PONDICHERRY UNIVERSITY
PUDUCHERRY

# M.Sc. Zoology

## (Choice Based Credit System - For Affiliated Colleges)

## Curriculum & Regulations

## (2022-2023 onwards)

**M.Sc. ZOOLOGY PROGRAMME**

**FOR AFFILIATED COLLEGES**

## 1. Aim

**To offer Postgraduate programme in Zoology under Choice Based Credit System (CBCS)**

## 2. Objectives

i. To understand the value of animal diversity and its relevance to the environment.
ii. To equip students to perform a level of higher competence in national and international organizations and competitive examinations.
iii. To inculcate entrepreneurial skills with special attention on aquaculture, value addition of marine food etc.
iv. To expose learners to frontiers and thrust areas of Zoology.
v. To offer courses on credit mode and enrich the quality of teaching-learning at higher education level.
vi. To encourage faculty to design and develop newer electives/ soft core courses.
vii. To enable students to make a choice between different streams of soft core/ elective courses.
viii. To facilitate credit transfer from courses offered through SWAYAM / MOOCs platforms.
ix. To acquire communication skill, interpersonal skill, technical skill, teamwork through co-curricular activities.

## 3. Programme Outcomes

i. Acquire the knowledge relating to classical and modern Zoology
ii. Analyse the concepts and mechanisms relevant to Zoology at cellular, biochemical and molecular levels to solve environmental and health problems.
iii. Equip to appear in competitive examinations and become teaching professionals
iv. Self-sustainable through self-employment and develop entrepreneurial skill in the fields of aquaculture, preservation and value addition of marine products etc.
v. Develop an attitude of more responsive and responsible individual towards the environmental needs.

**4. Eligibility**

Candidate for admission to M.Sc. Zoology shall be required to have passed B.Sc. Zoology/ Animal Sciences/ a course considered as equivalent to B.Sc. Zoology by Pondicherry University.

**5. Academic Year of the course implementation: 2022-23**

**6. Credit Based Curriculum**

**Credits:** CBCS defines different courses offered in a PG Programme in terms of Credits.

**Teacher Contact:** A Credit refers to the number of hours that a teacher contact is required per week for a given subject

**Classification of Courses:** Based on contents of syllabus and level of difficulty of Teaching – learning process, credits are assigned. For example,

| Credits | Nature of Course |
|---|---|
| 3 Credits Course | Generally, theory based courses for knowledge and skill in a core area/ laboratory based/ field study based subjects |

**6.1. Hard Core and Soft Core**

**Hard core:** Subjects which are basic and essential to a programme are called Hard Core (Compulsory) courses.

**Soft core:** Courses which are open for only a select group of students who opted for a specific specialization are called Soft Core/ Elective courses.

**Specialization:** Soft Core courses are designed and offered by a team of teachers of a programme based on their specialization. These also include related subjects available in MOOCs and SWAYAM platforms.

**6.2. Curricular Courses and Co-Curricular Activities**

**Curricular:** Curricular courses refer to all those subjects for which Credits assigned and taken into consideration for the calculation of CGPA and declaration of results. These courses include Hard Core course as well as Soft Core subjects. Regular classes will be conducted for all these subjects in a classroom.

**Co-Curricular:** Co-Curricular activities refer to such courses/activities that the students are expected to participate, but the credits earned are not included in the calculation of CGPA. These include participation in Skill development workshops, NSS/NCC and Sports activities, participation in awareness camps conducted in adopted

villages by the college. These also include completion of select courses through MOOCs/SWAYAM platforms.

### 6.3. Total Credits of a PG Programme in Zoology

The minimum number of credits that a student is expected to complete over a period of four semesters for M.Sc. Zoology is given below.

| Sl. No. | Programme | Hard Core | Soft Core | Total Credits |
|---|---|---|---|---|
| 1. | M.Sc. Zoology | 54 | 18 | 72 |

(Every Core subject is to be taught for prescribed number of hours. In addition to regular classroom teaching there should be at least 2 hours of Tutorials additionally. In case of Lab subject every 3 credit Lab requires 6 hours of Lab supervision. Accordingly, Teacher workload is to be calculated)

## 7. Course Design

**UGC Model Curriculum:** All Hard Core courses are compulsory courses and Soft Core courses are optional. All courses are designed and approved by PG Board of studies (BOS) incorporating UGC Model Curriculum/ NET/CSIR/Civil Services syllabus.

**Specialization subjects:** Twelve Soft Core Courses are designed based on Skill development/ ability enhancement and Career objectives of students. Field of specializations of existing faculty are also taken into consideration in designing Soft Core courses.

