book of Zoology Vol.III. General Book Depot. Allahabad.
5. Hyman, L.H. 1974. Comparative Vertebrate anatomy. University of Chicago Press, New York, Chicago.
6. Edwin H Colbert, 1969. Evolution of Vertebrate. Wiley Eastern University press, Ansari Road, New Delhi.
7. Hall, B.K. and Hallgrimsson, B., 2008. Strickberger's Evolution, IV Edition. Jones and Barlett Publishers, U.S.A.

### **REFERENCE BOOKS**

- 1) Arumugam, N. 2014. Animal diversity Volume -2 – Chordata. Saras Publication.
- 2) Saxena R.K. and Sumitra Saxena. 2016. Comparative Anatomy of Vertebrates. Viva Books.
- 3) Kent. 2015. Comparative Anatomy of the Vertebrates.McGraw Hill.
- 4) Edwin H. Colbert, Michael Morales and Eli C. MinKoff. 2011. Colbert's Evolution of the Vertebrates. Wiley.

5) Kenneth Kardong. 2018. Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill.

### 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	3	3	3	3	1	3	3	3	3	3	2	3	3	3	3
CO2	2	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	1	3	3	3	3	3	3	3	3	2	3
CO4	3	3	3	3	1	3	2	3	3	3	3	3	3	3	3

## THIRD YEAR

### 19 IZOT 51: CELL BIOLOGY

SEMESTER V

Credit Hours: 4

#### LEARNING OBJECTIVES

- To learn the structural organization of cell
- To learn the mechanism of endoplasmic reticulum and ribosomes
- To learn the structural organization of golgi apparatus and lysosome
- To learn the relation between nucleus and chromosomes
- To learn mechanism of cell division

#### Course outcomes

At the end of the semester students shall be able to

CO1: Acquire knowledge on basic structure and functions of cells

CO2: Differentiate various cell organelles and their role

CO3: Identify nucleus and chromosomes

CO4: Identify various stages of cell divisions

CO5: Work in various research and clinical organization

#### UNIT - I: Cell theory, Cellular organization and Cell Membrane

Discovery of cell, cell theory – protoplasm theory, organismal theory - Structural organization of prokaryote and Eukaryote - Virus - bacteria - Plasma membrane – Ultra structure models and functions.

#### UNIT - II: Endoplasmic Reticulum and Ribosomes.

Endoplasmic reticulum: morphology – ultra structure – types of endoplasmic reticulum - rough and smooth surfaced endoplasmic reticulum - Chemical composition and Functions.

Ribosomes: 70s ribosomes – 80s ribosome – ribosome structure – ribosomal RNA, ribosomal protein – polyribosome – functions of ribosomes.

#### UNIT - III: Golgi apparatus and Lysosome

Golgi apparatus: Morphology, ultra structure – origin and function – golgi complex and secretion.

Lysosomes: Lysosomal structure – lysosomal enzymes – polymorphism in lysosome- primary lysosome - secondary lysosome – Functions of lysosome.

## UNIT - IV: Nucleus and Chromosomes

Nucleus: Structure of interphase nucleus – Functions – nuclear envelope  
Chromosomes: structure, types and function of chromatin and chromosomes, Nucleolus: Structure – types and functions of nucleolus.

## UNIT - V: Cell Division

Mitosis: Process of mitosis – Karyokinesis - General events in interphase, Prophase, metaphase, anaphase and telophase.

Meiosis: Process of meiosis – first meiotic division – Second meiotic division, synaptonemal complex – significance of meiosis.

UNIT - VI: **Current Streams of Thought (Not for final exam):** Recent discoveries and Nobel prize in cellular and molecular research. Model of DNA damage. Cell death and regeneration.

## PRACTICAL

1. Light and compound microscopes – observation. principles and functions
2. Micrometry: a) Stage micrometer b) Ocular micrometer and c) Camera Lucida
3. Eukaryotic cell types – slides (Columnar Epithelial cell, Buccal Epithelial cell, Liver, Pancreas and muscle)
4. Observation of mitosis from onion root tip - squash
5. Observation of meiotic cell division stages from permanent slides
6. Blood smear of human – identification of drum stick chromosome (neutrophil)
7. Identification of Barr body -Human Buccal smear

## TEXT BOOKS:

1. Powar, C.B., 2012. Cell Biology, Himalaya Publishing house
2. Verma,P.S and V.K Agarwal 2001. Concept of cell Biology, S.Chand & Co. New Delhi.
3. Rastogi .S.C., 1992. Cell Biology. Hill Pub. Comp
4. Wilson, G.B and John H. Morrison, EWP, 1996, Cytology, Ed., 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.

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	1	3	3	3	3	3	3	3	3	3	2
CO3	3	3	3	3	1	3	3	2	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	2	3

## 19 IZOT 52: PRINCIPLES OF GENETICS

Semester V

Credit Hours: 4

### LEARNING OBJECTIVES

- To learn the fundamental concepts of genetics
- To learn about human health related genetic problems
- To learn polygenic inheritance, linkage and crossing over
- To understand genetics of Sex determination and sex linked inheritance
- To study extranuclear inheritance gene structure and mutation.

### Course outcomes

At the end of the semester students shall be able to

CO1: Interpret phenotypic expressions based on genotype

CO2: Understand and interpret genetically linked diseases, Polygenic inheritance and crossing over

CO3: Perform blood grouping and test metabolic disorders and Interpret genetics of sex determination and inheritance

CO4: Work in clinical laboratories and take up researches

### UNIT - I: **Mendelism, Interaction of Genes and Multiple Alleles**

Mendel's Laws of inheritance - Monohybrid – Dihybrid cross- Back Cross -Test Cross.

Interaction of Genes: Dominant Epistasis – Recessive Epistasis - Complementary - Supplementary.

Multiple Alleles: Coat Colour in rabbit - ABO Blood Group in man - Rh factor.

Gene Expression: Atavism – Lethality - Penetrance - Expressivity – Pleiotropism.

### UNIT - II: **Polygenic inheritance, Linkage and Crossing Over**

Polygenic inheritance: Kernal colour in wheat – Skin Colour in man

Linkage: Classical Views – Kinds of linkage – Linkage groups - Experimental examples.

Crossing over: Kinds of crossing over – Mechanisms – Theories – Experimental example.

### UNIT - III: **Sex Determination and Sex – Linked Inheritance**

Determination of Sex: Sex Determination in drosophila and man - Environmental Sex Determination – Gynandromorphs.

Sex linked inheritance in Drosophila and man – Y – linked gene – Sex influenced genes (Baldness in man) - sex limited genes (Sickle feathers in chicken).

#### UNIT - IV: **Extranuclear inheritance, Gene structure and mutation**

Extrachromosomal inheritance: Maternal inheritance in Limnaea – Kappa Particles in *Paramecium*.

Fine Structure of Gene: Cistron – Recon – Muton.

Mutation: Mutagens – point mutation – chromosomal aberration – polyploidy.

#### UNIT - V: **Population Genetics and Human Genetics**

Population Genetics: Hardy Weinberg Law - Gene Frequency – Genotypic frequency.

Human Genetics - Human Pedigree – Eugenics – Euthenics and Euphenics-

Human Syndromes – (Downs, Edward, Patau, Klinefelter's and Turner).

UNIT - VI: **Current Streams of Thought (Not for final exam)**: Molecular phylogenetics – Molecular cytogenetic techniques – FISH, GISH, DNA Finger Printing, Automated karyotyping, Chromosome painting – Human genome project – Applications of molecular genetics techniques in human welfare

#### **PRACTICAL**

1. Mendelian Dihybrid cross – Illustrating with model (Peas/Beads)
2. Dominant Epistasis – illustrating with model
3. Polygenic inheritance – illustrating with human height
4. Blood Grouping in man
5. Identification of human finger prints
6. Identification of chromosomal disorder forms in human (Karyotyping).
7. Identification of sex and mutation in drosophila (eye colour)
8. Calculation of gene frequency & genotypic frequency

#### **TEXT BOOKS**

1. Karvita B Aluwalla. 1991. Genetics, Wiley Eastern Ltd., New Delhi.
2. Veer Bala Rastogi. 1992. A Test book of Genetics. Kedar Nath Ram Nath Publication, Meerut. U.P.
3. Gupta P.K. 1996. Genetics, Rastogi Publication Ltd., New Delhi
4. Germa P.S and Agarwal V.K. 1998. Genetics. S.Chand and Co., New Delhi

#### **REFERENCE BOOKS**

- 1) William S. Klug, Michael R. Cummings and Chariotte A. Spencer. 2016. Concept of Genetics. Pearson.
- 2) Peter Snustad.D 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.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	1	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	1	3	3	2	3	3	3	3	3	3	3
CO4	3	2	3	3	1	3	3	3	3	3	3	3	2	3	3

## 19 IZOT 53: COMPARATIVE ANIMAL PHYSIOLOGY

Semester V

Credit Hours: 4

### LEARNING OBJECTIVE

- To learn nutritional requirements and metabolism
- To understand respiratory system
- To learn blood vascular system
- To learn physiology of respiration, excretion and neuronal functions
- To learn about the physiology of muscle, receptors and neurons

### Course outcomes

At the end of the semester students shall be able to

CO1: Understand basic biochemical molecules and their roles

CO2: Appreciate the nutritional requirements and the roles of nutrition in physiology

CO3: Learn the functioning and roles of respiratory and circulatory system

CO4: Analyse the physiology of excretion and osmoregulation

### UNIT - I: Digestion and Absorption

Mode of nutrition – autotrophs – heterotrophs – Intracellular digestion – Extracellular digestion- Digestion in invertebrates – Digestion in vertebrates : Digestion in mammals- digestion in the mouth - stomach – intestine – absorption – structure of villi – absorption of food (water and fat soluble vitamins – electrolyte, calcium and iron absorption).