### 7.1. Typical Course Design (for 72 Credits)

The M.Sc. Zoology programme is designed as given below

**M.Sc. Zoology**
**Total hard core - 54 Credits**
**Total soft core - 18 Credits**
**Total - 72 Credits**

| 72 Credits | | | | | | | |
|---|---|---|---|---|---|---|---|
| **I semester** | | **II semester** | | **III semester** | | **IV semester** | |
| Hard Core Theory | 9 | Hard Core Theory | 9 | Hard Core Theory | 9 | Hard Core Theory | 6 |
| Hard Core Practical | 3 | Hard Core Practical | 3 | Hard Core Practical | 3 | Hard Core Practical | 3 |
| Soft Core | 6 | Soft Core | 6 | Soft Core | 6 | Project | 9 |
| **Total** | **18** | **Total** | **18** | **Total** | **18** | **Total** | **18** |

### 7.2. Breakup of Hard and Soft core

11 Hard Core Theory = 11 x 3 = 33 Credits

4 Hard Core Practical = 4 x 3 = 12 Credits

1 Hard Core Project = 1 x 9 = 9 Credits

6 Soft Core Theory = 6 x 3 = 18 Credits

**TOTAL = 72 Credits**

### 7.3. Co-curricular and Extracurricular courses

In addition to the above courses for 72 credits every student is expected to complete at least 6 credits worth of co-curricular courses during summer and winter vacation. The tentative list of co-curricular courses is as follows

| Sl. No. | Co-curricular courses | Credits |
|---|---|---|
| 1 | Skill Development/Soft skills workshops (one/two) (Min Duration : 15 days) | 2 |
| 2 | Innovations and Entrepreneurship Development Workshops Industry – Interface, Incubation and Start-Up Programmes (Training for 15 days) | 2 |
| 3 | Village Adoption/Awareness camps, SHG, Basic Literary Clubs (15 days) | 2 |
| 4 | NSS/NCC Camp/Swatch Bharat/ Traffic Maintenance Activities/ Government schemes (2 weeks) | 2 |
| 5 | Participation in Seminars / Conferences/ Inter collegiate Meets /Science Day Celebrations, etc (Any 4 events for 15 days) | 2 |
| 6 | Completion of any one/two MOOCS/ SWAYAM Courses (30 hours) | 2 |
| **Any 6 Credits** | | |

### 7.4 Course Completion certificate

A certificate of completion for each activity shall be submitted by the student and endorsed by the HOD/ Faculty Co-ordinator before the end semester examination.

## 8 Programme Committee

### 8.1 CBCS Implementation

Every PG Programme shall have a 'Programme Committee'. It facilities the implementation of CBCS. It supervises the academic activities of the department. A programme Committee meets at least two times in a semester.

### 8.2 Constitution of Programme Committee

All faculty members in the department who are offering Hard Core/Soft Core courses are the members of programme Committee. Two student representatives, one each from I year and II year based on their academic merit are also co-opted to represent the students' views on academic matters.

### 8.3 Principal's Nominee

Principal will nominate one faculty from sister departments of the same college, as his nominee.

### 8.4 HOD is the Chairman

HOD is the Chairman of the programme Committee. He keeps a record of minutes of meetings. Other records like allotment of Subjects, time table, schedule of internal assessment tests, question papers etc, are to be maintained by HOD.

### 8.5 Course Plan

Faculty are expected to prepare their course plan, number of sessions of teaching. Field projects/ Lab practical sessions etc., and place before programme Committee.

### 8.6 Credit Transfer

Credit transfer from open source courses, method of evaluation for internal assessment tests, etc. are to be finalized in programme Committee.

### 8.7 Department Activities

Decisions relating to conduct of special Lectures/ Seminars/Conferences/Workshops for the benefit of students, students meet, Science Day celebrations, alumni meet etc., and the requirement of funds for equipment, annual tours are to be finalised in a programme Committee meetings.

### 8.8 Soft Skill Workshop

Every PG department should make arrangements for organising skill-workshops for communication and development of soft skills, Industry Interface meets, Campus placement meets. Smart classrooms are to be created for open source courses, organise Village camps for awareness meets on Government schemes, Climate change, Environment Protection, Girl child, Right to Education. Gender sensitization, etc.,

### 8.9 Academic Clubs

Colleges should organize Research clubs, Technology clubs, Science Exhibitions, Innovation and Patent Workshops, Entrepreneurship Development etc.

### 8.10 Membership in Professional Bodies

The PG Department should join as member in all professional bodies and conduct at least one annual Seminar on contemporary topics by inviting experts from professional associations.

### 8.11 Workload documentations

All the faculty members are expected to maintain documents relating to number of sessions of teaching (45 hours of direct contact Hours for a 3 credit subject and 60 hours for a 4 credit subject) in every semester.