### UNIT - II: Respiration

Respiratory organs – integumentary respiration- branchial respiration – external and internal gills – tracheal respiration - lungs- ventilation lungs - mammalian lungs – mechanism of breathing – exchange of gases in lungs – oxygen and carbon dioxide – Bohr's effect - Respiratory pigments - haemoglobin – chlorocruorin – haemocyanin – haemerythrin.

### UNIT - III: Circulation

Types of body fluids in animals – general properties and functions of blood – composition of blood – blood electrolytes formed elements – red blood cells – white blood cells – platelets – blood groups and transfusion – coagulation of blood - components of circulatory system – artery – vein – capillary – tubular heart - pulsating heart – ampullar heart – neurogenic heart – myogenic heart - open and closed type of circulation - structure and functions of mammalian heart.

### UNIT - IV: Excretion and Osmoregulation

Organs of excretion in animal groups – nitrogenous wastes – ammonia – urea – uric acid – ammonotelic animals – ureotelic animals – uricotelic animals – excretory organs –

archinephron – pronephron – mesonephron – opisthonephron – metanephros - structure and functions of mammalian kidney – osmoregulation in invertebrates and vertebrates.

#### UNIT - V: **Muscle, Receptors and Neuron**

Structure and functions of vertebrate muscle – skeletal muscle – smooth muscle – cardiac muscle – invertebrate muscle - synchronous and asynchronous flight muscle; Receptors – chemoreceptor – mechanoreceptor – phenoreceptor - acoustic receptive organ in insects – photoreceptor bioluminescence - structure and functions of neuron in invertebrates and vertebrates.

UNIT - VI: **Current Streams of Thought (Not for final exam)**: Recent discoveries in Animal physiology – Nobel prize in physiological (or) medical research.

#### **PRACTICAL:**

1. Pattern of osmotic response of Crab in two different media
2. Effect of chemical substance on respiratory metabolism of fish
3. Comparative study of vertebrate and insect eyes.
4. Ciliary mode of feeding in freshwater mussel
5. Effect of pH and amount of substrate activity of salivary amylase
6. Study of ciliary and amoeboid movements
7. Test for Nitrogenous waste products in cock-roach and birds
8. Test for ammonia, urea and uric acid.

#### **TEXT BOOKS:**

1. Prosser.C.L, 1984.Comparative animal physiology. W.B.Sanders & Co.,
2. Eckert.R. Animal Physiology and adaptation. W.H.Freeman and company
3. Hoar.W.S, 1987. General and comparative animal physiology. Prentice Hall of India Ltd., New Delhi
4. Schiemdt-Nielsen.K., 2002. Animal Physiology adaptation and environment. Cambridge, University Press, London .
5. Prosser.C.L., 1991. Environment and Metabolic Physiology. Wiley-Liss, New York

#### **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

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	1	3	2	2	3	3	3	3	2	3	3

## 19 IZOT 54: APPLIED ZOOLOGY

Semester V

Credit Hours: 4

### LEARNING OBJECTIVE

- To learn the methodology and significance of reproductive technologies
- To learn the basic of bioinformatics
- To learn the importance of aquaculture and vermicomposting
- To learn the Common practices in poultry science and dairy science

### Course outcomes

At the end of the semester students shall be able to

CO1: Perform basic computer operation and bio-informatics technologies

CO2: Get top opportunity in fertility clinics and technicians

CO3: Start entrepreneurial activities

CO4: Start poultry farming and dairy operations

### UNIT - I: **Bioinformatics**

Historical perspective on computer and their applications in biology - Introduction to programming - the internet and the biologists - data bases and information retrieval - genome information.

### UNIT - II: **Reproductive Technologies**

Gametes technology - collection and preservation of economically important invertebrates and vertebrates, sperm function tests, semen analyses - embryo sexing - methods and principles.

### UNIT - III: **Aquaculture**

Types of culture - general culture techniques-pond culture - polyculture. Integrated fish farming; farm construction and management; Induced breeding - hypophysation technique. Culture of ornamental fishes.

### UNIT - IV: **Poultry Science**

Introduction to poultry science – Important breeds of poultry – Desi – Chittagong and Leghorn – Layer house and Broiler house – Marketing of egg and Byproducts of poultry – Common diseases of poultry – Raniket, Coccidiosis and Coryza, Vaccination programme.

### UNIT - V: **Dairy Science**

Dairy farming – Definition – Scope – Dairy breeds of India – Exotic cow breeds – Jersey and Red Sindhi – Indian Breeds – Kangayam – Buffalo – Murrah – Milk – Composition – Nutritive value and Pasteurization of milk.

### PRACTICAL

1. Study about biological databases
2. Study about Genome informations
3. Histology of gametes (Testis and ovary)
4. Semen analysis
5. Hypophysation techniques-location and removal of Pituitary; Pituitary extract, Preparation and Preservation – Demonstration
6. Culture method of ornamental fishes
7. Charts – Important breads of poultry
8. Charts – Dairy breads of India
9. Charts – Exotic cow breads

### TEXT BOOKS

1. Kumar H.D, 1998. A text book of biotechnology, East-West Press Pvt.ltd., New Delhi
2. Dubey, R.C, 2014. A text book of biotechnology. S. Chand and Co. Ltd., New Delhi
3. Krishnan, N. 2001. Computer fundamentals and windows with internet technology. Scitech publications pvt.ltd, Chennai
4. Primrose, S.B. and R.M. Twyman, 2003. Principles of genome analysis, Black well science.
5. Banerjee, G.C., 2008. A text book of Animal husbandry, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi

### REFERENCE BOOKS

- 1) Arthur M. Lesk. 2014. Introduction to Bioinformatics. Oxford University Press.
- 2) Pevsner J. 2017. Bioinformatics and Functional Genomics. Wiley India.
- 3) Gideon Waddell. 2018. Poultry Science. Larsen and Keller Education.
- 4) Chauhan H.V.S. and S. Roy. 2018. Poultry Diseases, Diagnosis and Treatment. New Age International Pvt. Ltd.
- 5) Christian Snider. 2016. Dairy Farming: Animal Husbandry and Welfare. Syrawood Publishing House.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	2	3	3	3	1	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2
CO4	3	3	2	3	1	3	2	3	3	3	3	2	3	3	3

## 19 IZOT 61: BASIC EMBRYOLOGY

Semester VI

Credit Hours: 4

### LEARNING OBJECTIVES

- To learn the various concepts of developmental biology
- To learn gametogenesis and process of fertilization
- To learn cleavage, gastrulation and early embryonic developments
- To learn the processes of embryogenesis, organ formation and differentiation
- To learn metamorphosis and regeneration

### Course outcomes

At the end of the semester students shall be able to

- CO1: Assimilate knowledge on reproduction and development
- CO2: Differentiate between spermatogenesis and oogenesis
- CO3: Understand process of fertilization
- CO4: Understand the whole process of embryogenesis and Interpret metamorphosis and regeneration

### UNIT - I: Basic concepts of Embryology

Historical thoughts, concepts and scope of embryology. Theories – germplasm theory, mosaic theory, regulative theory, gradient theory and Speman's theory of organizers.

### UNIT - II: Gametogenesis

Reproductive organs – male and female reproductive system of frog, gametogenesis – spermatogenesis, oogenesis, perivitellogenesis and vitellogenesis.

### UNIT - III: Fertilization and early development

Fertilization – biological role of fertilization, basic requirements of fertilization, physiological aspects of fertilization – entry of sperm – activation of egg.

### UNIT - IV: Cleavage, Gastrulation and Organogenesis

Cleavage laws, types of cleavage, planes of cleavage and patterns of cleavage. Cleavage in amphioxus. Gastrulation - major events in gastrulation, morphogenetic movements and physiology of gastrulation. Gastrulation in amphioxus. Organogenesis -

comparative account on the development of brain and eye in frog and chick - development of foetal membranes.

#### UNIT - V: **Metamorphosis and Regeneration**

Metamorphosis - **Types**, hormonal control on metamorphosis, **factors controlling metamorphosis in insects and amphibians**. Regeneration - **types** and histological process – **regeneration in amphibians**.

#### **PRACTICAL**

1. Observation of different types of sperms – Amphibia, fish, frog, cock and man – slides/chart.
2. Observation of different types of eggs – Hen’s egg, fish, frog, hen and rat- slides.
3. Observation of early development in Amphioxus – 2,4,8 and 16 celled stage – slides.
4. Observation of blastula, gastrula - Amphioxus – slides.
5. Observation of larval stage in invertebrates – radia, cercaria, zoea, mysis, bipinnaria, auricularia, dipleurula and ophiopluteus.
6. Observation of early development in frog tadpole – slides. Mouth open stage, external gill stage and opercular fold stage – slides.
7. Observation of developmental stages in chick – 20, 24, 33, 48, 72, and 96 – slides.

#### **TEXT BOOKS**

1. Verma P.S., Agarwal V.K., and B.S. Tyagi, 2003 Chordate embryology S. Chand & Co, New Delhi.
2. Balnsky, B.I., 1981. Introduction of Embryology, Saunders College Publishing Ltd., New Delhi.
3. Berrill, N.J.1986. Development Biology, Tata McGraw Hill Publishing Co., New Delhi

#### **REFERENCE BOOKS**

- 1) Gilbert, S.F. 2010. Development Biology, Sinaer Associates Inc, Publishers Sunderland, Massachusets.
- 2) Madhavan K.S. 2018. Developmental Biology. Arjun Publishing House.
- 3) Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias. 2015. Principles of Development. OUP, Oxford.
- 4) Jain P.C. 2013. Elements of Developmental Biology. Vishal Publishing Co.
- 5) Berry A.K. 2016. An Introduction to Embryology. Emkay Publications.

#### **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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	2	3	3	3	1	3	3	2	3	3	3	2	3	3	3
CO3	3	3	3	2	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	2	3	3	3	2	3	3	2	3

## 19 IZOT 62: EVOLUTION-I

Semester VI

Credit Hours: 4

### LEARNING OBJECTIVES

- To learn the concepts of evolution
- To learn the origin of life and geological time scale and theories of evolution
- To learn the concepts of polymorphism, polyploidy and animal behaviors
- To learn about mechanisms of evolution
- To learn speciation and evolution man

### Course outcome

At the end of the semester students shall be able to

CO1: Understand and appreciate the concept of organic evolution and origin of life

CO2: Differentiate between various theories of evolution

CO3: Interpret polymorphism and population genetics and also explain the various animal behavior patterns

CO4: Understand the role of isolation in species formation and evolution and Get employment in zoological museums, zoological survey of India and paleontological institutes

### UNIT - I: Origin of Life

Introduction – Origin of life – Abiogenesis, Biogenesis, Time of origin, Urey and Miller Experiment. Evidence from Paleontology – Morphology and Comparative anatomy - Embryology - Physiological and Biochemical - Taxonomical – Geographical and Genetical Evidences.

### UNIT - II: Theories of Organic Evolution

Lamarckism – Salient feature - Use and Disuse theory - and Neo Lamarckism – Experimental evidences - Darwinism – Natural selection theory – Struggle for Existence – Survival of the Fittest – Origin of the new species – sexual Selection theory - Artificial Selection theory – Theory of Pangenesis – HMS Beagle - Darwin's finches and Neo Darwinism

### UNIT - III: Mechanism of Evolution

Mutation Theory – Modern version of mutation theory – Classification of mutation – Gene mutation – Molecular basis of gene mutation – Induced mutations – Chromosomal mutations – Evolutionary significance of mutation - Natural selection – Types of natural selection - Synthetic theory – Genetic Assimilation and Genetic Homeostasis – Non-adaptive traits.

#### UNIT - IV: Polymorphism and Population genetics

Polymorphism – Types and origin of polymorphism - Variation – Sources of variations – Elemental forces of evolution – Polyploidy – types – origin and significance – Hardy-Weinberg Law – Genetic Drift – Salient features of genetic drift – Evolutionary significance of genetic drift.

#### UNIT - V: Speciation, Isolation and Evolution of man

Speciation – Types of speciation – Mechanism of speciation – Patterns of speciation – Factors influencing speciation – Isolating mechanisms – Patterns of evolution - Evolution of man – Fossils, types and significance - Living fossils –Continuous and discontinuous distribution of animals – Mimicry and Colouration – Adaptation and adaptive radiation.

UNIT - VI: **Current Streams of Thought (Not for final exam):** Recent discoveries in Evolution- mechanism- the process of evolution- understanding phylogenies- ancient fossils and modern climate change.

#### PRACTICAL

1. Homologous organs, Analogous organs, vestigial organs
2. Fossils: Trilobite, nautilus, Ammonite
3. Animals of evolutionary importance: Peripatus, Limulus and Archaeopteryx  
Darwin's finches
4. Mimicry: leaf insects, Stick insects, Monarch and Viceroy butterfly
5. Adaptive colouration: Chamaeleon, Lycodon

#### TEXT BOOKS

1. Colbert, E.H. 1969. Evolution of vertebrates, Wiley, New York.
2. Arumugam, N. 2016. A text book of evolution – Saras Publication.
3. Rastogi, V.B. 2008. Organic evolution, Kedernath, Ramnath Publishers, Meerut.
4. Gupta.P.K., N. 2008. Cytology, genetics and Evolution, Rastogi Publications, Meerut.

#### REFERENCE BOOKS

- 1) Richard Swann Lull, 2012. Organic Evolution, Maxford, New Delhi.
- 2) Reena Mathur, Tomar and Singh, 2011. Evolution and behavior, Rastogi Publications, Meerut.
- 3) Clarkson E.N.K. 2011. Invertebrate Palaeontology and Evolution. Wiley India Pvt. Ltd.
- 4) Edwin H. Colbert, Michael Morales and Eli C. MinKoff. 2011. Colbert's Evolution of the Vertebrates. Wiley.
- 5) Kenneth Kardong. 2018. Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill.

#### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	1	3	3	3	3	3	3	3	2	3	3
CO3	2	3	3	3	1	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	1	2	3	3	3	3	3	3	3	3	3

## 19 IZOT 63: ECOLOGY

Semester VI

Credit Hours: 4

### LEARNING OBJECTIVES

- To analyse basic concepts in ecology
- To learn the role of Biotic factors ecosystem and biotic community
- To learn the conserve ecological resources
- To learn ecological succession, population and ecological and adaptation
- To learn biogeochemical cycles significance of natural resources and wildlife management
- To understand major ecological issues.

### Course outcomes

At the end of the semester students shall be able to

CO1: Analyse and appreciate the basic ecological concepts

CO2: Differentiate biotic factors and of biotic community

CO3: Critically evaluate the process of ecological adaptations and successions

CO4: Understand significance of natural resources and wildlife and their conservation

### UNIT - I: Basic Concepts and Abiotic factors

Definition of ecology and subdivisions – autecology and synecology. Major abiotic factors and their ecological significance - Air-general composition and ecological significances of oxygen and carbon dioxide; water – source, types, hydrological cycle, hydrocoles, mesocoles and xerocoles; Light – spectral distribution of solar light, zonation of water bodies based on penetration of light - biological effects of light and bioluminescence; Temperature - diurnal variations, thermal stratification of water bodies - Thermal adaptations (homeotherms, poikilotherms, hibernation, aestivation and thermal migration).

### UNIT - II: Biotic Factors, Ecosystem and Biotic Community

Biotic environment: Types, mechanisms and significance of various interspecific relationships (mutualism, commensalism, antibiosis, parasitism, predation and competition).

Ecosystem: Principal steps, components and structure, trophic levels, food chain, food web and ecological pyramids. Structure and functions of pond and forest ecosystems. Energy flow in an ecosystem.

Community: Definition, characteristics and community stratification in terrestrial, fresh water and marine habits, ecotone, edge effect, habitat, ecological niche, ecotypes and ecological indicators.

### UNIT - III: Ecological Succession, Population and Adaptations

Succession: Kinds, process and theories of succession. Patterns of succession – xerosere and hydrosere.

Population: characteristics of population, regulation of population (density independent and density dependent factors). Adaptations: fossorial, cursorial, arboreal, volant (flight) and desert adaptations.

#### UNIT - IV: **Biogeochemical Cycles, Natural Resources and Wild Life Management.**

Carbon, nitrogen and phosphorous cycles. Renewable and non – renewable natural resources and their conservation. Causes of wild life depletion in India. Common endangered species in India. Necessity and modes of conservation. Major wild life sanctuaries, national parks and biosphere reserves in India and their significances.