### 8.12 Students Attendance

Individual Faculty should also maintain the student's attendance for the sessions handled by them. A minimum 70% attendance is essential to allow a student to appear for the End Semester Examination (The same rule is applicable for every Internal Assessment test as well.) Students cannot register for subjects where they have shortage of attendance for end semester exam.

## 9 Evaluation

### 9.1 Total 100 marks

All curricular courses are evaluated for 100 marks. The Internal Assessment component is for 40 per cent and End Semester is for 60 per cent marks.

### 9.2 Breakup of Internal Assessment marks

Each theory and Practical course shall have the following breakup of Internal Assessment Marks

| | |
|---|---|
| Internal Assessment tests (2x15) | :30 Marks |
| Seminar/ assignment/ presentation/viva | :10 Marks |
| **Total** | **40 Marks** |

### 9.3 Internal Test Schedule

Internal Assessment Tests for all subjects in a given semester are expected to be conducted during a specific period. Program Committee prepares the Internal Assessment schedule.

a) First Test series is to be conducted in first week of September, 2nd Test series in the second week of October and in third week of November, End-Semester examinations begin.
b) In case of even semester (2nd, 4th) the first Internal Assessment test series is in the 2nd week of February and second Internal Assessment test series is in the 3rd week of March and the end Semester exam will be during fourth week of April.

c) Internal Assessment Tests shall be conducted for all the subjects in a particular week continuously for both first and second year students.
d) The faculty Co-Ordinator and HOD will coordinate the paper setting work, room arrangements, invigilation, etc.,

**9.4 Evaluation in one week**

The Internal Assessment test papers are to be evaluated within one week and feedback to be given to students. All test papers should be preserved until end semester exams are conducted.

**9.5 Minimum 40%**

The Passing Minimum for Internal Assessment tests is 40% of 40 Marks.

**9.6 Re-test Facility**:

A Re-test may be conducted for all those failed to secure 16 marks (40% of 40 Marks) in IA. No re-test will be allowed to those who are irregular, absent without any valid reason and without any prior approval from all concerned Faculty and HOD.

**9.7 Consolidated IA Marks**

A Programme Committee meeting (without student representatives) shall be conducted to approve the Internal Assessment marks awarded by all Teachers before submitting the same to the University.

**9.8 Passing Minimum – Aggregate 50 Marks**

The passing minimum in End Semester Examination is 40 per cent. However, a student should get 50 marks when Internal assessment and End semester marks are put together.

| | Maximum Marks | Minimum Marks 40% | Passing Minimum (Aggregate) |
|---|---|---|---|
| **Internal** | **40** | **16** | **50** |
| **External** | **60** | **24** | |
| **Total** | **100** | | |

## SCHEME OF THEORY QUESTION PAPER (END OF EACH SEMESTER)

Time: 3 hours. Maximum: 60 Marks

**SECTION – A (10 x 1 = 10 Marks)**
**Answer ALL questions, MCQ (4 choices)**
(Minimum two questions from each unit)

**SECTION – B (4 x 5 = 20 Marks)**
**(Answer ALL questions (Internal Choice), each in not more than 200 words**
(Minimum one question from each unit)

**SECTION – C (3 x 10 = 30 Marks)**
**Answer any THREE questions (out of 5 questions), each in not more than 1000 words**
(Minimum one question from each unit)

## SCHEME OF PRACTICAL EXAMINATION (END OF EACH SEMESTER)

Time: 3 Hours Maximum: 60 Marks

| | | |
|---|---|---|
| Question I | Major Practical Exercise (10+5) | - 15 |
| Questions II | Minor Practical Exercise (7+3) | - 10 |
| Questions III | Spotters (5×3) | - 15 |
| Question IV | Record | - 10 |
| Question V | Viva Voce | - 10 |

**TOTAL MARKS FOR PROJECT** **200 Marks**

| | | |
|---|---|---|
| **Internal** | : | 50 Marks |
| **External** | : | 100 Marks |
| **Viva-Voce** | : | 50 Marks |
| **Total** | : | **200 Marks** |

**The scheme of allotment for internal assessment marks**

| | | |
|---|---|---|
| Topic selection | : | 5 Marks |
| Experimentation/Data collection | : | 10 Marks |
| Punctuality | : | 5 Marks |
| Compilation | : | 10 Marks |
| Content | : | 10 Marks |
| Presentation | : | 10 Marks |
| **Total** | | **50 Marks** |