#### UNIT - V: **Major Ecological Issues**

Environmental pollution: Major sources, causes, impacts and control measures of air, water, noise, radiation, thermal and land pollutions. Reasons, ecological consequences and remedial measures of green house effect, global warming, sea level rise, water scarcity and importance of water conservation.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Recent trends in Ecology – Conservation and restoration ecology- Adaptability – Territoriality in small animals – Nobel prize for Ecology.

#### **PRACTICAL**

1. Estimation of dissolved oxygen
2. Estimation of dissolved CO<sub>2</sub>
3. Determination of salinity
4. Determination of nitrites
5. Determination of TDS.
6. Identification of planktons
7. Quantitative estimation of planktons
8. Food chain
9. Adaptations: Fossorial, cursorial, volant and dessert adaptations
10. Inter specific interactions: Symbiosis, parasitism and predation.

#### **TEXT BOOKS**

1. Ananthakrishnan, T.N. and S. Viswanathan.1996.Principles of Animal Ecology
2. Rastogi, V.B. and M.S. Jayaraj, 2001.Animal Ecology and Distribution of Animals, Kedar Nath Ram Nath. Meerut.
3. Verma, C.P. and V.K. Agarwal. 1996. Environmental Biology, S.Chand & Co Ltd., New Delhi.

#### **REFERENCE BOOKS**

- 1) Rana S.V.S. 2013. Essentials of Ecology and Environmental Science. Prentice Hall India.
- 2) Meetu Gupta.2018. Fundamentals of Environmental Biology. I.K. International Publishing House.
- 3) Purohit S.S. and V.K.Agrawal. 2014. Ecology and Environmental Biology. Agrobios.
- 4) Manoj Kumar Sharma. 2013. Environmental Biology. Vayu Education of India.

5) Charles H. Eccleston. 2011. Environmental Impact Assessment: A Guide to Best professional Practices. CRC Press.

### 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	2	3	3	3	1	3	3	3	3	2	3	3	3	3	2
CO2	3	3	3	3	1	3	3	3	3	3	3	2	3	3	3
CO3	3	2	3	3	1	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	2	3	3	2	3

## 19 IZOT 64: ANIMAL CULTURE TECHNIQUES

Semester VI

Credit Hours: 4

### LEARNING OBJECTIVES

- To learn vermicomposting
- To learn apiculture
- To learn sericulture
- To learn aquaculture

### 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 as a profession

CO4: Start aquaculture and also take up jobs in animal culture industry

### UNIT - I: Vermicomposting

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

### UNIT - II: Apiculture

Types of honey bees - bee colony-structural adaptation 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: Oyster culture

Seed production and collection – Feed and nutrition - edible oyster and pearl oyster – Predators and environmental factors affecting oyster culture.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : animal culture: Recent discoveries in animal cell culture – Nobel prize in tissue culture or cell culture (or) medical research- recent achievement in animal culture.

### PRACTICAL

1. Types of earthworms- Epigeic, Anaecic.
2. Pit method of vermicomposting. Spotter-Vermicompost, Vermiwash.
3. Mounting Legs, Sting, Mouth parts of honey bee.
4. Observation of life cycle of honey bee.
5. Study of beehive and its accessories.
6. Observation of Life cycle of silkworm.
7. Demonstration of silk gland.
8. Identification of carps- Catla, Rogu, Mrigal, Silver carp, Grass carp, Common carp.
9. Estimation of Hardness and Salinity.
10. Identification of brackish water prawns- *Penaeus monodon*, *Litopenaeus vannamei* and Fresh water Prawn – *Macrobrachium rosenbergii*.
11. Determination of Nitrite and Silicate in water.

### 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 Survery, England.
3. Marry Christ Violet .A. Vermitechnology 2014, 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.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	2	3	3
CO2	3	2	3	3	1	3	3	3	3	3	3	3	3	3	2
CO3	3	3	3	3	1	3	2	3	3	2	3	3	3	3	3
CO4	2	3	3	3	1	3	3	3	3	3	3	2	3	2	3

## FOURTH YEAR

### 19 IZOT 71: STRUCTURE AND FUNCTIONS OF INVERTEBRATES AND VERTEBRATES

Semester VII

Credit Hours: 4

#### 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 in various groups of invertebrates
- To evaluate the larval forms of invertebrates to acquire knowledge on various organ systems of vertebrates

#### Course outcomes

At the end of the semester students shall be able to

CO1: Understand the morphological features and physiological features like Respiration, 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

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, nail, hooves, feather and hairs. Skeletal elements of the body – account of jaw suspensorium, 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.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Methods of identification and classification of new species in animal kingdom.

### **PRACTICALS**

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

### **TEXT BOOKS**

1. Ekambaranatha Ayyar.M , 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. Ekambaranatha Ayyar.M.,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.

## 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	3	3	2	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	2	3	3	3	2	3
CO3	2	3	3	3	1	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	2	3	3	3	3	3	3	3	2

## 19 IZOT 72: DEVELOPMENTAL BIOLOGY

Semester VII

Credit Hours: 4

### 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

### 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 and also Take up jobs in fertility clinics and research labs

### 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 amphibians, 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.

UNIT - VI: **Current Streams of Thought (Not for final exam)**: Chromosomal sex determination in mammals, control of mammalian sex determination, Environmental sex determination, temperature dependent sex determination, hormonal regulation of the sexual phenotype.

#### PRACTICAL

1. Demonstration of male and female reproductive system in mammals (rat) - specimens
2. Dissection and mounting of chick blastoderm 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, 4<sup>th</sup> Edition, Saunders'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. Rastroggi Publication.
- 5) Berry A.K. 2016. An Introduction to Embryology. Emkay Publications.

### Outcome Mapping

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

## 19 IZOT 73: CELL AND MOLECULAR BIOLOGY

Semester VII

Credit Hours: 4

### LEARNING OBJECTIVES

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

### Course outcomes

At the end of the semester students will be able to

CO1: Interpret the structural and functional significances of DNA and RNA

CO2: Perform molecular biological techniques

CO3: Take up research career in molecular biology

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

### UNIT - I: Cell structure and Cell membrane

Cell Structure: Introduction – Structural organization of prokaryotic and eukaryotic cells; structural 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 reticulum and ribosomes: morphology and functions of endoplasmic reticulum - Structure of ribosomes and rRNAs - Organization of ribosomes – Role of ribosomes in protein synthesis.

### UNIT - III: Organelles of Bioenergetics & Biogenesis

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

Organalle of Biogenesis: Chloroplast – Ultrastructure - photochemical reaction in biogenesis - Light reaction and Dark reaction – Role of CO<sub>2</sub> and H<sub>2</sub>O in photosynthesis – ‘Z’ scheme.

#### UNIT - IV: DNA Structure and Replication

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

**DNA replication:** Prokaryotic and eukaryotic DNA replication – Semi- conservative replication mechanism, enzymes and necessary proteins origin, initiation, Termination - DNA polymerase, 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.

UNIT – VI: **Current Streams of Thought (Not for final exam):** Recent discoveries and Nobel prize in cellular and molecular research. Advanced research on assembly of ribosomes and ribosomal structure. Recent approach on purification and separation of nucleic acids; Analysis of protein interactions.

#### 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<sup>th</sup> Edition) UK
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. Karp, G., 1979. Cell Biology. Mc Graw Hill kogatusha Ltd. Japan.

## 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.

## Outcome Mapping

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

## 19 IZOT 81: ANIMAL PHYSIOLOGY

Semester VIII

Credit Hours: 4

### LEARNING OBJECTIVES

- To learn the significance of food and physiology of digestion
- 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

### 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

### 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 functions 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<sub>2</sub> – Haldane's effect.

## UNIT - V: Nervous system, Muscle and Sense organs

**Nervous 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.

UNIT - VI: **Current Streams of Thought (Not for final exam):** Cell biology: Recent discoveries in cell physiology – Nobel prize in physiological (or) medical research – Advances research on need of oxygen for functions of cell; Sense and respond to cell to the Oxygen level; Cell adjustment with level of oxygen at high altitudes .

## 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. Verma.P.S., 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. Tirunelveli
- 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

## Outcome Mapping

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

## 19 IZOT 82: GENETICS

Semester VIII

Credit Hours: 4

### 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.

### 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

### 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 jobs 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 – applications of recombinant DNA technology.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Genetic Engineering Techniques - Genes for Vaccines – Gene therapy – DNA profiling – Animal and plant improvement - Human genome project – Genomic library - Genome database, Genome sequence database, Human genome database.

### 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. Verma P.S. and Agarwal V.K. 1998. 'Genetics'. S. Chand and Co., New Delhi.

### REFERENCE BOOKS

- 1) William S. Klug, Michael R. Cummings and Chariotte A. Spencer. 2016. Concept of Genetics. Pearson.
- 2) Peter Snustad .D 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.