**M.Sc. ZOOLOGY**
**SCHEME OF PAPERS UNDER CBCS**

| Sl. No. | Course Code | Title of Paper | Nature | Hours per Week | Credits | Total Credits |
|---|---|---|---|---|---|---|
| **I Semester** | | | | | | |
| 1 | ZOOHC101 | Functional Anatomy of Invertebrates | Hard Core | 3 | 3 | 18 |
| 2 | ZOOHC102 | Comparative Anatomy of Chordates | Hard Core | 3 | 3 | |
| 3 | ZOOHC103 | Principles of Ecology | Hard Core | 3 | 3 | |
| 4 | ZOOSC104 | Soft Core | Soft Core | 3 | 3 | |
| 5 | ZOOSC105 | Soft Core | Soft Core | 3 | 3 | |
| 6 | ZOOHP106 | Practical - I. (ZOOHC101 - ZOOHC103) | Hard Core Lab | 6 | 3 | |
| **II Semester** | | | | | | |
| 7 | ZOOHC207 | Biomolecules and Structural Biology | Hard Core | 3 | 3 | 18 |
| 8 | ZOOHC208 | Cell and Molecular Biology | Hard Core | 3 | 3 | |
| 9 | ZOOHC209 | Animal Physiology and Endocrinology | Hard Core | 3 | 3 | |
| 10 | ZOOSC210 | Soft core | Soft Core | 3 | 3 | |
| 11 | ZOOSC211 | Soft Core | Soft Core | 3 | 3 | |
| 12 | ZOOHP212 | Practical – II (ZOOHC207 - ZOOHC209) | Hard Core Lab | 6 | 3 | |
| **III Semester** | | | | | | |
| 13 | ZOOHC313 | Genetics | Hard Core | 3 | 3 | 18 |
| 14 | ZOOHC314 | Developmental Biology | Hard Core | 3 | 3 | |
| 15 | ZOOHC315 | Immunology | Hard Core | 3 | 3 | |
| 16 | ZOOSC316 | Soft Core | Soft Core | 3 | 3 | |
| 17 | ZOOSC317 | Soft Core | Soft Core | 3 | 3 | |
| 18 | ZOOHP318 | Practical - III (ZOOHC313 - ZOOHC315) | Hard Core Lab | 6 | 3 | |
| **IV Semester** | | | | | | |
| 19 | ZOOHC419 | Biological Techniques and Bioinformatics | Hard Core | 3 | 3 | 18 |
| 20 | ZOOHC420 | Fisheries and Aquaculture | Hard Core | 3 | 3 | |
| 21 | ZOOHC421 | Project | Hard Core | 12 | 9 | |
| 22 | ZOOHP422 | Practical - IV (ZOOHC419 -ZOOHC420) | Hard Core Lab | 6 | 3 | |
| | | | | | **Total Credits** | **72** |

## SCHEME OF PAPERS AND MARKS ALLOTMENT

| Sl. No. | Paper Code | Title of Paper | Int. Mark | Ext. Mark | Total Marks |
|---|---|---|---|---|---|
| **I Semester** | | | | | |
| 1 | ZOOHC101 | Functional Anatomy of Invertebrates | 40 | 60 | 100 |
| 2 | ZOOHC102 | Comparative Anatomy of Chordates | 40 | 60 | 100 |
| 3 | ZOOHC103 | Principles of Ecology | 40 | 60 | 100 |
| 4 | ZOOSC104 | Soft Core | 40 | 60 | 100 |
| 5 | ZOOSC105 | Soft Core | 40 | 60 | 100 |
| 6 | ZOOHP106 | Practical - I. (ZOOHC101 - ZOOHC103) | 40 | 60 | 100 |
| **II Semester** | | | | | |
| 7 | ZOOHC207 | Biomolecules and Structural Biology | 40 | 60 | 100 |
| 8 | ZOOHC208 | Cell and Molecular Biology | 40 | 60 | 100 |
| 9 | ZOOHC209 | Animal Physiology and Endocrinology | 40 | 60 | 100 |
| 10 | ZOOSC210 | Soft core | 40 | 60 | 100 |
| 11 | ZOOSC211 | Soft Core | 40 | 60 | 100 |
| 12 | ZOOHP212 | Practical – II (ZOOHC207 - ZOOHC209) | 40 | 60 | 100 |
| **III Semester** | | | | | |
| 13 | ZOOHC313 | Genetics | 40 | 60 | 100 |
| 14 | ZOOHC314 | Developmental Biology | 40 | 60 | 100 |
| 15 | ZOOHC315 | Immunology | 40 | 60 | 100 |
| 16 | ZOOSC316 | Soft Core | 40 | 60 | 100 |
| 17 | ZOOSC317 | Soft Core | 40 | 60 | 100 |
| 18 | ZOOHP318 | Practical - III (ZOOHC313 - ZOOHC315) | 40 | 60 | 100 |
| **IV Semester** | | | | | |
| 19 | ZOOHC419 | Biological techniques and Bioinformatics | 40 | 60 | 100 |
| 20 | ZOOHC420 | Fisheries and Aquaculture | 40 | 60 | 100 |
| 21 | ZOOPW421 | Project | 50 | 150 | 200 |
| 22 | ZOOHP422 | Practical - IV (ZOOHC419 -ZOOHC420) | 40 | 60 | 100 |
| | | **Total** | **890** | **1410** | **2300** |

**I Semester**

**Code: ZOOHC101- FUNCTIONAL ANATOMY OF INVERTEBRATES**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To enlighten the principle and practice of taxonomy and systematics of animals.
2. To illuminate the students with adequate scientific details on lower and higher invertebrate organizations and their adaptations.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- understand the various rules and laws adopted in nomenclature of animals and the recent advancements in taxonomy.
- know about the basic pattern of animal organizations and their peculiarities
- develop understanding how animals changed from unicellular to multicellular body plan.
- understand the structural modifications and functions of invertebrate fauna.

**UNIT I Introduction to Taxonomy** **10 Hours**

International Code of Zoological Nomenclature, Tautonyms, Synonyms and Homonyms; species concept, clades; Classification: morphological and evolutionary (molecular). Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity; 3 domain classification. Trends in taxonomy - Chemotaxonomy, cytotaxonomy and molecular taxonomy, dendrogram.

**UNIT II Locomotion and Nutrition** **12 Hours**

Origin of Metazoa; Types of symmetry; Origin of Bilateria; Organization of coelom: types and significance; Locomotion: amoeboid, flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Nematoda, Annelida and Echinodermata; Nutrition and Digestion: Feeding and digestion in lower Metazoa; Filter feeding in Annelida, Mollusca and Echinodermata.

**UNIT III Respiration and Excretion** **13 Hours**

Respiration: Respiratory organs- gills, trachea, book lungs, book gills; Respiratory pigments; Mechanism of respiration; Excretion and Osmoregulation: Contractile vacuoles, Renette cell, chloragogen cells, coelom, coelomoducts, proto-nephridia, metanephridia, green glands, coxal glands, Malpighian tubules, organ of Bojanus; Mechanism of excretion.

**UNIT IV Nervous system and Minor Phyla** **10 Hours**

Nervous system: Primitive- Coelenterata and Echinodermata; Advanced – Annelida, Arthropoda and Mollusca. Larval forms of free living and parasitic invertebrates and their evolutionary significance. Concept, general characters and significance of minor phyla; Concept and significance of connecting links in invertebrates.

**Recommended Books**


1. Barnes, R.D. 1987. Invertebrates Zoology, V edition. W.B. Saunders Co. Philadelphia.
2. Barrington, E.J.W. 1983. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
3. Brij Mohan Singh (2021) Structure and Function of Invertebrates. Akinik Publications, New Delhi.
4. Hyman, L.H. 1962. The Invertebrates. Vol, 2. McGraw Hill Co., New York.
5. Jordan E.L & Verma, P.S. 2018. Invertebrate Zoology. S. Chand Publications. New Delhi
6. Kapoor, V.C.2010. Theory and Practice of Animal Taxonomy. Oxford & IBH Pub. New Delhi
7. Kotpal R.L.2016. Modern Textbook of Invertebrates. Rastogi Publications, New Delhi
8. Richard C. Brusca, Wendy Moore, Stephen M. Shuster (2021) Invertebrates. Sinauer Associates is an imprint of Oxford University Press;
9. Russel-Hunter, W.D. 1962.A Biology of higher Invertebrates, the Macmillan Co. Ltd., London.
10. Sedgwick, A. 2000. Student Text Book of Zoology. Vol. I, II and III. Low Price Publication, New Delhi.
11. Simpson, G.G. 1990. Principles of Animal Taxonomy. Columbia University Press, New York, United States.

**I Semester**

**Code: ZOOHC102 – COMPARATIVE ANATOMY OF CHORDATES**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To enlighten the principle and practice of taxonomy and systematics of chordates
2. To comprehend the origin and diversity of proto-chordates and vertebrates.
3. To learn the salient features, evolution, comparative anatomy and adaptations of vertebrates.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- understand the diversity and distribution of animals
- understand the relevance of proto-chordates in evolution
- appreciate establishment of structures meant for their adaptations
- understand the comparative anatomy of chordates.