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

## 19IZOT 83: IMMUNOLOGY

Semester VIII

Credit Hours: 4

### 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.

### Course outcomes

At the end of the semester students shall be able to

CO1: Analyse the various immunological issues

CO2: Apply immunological principles for various immunological testing procedures

CO3: To Interpret the results of immunological experiments

CO4: Carry out immunological investigation and also take up jobs in clinical labs and related institutions

### 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<sub>H</sub> Cells, T<sub>c</sub> 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 Fabricius. 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 & heterogeneity,

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.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Significant immunological development in recent years. Immunotherapy. Auto immune diseases and immune deficiencies. Organ transplantation and stem cell research.

#### PRACTICAL

1. Demonstration of lymphoid organs
2. Cell imprinting of lymphoid organs
3. Histology of lymphoid organs -slides
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, 2<sup>nd</sup> 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 Immunology. 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.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	1	2	3	3	2	3	3	2	3	2	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

## FIFTH YEAR

### 19IZOT 91: EVOLUTION- II

Semester: IX

Credit Hours: 4

#### 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

#### 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.

#### 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

- Theories of organic evolution: Lamarck's Evolutionary propositions - Critical analysis of Lamarck's prepositions - Neo-Lamarckism..
- Theory of natural selection : Darwin – Wallace theory of natural selection - Critical analysis of Darwinism – Neo-Darwinism - Modern synthetic theory.

#### Natural Selection and process :

- 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.
- 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 heterozygotes - Frequency – Dependent selection.

#### UNIT - II : Mechanism

##### i) Variation and evolution

Basic units of variability – effect and types. Genetic 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 factors.

Direction of selection – centripetal selection – Centrifugal selection .

**ii) Polymorphism and evolution:**

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

**ii) Polyploidy and evolution**

Polyploidy in animal and plants- types of polyploids- direct effect of Polyploidy-origin of 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 – zygotic mortality - hybrid inviability- hybrid break down – genetic basis of reproductive isolation - origin – significance .

**ii) Speciation and evolution:**

Species concept morphological – Genetic - Sterility based – Biological – sibling concepts - Monotypic 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 or concealing colouration - standard faunal colours – warning or revealing colours - mimetic colouration – confusing and sexual colouration.

**UNIT - V:**

**i) Trends and rates**

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 - primate, 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: Biological future of mankind-positive and negative eugenics-mankind and the organic world evolution – biochemical evolution.

**UNIT - VI: Current Streams of Thought (Not for final exam):** Recent discoveries in Evolution- mechanism- the process of evolution- understanding phylogenies- ancient fossils and modern climate change.

**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- Eg. Sea Horse(male) (c) Sepecial sound producing organs E.g ciccada insect (male)(d) Special using Rhinoceros beetle (male).
3. Polymorphism- (a) Transient Polymorphism 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 mimicing, e.g. Kallima butterfly, Geometrid moth.Stick insect, Lead 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.

**Text book:**

1. Bergstrom, Carl T. and Lee Alan Dugatkin, 2016. Evolution (Second Edition), Norton and company 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,

**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	3	3	3	3	1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	1	3	3	3	3	3	3	2	3	3	2
CO3	3	2	3	3	1	3	2	3	3	3	3	3	3	2	3
CO4	3	3	3	3	1	3	3	3	3	3	2	3	3	3	3

## 19IZOT 92: ENVIRONMENT & BIODIVERSITY CONSERVATION

**Semester: IX**

**Credit Hours: 4**

### **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

### **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

### **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 Brundtland 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 hotspots. 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,

UNIT - VI: **Current Streams of Thought (Not for final exam):** Anthropogenic biodiversity crisis and genesis of anthropocene. Salient markers of anthropocene and its impending dangers. Possible sixth mass extinction and probable means to avert it.

### **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/Nitrite 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

**Outcome Mapping**

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

## 19IZOT 93: ANIMAL BEHAVIOURS

Semester: IX

Credit Hours: 4

### 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

### 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

### 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 rhythms in animal behaviour .

### UNIT - II: Communication behaviour

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

**UNIT - VI: Current Streams of Thought (Not for final exam):** Recent discoveries in Animal behaviours- Phylogeny and animal behavior- proximate mechanisms in animal behavior.

**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.

**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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	1	3	3	3	3	3	3	2	3	3	3
CO3	2	3	3	3	1	3	2	3	3	3	3	3	3	2	3
CO4	3	3	3	3	1	3	3	3	3	2	3	3	3	3	2

## 19IZOT 94: BIOTECHNOLOGY

**Semester: IX**

**Credit Hours: 4**

### 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

### 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

### 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 Technology** - 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 - Transgenic 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, Intellectual Property Right (IPR) and Protection (IPP).

**UNIT - VI: Current Streams of Thought (Not for final exam)** : Recent discoveries in Biotechnological field – Nobel prize in biotechnology research-Stem cell -definition-preservation, sources, culture-characterization- uses- stem cell therapy.

## **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. New Delhi

## **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.

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
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CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	2	3	1	3	3	2	3	3	3	3	3	3	2

# 19IZOT 101: BIOCHEMISTRY

**Semester: X**

**Credit Hours: 4**

## 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

## Course outcomes

At the end of the semester students shall be able to

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

CO2: Able to discriminate various metabolic disorders

CO3: To take up jobs in clinical labs

CO4: To analyze biological samples of bio-chemical importance

## UNIT - I: **Buffers and Carbohydrate.**

i). pH and buffers – Water, carbon dioxide 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 carbohydrate metabolism.

## UNIT - II : **Proteins:**

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

**UNIT - VI: Current Streams of Thought (Not for final exam):** Recent discoveries in Biochemical field – Nobel prize in biochemical (or) medical research-New method uses fluorescence to identify disease-causing forms of proteins.

**Text books**

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

**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:**

1. Qualitative tests for carbohydrates, Amino acids, proteins lipids and nucleic acids; amines urea;( thiourea).
2. Determination of the molecular weight of a monocarboxylic 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<sub>h</sub> 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.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
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CO3	2	3	3	3	1	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	2

## 19IZOT 102: ENDOCRINOLOGY

Semester: X

Credit Hours: 4

### 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.

### 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

### 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: Thyroid gland and parathyroid gland

Thyroid 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 their 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 crustacea – endocrine control of moulting and metamorphosis – Neuroendocrine system in insects- endocrine control of development – thoricotrophic hormones - ecdysone- Juvenile hormone functions – moulting in adult insects.

UNIT - VI: **Current Streams of Thought (Not for final exam)** : Future of Endocrinology – Therapeutic advances in endocrinology and Metabolism – Latest innovations in imaging- Diagnostics in Endocrinology – Innovations in endocrinology – diabetology and nutrition.

#### PRACTICAL

1. Dissection of endocrine organs in vertebrates
2. Dissection of reproductive systems in vertebrates- Demonstration
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. Parabiosis in cockroach
8. Dissection of ovariectomy in cockroach
9. Vaginal smear showing various stages of estrus cycles in mice.
10. Study on influence of insulin in blood glucose level.

#### TEXT BOOKS

1. Turner C.D. 1996. General endocrinology. 4<sup>th</sup> 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 5<sup>th</sup> 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.

### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	2	3	3	3	3	3	3	3	3
CO3	3	2	3	3	1	3	3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

## FIFTH YEAR : TENTH SEMESTER

### 19 IZO PR 104: PROJECT

### DISSERTATION AND VIVA-VOCE

## DEPARTMENT ELECTIVES

### **Elective - 1** 19IZOTE15-1

## **MEDICAL ENTOMOLOGY**

### **LEARNING OBJECTIVES**

- To acquire Knowledge of the Classification of Arthropod Vectors insects in Medical Entomology.
- To study the life Cycles of Vector Insects.
- To Learn Various Vector borne diseases - Transmission and Control Measures.

### **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

### **UNIT - I: Introduction**

Scope of Medical Entomology- Classification of Arthropoda. Classification of Arthropods of Medical and Public Health importance. Mechanism of Transmission of diseases by Arthropods- Mechanical and Biological; Metamorphosis – Complete and Incomplete. Insect Mouth Parts – Chewing and Sucking.

### **UNIT - II: Mosquitoes and Louse**

MOSQUITO: Morphology – Life history , Difference of Anopheles and Culex - Public Health importance – Control Measures.

LOUSE :- Morphology - Life cycle- Difference between Head&Body - Public Health importance – Control Measures

### **UNIT - II: Tsetse fly and Sand fly**

TSETSE FLY: Morphology - Life history - Public Health importance - Control Measures.

SAND FLY :- Morphology –Difference between Male and Female - Life history - Public Health importance – Control Measures.

**UNIT - IV: Fleas and House fly**

FLEAS: Morphology –Difference between Male and Female - Life history - Public Health importance – Control Measures.

HOUSE FLY:- Morphology – Life history - Public Health importance – Control Measures.

**UNIT - V: Other Arthropod vectors**

TICKS : Morphology - Life cycle- Difference between Hard and Soft ticks - Public Health importance – Control Measures.

MITES : Morphology – Life history - Public Health importance – Control Measures.

**Text Books:**

- 1) D.B. Tembhare 2012 , Morden Entomology ,Second Revised & Enlarged Edition – Chennai
- 2) Dr. B.K. Tyagi , 2012 Medical Entomology, Scientific publishers.Chennai

**Reference Book**

- 1) Rathanswamy, G.K, 2010 A Hand book of Medical Entomology. S.Viswanatham Printers & Private & Ltd. Chennai
- 2) Vasantharaj Devid, and V.V. Ramamurthy, 2011, Elements of Economic Entomology.Namrutha Publications , Chennai -600116

**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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

## DEPARTMENT ELECTIVES

### **Elective - 1** 19IZOTE15-2 **BIO-PHYSICS**

#### **LEARNING OBJECTIVES**

- To refresh knowledge of basics biophysics
- To appreciate how various laws of physics are applicable in biological system
- To understand movements and dynamics properties of molecules in biological systems
- To gain the knowledge on physical properties of molecules in structural and physiological process
- To apply physical principles in chemical reactions and physiological systems

**Course outcomes:** At the end of the semester students shall be able to

CO1: To analyze the various forces responsible of biological molecular structure

CO2: To gain the knowledge of cellular permeability

CO3: To understand the dynamics of biological systems

CO4: To correlate the biomolecular structure to its specific functions

#### **UNIT - I: Introduction**

Introduction to Biophysics - Application of Physics in Biological Sciences - Biophysics of water - Molecular structure of water - Hydrogen bonds - physical properties of water.

Thermodynamics - Laws of thermodynamics and its applications to biology

#### **UNIT - II: States of matter**

States of matter - Colloidal state – size of colloidal particles – Different types of colloidal dispersion (sol, aerosol, emulsion, foam, gel) - Preparation of lyophilic and lyophobic sols – Protective colloids, gold number - Stability of colloids – Precipitation, coagulation, flocculation of colloidal particles – Colloidal particles of milk and blood with their functions. Properties of colloids – Tyndall effects, surface tension, viscosity, surface absorption, detergent action, electrical, optical and kinetic properties.

Osmosis - Phenomenon of osmosis – Osmoregulation in the body – Electro osmosis – Donnan membrane equilibrium – Applications – artificial kidney - dialysis of blood.

### UNIT - III: **Membrane Biophysics**

Membrane Biophysics – Cell membrane structure, Composition of biological membrane and stability of bio membranes – membrane transport.

Determination of molecular weight of macro molecules by Chemical composition, Sedimentation – Molecular sieving – Light scattering – Osmotic pressure methods.

Units of measurement of solutes in solution – normal, molar, molal, milli equivalents and milli osmol, ionic strength.

### UNIT - IV: **Biophysical basis**

Biophysical basis for gaseous exchange in lungs and tissues – Partial pressure of CO<sub>2</sub> (pCO<sub>2</sub>) and O<sub>2</sub> (pO<sub>2</sub>) – Influence of O<sub>2</sub> and CO<sub>2</sub> in RBC and body fluids during respiration – Physiological curve of formation and dissociation of oxyhaemoglobin (HbO<sub>2</sub>) and carbon dioxide haemoglobin (HbCO<sub>2</sub>) – Various physiological factors in these curves

Molecular organization of protein – primary, secondary, tertiary and quaternary structure. Main chain and side chain torsion angles, Alpha helix, beta sheet, turns. Ramachandran plot.

### UNIT - V: **Bioenergetics**

Physics behind vision mechanism of accommodation, visual activity, Ophthalmoscope, colour vision, perimetry), hearing (hearing mechanics and abnormality) and mechanism of conduction of nerve impulse.

Bioenergetics – Energy and its forms – Concept of Free energy – Enthalpy and entropy – Redox potential and its calculation, redox coupling. High energy compounds in biological system, ATP: ATP bioenergetics.

### **Text Books**

Narayanan, P. 2007. Essentials of Biophysics. New Age Internationals, New Delhi.

Paul Davidovits. 2012. Physics in Biology and Medicine. Academic Press, N.Y., USA.

Pranab Kumar Banerjee. 2010. Introduction to Biophysics. S.Chand & Co., New Delhi.

Rodney Cotterill. 2014. Biophysics - An Introduction. Wiley, USA.

Srivastava, P.K. 2011. Elementary Biophysics. Narosa Publishing House, New Delhi.

Subramanian, M.A. 2015. Biophysics – Principles and Techniques. MJP Publishers, Chennai – 5.

## Reference Books

Claycomb, J.R. 2011. Introductory Biophysics: Perspectives on the Living State. Jones & Bartlett, New Delhi..

Haynie, D.T. 2010. Biological Thermodynamics. Cambridge University Press, India.

Meyer B. Jackson. 2010. Molecular and Cellular Biophysics. Cambridge University Press. London.

Roland Glaser 2012. Biophysics: An Introduction. Springer, German.

Volbenshtein, M.V. 1983. Biophysics. MIR Publishers, Moscow.

William Stillwell . 2016. An Introduction to Biological Membranes: Composition, Structure and Function. Elsevier Science.

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

### Elective - 2

19IZOTE35-1

## AQUACULTURE

### LEARNING OBJECTIVES

- To acquire knowledge about the important aspects of aquaculture
- To know the different types of culture
- To obtain knowledge about aquarium keeping
- To gather information about mariculture
- To learn the role of organizations involved in aquaculture

### Course outcomes

At the end of the semester students shall be able to

CO1: Master the theoretical and practical aspects of fisheries across different species

CO2: Apply the Aquaculture methods and procedures for higher studies and

research

CO3: To take up jobs in Aquaculture farms

CO4: To analyze biological samples of Aquaculture ponds

UNIT – I: Aquaculture -definition - scope and importance -status of aquaculture in India and world. Biology of Indigenous cultivable fishes(Catla, Rogu, Mrigal).

UNIT – II: Different types of cultures, Monoculture, Poly culture. Composite fish culture, Cage culture , Pen culture, Race way culture- Extensive and intensive culture.

UNIT - III: Aquarium – Setting – requirements. Major aquarium fishes (Guppy, Gold fish, fighter fish, Gourami and Zebra fish) and their biology.

UNIT – IV: Mariculture – pearl oyster culture- pearl production, laboratory phase and farm phase ;Shrimp culture- PL stocking in pond maintenance and management culture ponds ; seaweed culture.

UNIT – V: Economics of Aquaculture. Organizations involved and their role of aquaculture – CIBA, RGCA, CIFA, CIFE, MPEDA and CMFRI.

Reference Books:

1. Gupta.SK & P.C. Gupta.2017. General and Applied Ichthyology. S.Chand & Co, New Delhi.
2. Keshav Kumar Jha.2010 Aquaculture, Daya publishing, Delhi.
3. Pillay, T.V.R.2012. Aquaculture Principles and practices Blackwell publishing, New Delhi.
4. Santhanam, Sugmaran and P.Natarajan, 1997. Manual of fresh water Aquaculture . Oxford and IBH Pub.Co., Ltd., New Delhi.
5. Shanmugam. K. 1990. Fishers Biology and Aquaculture. Leo Pathippagam, Madras – 600083.
6. Kuraian C.V. and V.O. Sebastien 1982. Prawns and Prawn Fisheries of India. Hindustan Publishing Corporation New Delhi.
7. Srivastava, C.B.L. 1985. A Text book of Fisheries science and Indian Fisheries Kitab Mahal, Allahabad.

### Outcome Mapping

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

**Elective - 2**  
**19IZOTE35-1**  
**PISCICULTURE**

**Course Objectives**

- To generate interest in culturing fish for human consumption
- To create awareness about common cultivable fishes
- To learn various breeding techniques in fishes
- To acquire knowledge regarding various fish diseases
- To learn management of fish farm
- To develop skills in common methods of fish harvesting, preservation and processing

**Course Outcome**

After successful completion of the course the candidate shall be able to:

- 1. Take up employment in commercial fish farms
- 2. Start entrepreneurship in fish farming sector.
- 3. Identify common cultivable fishes
- 4. Identify and manage common fish diseases
- 5. Take up employment in industrial fisheries sector
- 6. Start entrepreneurship involving harvesting and post harvesting technologies

**UNIT - I: Scope of Pisciculture and Common Cultivable Fishes**

Definition, overview and scope of finfish culture in India. Desirable characteristics of cultivable fishes. Biology of Indian major carps: *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*. Biology of exotic carps: Grass carp, Silver carp and Common carp.

**UNIT - II: Fish Breeding Techniques**

Natural and induced breeding. Bundh breeding techniques: Dry and wet bundhs. Hypophysation technique. Recent trends in induced breeding: HCG, SG-G100/ LH-RH dopamine antagonist combination.

### **UNIT - III: Fish Farm and its Management**

Construction of fish farm: Selection of site, topography, soil type and water supply. Layout, Embankment, size of ponds, outlet, inlet. Types of ponds: Nursery, rearing and stocking ponds. Farm management: Management of nursery, rearing and stocking ponds.