**UNIT I Morphology and Integument** **13 Hours**

General characteristics and classification of chordates; Origin of chordates; Concept of Protochordata; Origin of vertebrates; Vertebrate morphology: *Mullet, Rana and Varanus.* Integument and its derivatives: Development, structure and functions of skin; scales, feathers, hair, beaks, claws, nails, horns, antlers, hoofs, antlers and glands.

**UNIT II** Skeleton **and Circulation** **11 Hours**

Form and function of axial and appendicular skeleton of vertebrates; Jaw suspension; General plan of circulatory system, blood in various vertebrates; Evolution of heart, aortic arches and portal systems.

**UNIT III Respiration and Excretion** **10 Hours**

Characters of respiratory tissue; Structure and mechanism of respiratory organs of vertebrates; Accessary respiratory organs of vertebrates. Evolution of kidney of vertebrates; Structure of urino-genital system of vertebrates

**UNIT IV Neural and Sensory organs** **11 Hours**

Characters of nervous tissue; comparative anatomy of brain and spinal cord of vertebrates; Cranial and spinal nerves; Peripheral and autonomous nervous system. Simple receptors, organs of olfaction and gustatory, lateral line system, electroreception.

**Recommended Books**


1. Alexander, R.M. 1998. The Chordates – Cambridge University press, London.
2. Arnold G.K and Frye.B.E. 1977. Chordate Structure and Function. Second edition. Macmillan Pub Co, UK.
3. Ekambaranatha Ayyer and Ananthakrishnan. 2008. Manual of Zoology - Chordata. Volume II. S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai
4. John Zachary Young, 2001. The Life of Vertebrates, Oxford University Press, New Delhi
5. Jordan E. L and Verma, P.S. 2016. Chordate Zoology. S. Chand publications. New Delhi
6. Kenneth V. Kardong, 2015. Vertebrates: Comparative Anatomy, Function, Evolution 7$^{th}$Edition.Tata McGraw Hill Education Pvt. Ltd. New York.
7. Kotpal R.L.2014. Modern Textbook of Zoology. Rastogi Publications. New Delhi
8. Romer, A.S., 1979. Hyman's Comparative Vertebrate Anatomy, 3rd Edition, The University of Chicago Press, London.
9. Virender Tomar, 2012, Anatomy of Vertebrates, Sonali Publications. New Delhi.
10. Weischert, C.K., 1965. Anatomy of Chordates, McGraw Hill Book Co., Inc., NewYork.

**I Semester**

**Code: ZOOHC103 - PRINCIPLES OF ECOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To learn the concept of biosphere and interactions between species and their environments
2. To invest knowledge on the components of ecosystem and concept of habitat and niche
3. To understand population ecology and animal interactions.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- understand the significance of scientific study of ecology
- analyse complex interactions among the various animals of different phyla
- understand the concepts of ecosystem and species interactions

**Unit I Introduction to Ecology** **10 Hours**

Concept of Biosphere; Gaia Hypothesis; Biome: Definition, Ecological features of Tundra, Desert, Savannah and Tropical Rain forest; Laws of limiting factors; Recycling of nutrients: C, N, P & S; Concept of habitat and niche: niche width and overlap, fundamental and realized niche, resource partitioning.

**Unit II Ecosystem** **12 Hours**

Ecosystem: structure and function; energy flow and primary production and secondary production; Food chain: Linear and Y-shaped; Food web; Energy flow through the ecosystem, Ecological pyramids; Ecological efficiencies; Concept of ecosystem services: Ecological, economic, social, ethical, aesthetic and informational values. Environmental movements: Bishnois. Chipko, Silent valley, Big dam.

**Unit III Population Ecology** **11 Hours**

Concepts of Population: Unitary and Modular populations; Unique and group attributes of population; Exponential and logistic growth, r and k strategies; Population regulation - density-dependent and independent factors. Life history strategies: reproductive effort, offspring size and cost-benefit ratio.

**Unit IV Community Ecology** **12 Hours**

Community characteristics; vertical stratification, Ecotone and edge effect; Ecological succession: Theories pertaining to climax community. Types of interaction: Positive interactions: commensalism, proto-cooperation, and mutualism. Negative interactions:

parasitism and allelopathy; Gause's Principle; Lotka-Volterra equation for competition and Predation.