### **UNIT - IV: Common Fish Diseases and Their Management**

Environmental stress and their management: Temperature, light, dissolved gases, pH and ammonia. Nutrient deficiency diseases related to protein, carbohydrate, lipid and vitamins. Bacterial diseases: Furunculosis and abdominal dropsy. Viral diseases: Viral haemorrhagic septisemia and infections pancreatic necrosis. Fungal diseases: Saprolegniasis and gill rot. Protozoan diseases: Ichthyophthiriasis and whirling diseases: Disease caused by helminths: Ligulosis and dactylogyrosis. Disease caused by arthropods: Argulosis and ergasilosis.

### **UNIT - V: Fish Harvesting and Post Harvesting Technologies**

Fishing gears: Gill nets, traps, cast net and drag net. Causes of fish spoilage and common methods of preservation: Chilling, freezing, freeze-drying, smoking, sun drying, salting and canning. Fish products and by-products: Fish liver oil, fish meal, fish manure and isinglass.

#### **Text Book**

1. S.C. Agarwal (2007). A Hand Book of Fish Farming 3<sup>rd</sup> Ed. Narendra Publishing House, New Delhi, India.
2. N. Arumugam (2008). Aquaculture. Saras Publication, Nagercoil, Tamil Nadu, India.

#### **References Books**

1. M.S. Reddy and K.R.S.S. Rao (2008). A Text Book of Aquaculture, 2<sup>nd</sup> Ed. Discovery Publishing House, New Delhi, India.
2. R.K. Rath (2011). Freshwater Aquaculture 3<sup>rd</sup> Ed. Scientific Publishers, Jodhpur, India.
3. K.K. Jha (2010). Aquaculture, Daya Publishing House, Delhi, India.
4. R. Thanavel (2014). A Handbook of Fish Diseases. Astha Publishing, New Delhi, India.
5. S.K. Gupta and P.C. Gupta (2006). General and Applied Ichthyology. S. Chand and Company, New Delhi, India.

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

### Elective - 3

#### 19IZOTE55-1 BIOINFORMATICS

### LEARNING OBJECTIVES

- To make the students to understand about Bioinformatics and its scope.
- To search and retrieve information from primary and secondary databases
- To work with the sequence alignment tools available in internet
- To gain the knowledge about various tools and applications of genomics and proteomics.
- To know about the applications of bioinformatics in various fields.

### Course outcomes

At the end of the semester students shall be able to

CO1: Master the theoretical and practical aspects of Bio-informatics

CO2: Apply the Bio-uinformatical methods and procedures for higher studies and research

CO3: To take up jobs in medical industries

CO4: To analyze biological samples through bioinformatical importance

#### UNIT - I: **Overview of Bioinformatics**

Introduction to Bioinformatics – Definition – History of bioinformatics – scope.  
Sequences – homology – similarity – sequence retrieval.

#### UNIT - II: **Bioinformatics Databases**

Primary Databases – Nucleotide databases – EMBL – DDBJ – GENBANK, Protein databases – SWISSPROT – PIR – MIPS, Metabolic Databases KEGG – ECOCYE, Secondary databases – PROSITE – PRINTS – BLOCKS,

#### UNIT - III: **Sequence Alignment Tools**

Search engines – Entrez, SRS, STAG. Sequence similarity search – Pairwise alignment – BLAST, FASTA, Multiple sequence alignment – Clustal W – Clustal X.

#### UNIT - IV: **Genomics and Proteomics**

Genomics – DNA sequencing – Applications. Proteomics – Protein structure classifications – Tools and applications – Metabolomics – Tools and applications,

#### UNIT - V: **Applications of bioinformatics**

Industrial applications – Clinical and research applications – ethical and legal issues in bioinformatics – accuracy and error – appropriate uses and users.

#### **Course outcome:**

CO1: This course is designed to introduce future biologists to know about bioinformatics tools and analysis methods.

CO2; Students will become familiar with a variety of currently available genomic and proteomic databases

CO3: Students should be more comfortable working with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.

CO4; This course is designed to give students both a theoretical background and a working knowledge of the techniques employed in bioinformatics.

#### **Text Books:**

1. Terasa K. Attwood, David J. Parry Smith and Samiron Phukan, 2007. Introduction to Bioinformatics, Dorling Kindersley ppvt. Ltd., licenses to Pearson Education, South Asia.
2. Arthur M. Lesk, 2014. Introduction to Bioinformatics, Oxford university press, United Kingdom.

#### **Reference Books:**

1. S.C. Rastogi, Namita Mendiratta and Parag Rastogi, 2013. Bioinformatics: Methods and Applications: (genomics, proteomics and drug discovery) 4th Edition, Kindle Edition, PHI Learning Pvt. Ltd., New Delhi.
2. Marketa J Zvelebil and Jeremy O. Baum, **2007**. Understanding Bioinformatics, Garland Science, Taylor and Francies Group, Newyork and London.
3. Anna Tramontano, 2007. Introduction to Bioinformatics, Chapman & Hall/CRC, Taylor and Francies Group, Newyork and London.
4. Harisha S, 2007. Fundamentals of Bioinformatics, IK International Publishing, New Delhi.

## 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
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CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

### Elective - 3

19IZOTE55-1

### Medical Laboratory Techniques

#### LEARNING OBJECTIVES

The basic aim is to provide knowledge for performing laboratory investigation related to diagnosis and treatment.

**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

#### UNIT - I: Introduction and scope

Introduction and scope of the subject - Design of a lab - GLP, lab grades (level 1,2,3,4)  
- Cleaning, maintenance and care of glassware - Sterilization - physical and chemical method - Disposal of specimens and infected materials

#### UNIT – II: Collection of Sample

Hematology- Collection of Blood Sample -Smear Preparation - Blood Cells - Enumeration of RBC And WBC - Packed Cell Volume - Erythrocyte Sedimentation Rate - MCV - MCH - MCHC - Platelet Count Bleeding Time - Clotting Time - Prothrombin Time - Hemoglobin estimation - Blood Pressure.

#### UNIT – III: Analysis

Liver Function Test- Enzymes SGOT, SGPT, Liver Pigments - Urine - collection - physical and chemical parameters routinely analyzed - Pregnancy test - Analysis of stool,

semen, cerebrospinal fluid - Pathology tests for viral diseases - measles, poliomyelitis, hepatitis, HIV I

**UNIT – IV: Diagnosing**

Tests for bacterial diseases - tuberculosis, whooping cough - tetanus - diphtheria, cholera - Tests for protozoans - amoebic dysentery, malaria, leishmaniasis - Tests for helminths - filariasis, cysticercoids - Tests for life style disease - Cardiac disorders - Diabetes I and II - Obesity –Allergy - Tests for auto immune disease - SLE, MG, RA, autoimmune hepatitis, MS - Tests for cancer, Alzheimer, Parkinson’s disease.

**UNIT – V: Reporting**

Records and preparation of reports

**Text Books**

1. Baker F.J. and Silverton R.E 1998. Introduction To Medical L Laboratory Technology. Hodder Arnold Publication.
2. Text book of Medical Laboratory Technology by Praful B. Gudkor. Palani Publication House (2005).
3. Medical Laboratory Science and Theory by J. Ochei, A. Kothakkar Mc. Growth Hill (2000).

**Reference Books**

1. Manual of Medical Laboratory Technology by S. Ramakrishnan, K.N. Sulochana Jaya Pee Brothers Medical Publishers (P) Ltd. (2012).
2. A Manual of M.L.I. By A.U. Naigonkar Pragates Book (P) Ltd (2008).
3. Basic MLT Techniques (Medical Lat Tech) by Barbara H. Estridge Anna P. Reynolds Norma J. Walters Learning Delmar Thomson (2000).

**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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**Elective - 5**  
**IN EIGHTH SEMESTER**  
19IZOTE84 -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

**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

**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 – Vasadefrens – 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.

**UNIT – VI: Current Streams of Thought :** Recent Techniques : Ericulture –Newer insecticides in pest management – Recently introduced pests- Pheromones in pest management – Insect migration – Monarch butterfly and dragon fly migration.

### **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.

## Outcome Mapping

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CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**Elective - 5**  
**IN EIGHTH SEMESTER**  
19IZOTE84-2  
**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.

## 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

#### **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**

Airborne 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.

#### 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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**Elective - 7**  
**IN NINTH SEMESTER**  
19IZOTE95-1  
**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

**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

**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 important fishes: Hilsa, oil sardine, Mackerel and Bombay duck. Crustacean 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 (*Pinctada 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.

UNIT – VI: **Current Streams of Thought** : *Penaeus vannamei* – Asian parafic white prawn – resistant to white spot virus – high stocking density – probiotics – No water exchange - higher profit in aquaculture – GEM tilapia culture - Sea bass culture in freshwater .