**Recommended Books**


1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc. USA.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings San Francisco, USA.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert E. Ricklefs and Gary L. Miller (1999). Ecology. W.H.Freeman & Co Ltd. New York.
5. Robert Leo Smith, Thomas M. Smith., (2000). Ecology and Field Biology Benjamin Cummings, San Francisco, USA.
6. Peter D Stiling. (1995). Ecology: Theories and Applications. Pearson Education, London.
7. Smith, R.L.(1986). Elements of Ecology. Harpet and Row Publishers, New York

**I Semester**
**ZOOHP106 -PRACTICAL I**
**(Papers covered ZOOHC101 - ZOOHC103)**

**6 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To familiarize with museum specimens of invertebrates and chordates
2. To Demonstrate the respiratory structures of animals
3. To understand the bones and integumentary structures of vertebrates

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- have hands on experience of dissecting invertebrates and chordates
- perform laboratory procedures in taxonomy, biomolecules and structural biology
- identify the invertebrate, chordate and vertebrate animals/specimens
- appreciate the diversity of animals and their structural peculiarities
- recognize the types of mouth parts and integuments of different animals

**Invertebrata**

1. Study of water balance in Paramecium PC based (Demo).
2. Observation and identification of microscopic slides. Models of coelom, gills, booklungs, trachea, gill books, nephridia, malpighian tubules and nerve cells.
3. Observation and identification of larval forms of free living and parasitic invertebrates.
4. Observation and identification of parasites.
5. Study of museum specimens related to theory.
6. Mounting of mouthparts of mosquito/cockroach/ Radula/ Body Setae of Earthworm.
7. Identification, collection and submission of any 5 economically important insects.

**Chordata**

8. Osteology – skull, lower jaw and vertebrae.
9. Observation and identification of microscopic slide and museum specimen related to chordates.
10. Mounting of olfactory rosette in a fish.
11. Mounting of different types of scales of fishes and feathers of birds.

**Animal Ecology and Ethology**

12. Estimation of dissolved oxygen by Winkler's method.
13. Estimation of dissolved carbondioxide
14. Estimation of Salinity
15. Observation of animal association – Intra and Inter-relationship among animals.
16. Observation of population growth pattern of Drosophila in the laboratory.
17. Observation of bee hive/bird nest/ termitorium/ male to male aggregation.

**II Semester**

**Code: ZOOHC207 BIOMOLECULES AND STRUCTURAL BIOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To gain knowledge on biomolecules and their role in living system.
2. To understand the functions of biomolecules in a cell.
3. To learn various metabolic pathways in living system.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- realize the structural and functional properties of biomolecules and metabolic pathways.
- understand the various types of metabolism and energetics in relation to biology
- acquire knowledge about the classification and the role of enzymes in metabolism

**Unit I Basics of Biomolecules** **12 Hours**

Biomolecules and their role in biological system; Chemical bonds; Structure, classification and properties of carbohydrates; Structure and classification of amino acids; Uncommon amino acids; Structure, classification and properties of proteins; Ramachandran Plot, Role of Chaparones; Denaturation and renaturation of proteins.

**Unit II Lipids and Nucleic acids** **12 Hours**

Structure, classification and properties of lipids. Classification of fatty acids -saturated and unsaturated; Triglycerides, Phospholipids, Sphingolipids, Cholesterol. Nucleic acids: composition; Structure of DNA; A, B and Z DNA; Types of RNA.

**Unit III Enzymes** **10 Hours**

Classification and properties of enzymes; Mechanism of enzyme action and inhibitors of enzymes; Role of vitamins and cofactors on enzymes; Kinetics: Michaelis-Menten equation and Lineweaver-Burk plots; Ribozymes and concept of abzymes.

**Unit IV Metabolism** **11 Hours**

Glycolysis, Citric acid cycle, oxidative phosphorylation and their interrelationship; Glycogenesis, Glycogenolysis, Gluconeogenesis, hexose monophosphate shunt; Catabolism of amino acids: Transamination, Deamination, Urea Cycle; Biosynthesis and oxidation of fatty acids.

**Recommended Books**


1. Ambika Shanmugam.2016. Fundamentals of Biochemistry for Medical Students: Indian Edition. Lippincott Williams & Wilkins. Philadelphia.
2. David L. Nelson and Michael Cox. 2021. Lehninger Principles of Biochemistry: International Edition., W.H.Freeman & Co Ltd. New York.
3. Freifelder, D. 1996. Physical Biochemistry W.H. Freeman & Co Ltd., US
4. Garret, R.H. and C.M. Grisham.2004. Biochemistry. Saunders College Publishers. US
5. Jain; J.L Sunjay Jain and Nitin Jain 2016. Fundamentals of Biochemistry. S. Chand Publication, New Delhi.
6. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. 2010.Biochemistry. W.H. Freeman & Co Ltd., US
7. Malacinski, G.M. 2008. Freifelder's Essentials of Molecular Biology. Jones and Bartlett Publishers. US
8. Thomas.E. Creighton, 2010. Protein Structure and Molecular Properties W.H. Freeman &Co. Ltd., US
9. Vanholde & Johnson. 2005. Principles of Physical Biochemistry: International Edition. Pearson Education India.
10. Voet, D. and J.G. Voet. 2010. Biochemistry, John Wiley & Sons. Hoboken.