#### 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. Invincible Publishers.
- 3) Pillay T.V.R. and M.N. Kuttu. 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.

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CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**Elective - 7**  
**IN NINTH SEMETER**  
19IZOTE95-2  
**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

**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

**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 – II: **Biotransformation and Excretion 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.

UNIT – VI: **Current Streams of Thought** : Future of toxicology-An industry case study-Advances in invitro approaches to toxicology –Organ – on a clip models.

## **TEXT BOOKS**

1. Sharma, P.D., 1996. Environmental biology and toxicology. Rastogi Publication, Meerut, India
2. Frank C. Lu 1985. Lu's Basic Toxicology. Hemisphere 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) Kamalleshwar Pandey, J.P. Shukla 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.

## Outcome Mapping

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CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

## ANCILLARY - I

### INTEGRATED M.Sc. ZOOLOGY (5 Years) SYLLABUS FOR ANCILLARY PAPER OPTED BY OTHER SCIENCE DEPARTMENT

#### 19IZOA15: ANCILLARY ZOOLOGY- I (ANIMAL DIVERSITY-I)

#### LEARNING OBJECTIVES

- To learn the principles of animal taxonomy
- To learn the classification of animals upto orders
- To learn the salient features and various systems of different phyla

#### Course Outcomes

CO1: Identify a fauna based on morphological character

CO2: Identify poisonous and non- poisonous snakes

CO3: Identify extinct fauna

CO4: Distinguish primitive mammals

CO5: Understand origin of chordates

UNIT – I: Principles of classification-salient features and classification upto orders in non-chordates. Protozoa- Type study Entamoeba. Porifera and coelenterata-Type Sycon sponge, Obelia

UNIT – II: Platyhelminthes and Nematelminthes-Type study-Planaria- parasitic adaptations. Ascaris-Annelida –Salient features-Type study-Earthworm,.

UNIT – III: Arthropoda-Salient features-Cockroach- Molluscs-Salient features Type study- Fresh water mussel- torsion in mollusca- Echinodermata-Salient features Asterias- Echinoderm larvae-their significance.

UNIT – IV: Origin and salient features of chordates. Agnatha - salient features-Type study-affinities Fishes- parental care ,respiratory organs, migration. Amphibians- Salient features - parental care

UNIT – V: Reptiles-Salient features, extinct reptiles, poisonous snakes of India. Birds-salient features flightless birds - adaptive radiation. Mammals. salient features brief account of monotremes, marsupials - Dentition in mammals.

## **PRACTICALS**

1. Examination of paramecium, amoeba, euglena.
2. Study of sycon, hylonema and spongilla from slides and specimens
3. Slides and specimens of hydra, obelia, aurelia, sea-anemone, 4. Slides and specimens of Fasciola and Taenia
5. Slides and specimens of ascaris
6. Cockroach – demonstration of digestive system and mounting of mouth parts
7. Prawn- demonstration and mounts: Mounts of Radula, ctenidium
8. Echinoderm -specimen study.
9. Amphibia- museum specimens.
10. Reptiles- museum specimens.
11. Aves-mounts and museum specimens.
12. Mammals- museum specimens

## **TEXT BOOKS:**

1. Ekambaranatha Ayyar.M,1973 A Manual of Zoology –Part –I, Invertebrata S.Viswanathan (Printers and Publishers)Pvt.Ltd.Madras.
2. Jordon, E.L and P.S .Verma ,1985, Invertebrate Zoology. S.Chand and Co. Ltd.New Delhi
3. Ekambaranatha Ayyar.M,1973, A Manual of Zoology –Part –I, Invertebrata S.Viswanathan(Printers and Publishers)Pvt.Ltd.Madras.
4. Jordon ,E.L and P.S .Verma ,1985, Invertebrate Zoology. S.Chand and Co. Ltd.New Delhi
5. Ekambaranatha Ayyar.M, 1973A Manual of Zoology Part II .Chordata S.Viswanathan Printers and publishers, Pvt.Ltd.,Madras
6. Young.J.Z, 1988. The Life of Vertebrates. Oxford at the clarendon press,London
7. Adam Sedgwick, 1960. A students Text Book of Zoology Vol.III. General Book Depot, Allahabad

## **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.

## Outcome Mapping

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CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**ANCILLARY-II**  
**19IZOA16: Ancillary Zoology Paper-II**

**LEARNING OBJECTIVES**

- To learn the cytological details of cells
- To learn anatomical details of human
- To learn the basic principles of genetics
- To learn the developmental process in frog
- To learn basic concepts of evolution

**Course outcomes**

At the end of the semester students shall be able to

- CO1: Identify various organelles and their functions
- CO2: Correlate developmental patterns in animals
- CO3: Understand evolutionary process taking place in biological world
- CO4: Analyse the anatomical details of human
- CO5: Critically evaluate genetic principles involved in multiple alleles and sex determination

**UNIT – I: Cell Biology**

**Introduction:** Microscopy and Cytological techniques.

**Animal cell - Ultra structure :** Plasma membrane - Nucleus - Mitochondria - Ribosomes - Endoplasmic reticulum - Lysosomes - Golgibodies - Centrosomes - Chromosomes.

**Cancer Biology:** Cancer definition - Types of cancer - Management of cancer-Radio therapy-Chemotherapy.

**UNIT – II: Human Anatomy**

**Human systems :** The integumentary - Skeletal - Muscular - Digestive - Respiratory - Circulatory - Lymphatic - Nervous – Sense organs - Endocrine - Excretory – Reproductive systems.

**UNIT – III: Genetics**

Introduction - Multiple alleles - Quantitative inheritance – Sex determination - Sex linked inheritance - Pleiotropy-Hardy Weinberg law- Population genetics.

## UNIT – IV: **Developmental Biology**

Introduction - Types of eggs - Cleavage and types - Frog's egg - Gastrulation in frog embryo - Organogenesis in frog-Development of eye and heart in frog.

## UNIT – V: **Origin of life**

Theories - Geological time scale - Fossils - Extinct animals – Mass extinction-Evidences for evolution-Comparative anatomy-Embryology- Physiology-Vestigial organs-Geographical distribution.

### **Practicals:**

1. Study of microscope-Light Microscope
2. Preparation of mitosis in onion root tip
3. Identification of blood group
4. Experiments on mendelian inheritance
5. Vital staining chick blastoderm
6. Study of animal adaptation

### **Text Books:**

1. Verma P.S and V. K. Agarwal 1/e Reprint 2002. Concept of Cell Biology, S. Chand and Company Ltd, Ram nagar, New Delhi - 110 055.
2. Verma P. S. and V. K. Agarwal Reprint 2003. Genetics, S. Chand and Company Ltd, Ram nagar, New Delhi - 110 055.
3. Ranganathan T. S. 6/e Rev. 2002. A Text book of Human Anatomy, S. Chand and Company Ltd, Ram nagar, New Delhi - 110 055.
4. Verma P. S. and V. K. Agarwal Reprint 2003. Chordate Embryology, S. Chand and Company Ltd, Ram nagar, New Delhi - 110 055.
5. Arumugam N. Reprint. 1999. A Text book of Embryology, Saras Publication A R P Camp Rd, Peria vilai, Kottar, Nagercoil - 629 002.
6. Verma P. S. and V. K. Agarwal Reprint 1999. Concept of Evolution, S. Chand and Company Ltd, Ram nagar, New Delhi - 110 055.
7. Arumugam N. 9/e.1999. Organic Evolution, Saras Publication A R P Camp Rd, Peria vilai, Kottar, Nagercoil - 629 002.

### **Reference Books**

- 1) Arnold Berk, Chris A. Kaiser and Harvey Ledish. 2016. Molecular Cell Biology. WH Freeman.
- 2) Sandeep Saxena. 2012. Animal Physiology. Oxford University Press.
- 3) Robert Tamarin. 2017. Principles of Genetics.. McGraw Hill.
- 4) Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias. 2015. Principles of Development. OUP, Oxford.

5) Kenneth Kardong. 2018. Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill.

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CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3

**ELECTIVE COURSES OFFERED TO THE STUDENTS OF OTHER DEPARTMENT  
IN VIII SEMESTER**

**19IZOOX815 : ANIMAL CULTURE TECHNIQUES**

**LEARNING OBJECTIVES**

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

**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

**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 breeding.

#### **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.

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**ELECTIVE COURSES OFFERED TO THE STUDENTS OF OTHER DEPARTMENT  
IN IX SEMESTER**

**19IZOOX915 : 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.

**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

**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, occurrence 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 hotspots 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.

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## VALUE ADDED COURSE

(Combini dly offered by Department of Physics and Zoology)

### 19IPHYX915.1: 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

#### 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

#### 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 electrophoresis, Poly Acrylamide. Gel Electrophoresis.

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, 5<sup>th</sup> Edition, Lea and Febiger.

#### **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	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3