**II Semester**
**Code: ZOOHC208- CELL AND MOLECULAR BIOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To learn the structural and functional details of the basic unit of life at the molecular level.
2. To study the molecular basis of cellular interactions, energy transformation, regulation and control of genes, cell cycle and information transfer.
3. To understand the role oncogenes and its abnormalities.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- appreciate the structural organization and functions of cell organelles
- understand the cell cycle, interactions and signaling
- learn about central dogma, DNA repair
- enrich the knowledge on cancer and its expression

**Unit I Cell Membrane and Cytoskeleton** **10 Hours**

Cell membrane organization: Structure and functions of membrane proteins; Integral, peripheral and lipid-anchored membrane proteins; Junctional complexes and CAMs; Receptor mobility and clustering in the lipid bilayer; Cellular trafficking. Cytoskeleton: composition and functions; Microtubules vs Actin - their organization, association with membrane.

**Unit II Organization of DNA and Cell Cycle** **10 Hours**

Structural organization of eukaryotic DNA and genes: Operon, unique and repetitive DNA, interrupted genes, gene families, and transposons; Cell division, Cell cycle, check points and their regulation; Cell signalling – types; Role of growth factors on cell cycle.

**Unit III Central Dogma** **13 Hours**

Concept of central dogma; DNA Replication in eukaryotes: genomic, centromeric, telomeric and mitochondrial; Transcription in eukaryotes; Post-transcriptional modifications and inhibitors of transcription; Genetic code; Translation, Post translational modification of proteins, inhibitors of translation.

**Unit IV DNA Damage and Cancer** **12 Hours**

DNA-damage- agents; DNA repair: Nucleotide excision repair, Mismatch repair, Recombination repair and Double strand break repair; Tumour Vs Cancer, Types of Cancer, Proto-oncogenes, oncogenes, tumour suppressor genes; Ageing and apoptosis.

**Recommended Books**


1. Avers. C.J., 1986. Cell Biology. Addison-Wesley Publishing Company.
2. Bruce Alberts, Dennis Bray, Julian Lewis, Keith Roberts, James D. Watson, 2017, Molecular Biology of the Cell, Garland Science, New York.
3. De Robertis, E.D.F. and De Robertis. E.M.F. (2001). Cell and Molecular Biology, B.I Publications Pvt Ltd, India.
4. George M Malacinski. 2015. Freifelder's Essentials of Molecular Biology, 4Th/Ed; Published by Jones & Bartlett, U.S.
5. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Hoboken.
6. Keith Wilson, John Walker.2010. Principles and Techniques of Biochemistry and Molecular Biology. (2010). Cambridge University Press.
7. Lodish, H., Berk A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, S.L.and Darnell, J. Molecular Cell Biology. (2004). W.H. Freeman & Co., New York.
8. Powar, C.B, 2002 Cell Biology. Himalaya Publishing House. Mumbai, India
9. Rasthogi, R.C. 2006, Cell and Molecular Biology, New Age International Publishers. New Delhi.
10. Verma, P.S. and Agarwal. 2004. Text book of Cell Biology. S. Chand Ltd. India

**II Semester**

**Code: ZOOHC209 ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To study the functioning of organ systems across the animal world
2. To understand nutrition, respiration, circulation, excretion and neural coordination of animals with reference to human
3. To acquire knowledge on endocrine glands and functions.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- understand and appreciate animal physiology.
- understand the physiological processes and organ systems of animals
- understand how these systems produce physiological responses.
- appreciate the system of control and coordination of animals
- acquire knowledge about the chemical co-ordination of life

**Unit I Digestion- Respiration** **12 Hours**

Digestion and absorption of carbohydrates, proteins and fats; Role of gastrointestinal hormones in digestion; Structure of skeletal muscle fibres; Neuro-muscular junction; Mechanism of skeletal contraction; Physiology of heart, cardiac cycle, neural and hormonal control of heart beat; ECG- principle and interpretation. Physiology of respiration; transport of oxygen and carbon di oxide; neural and chemical regulation of respiration.

**Unit II Excretion- Neural coordination** **11Hours**

Physiology of excretion in man; Regulation of water, electrolyte and acid – base balance. Factors influencing urine formation. Nerve impulse: Conduction and synaptic transmission; Central Nervous system: Autonomic and Peripheral nervous system; Sense organs: Vision, hearing and olfaction in mammals.

**Unit III Hormones and metabolism** **11 Hours**

Classification of hormones; Biosynthesis and secretion of peptide, amide and steroid hormones; Nature of hormone action; Hormone receptor and types; Hormonal regulation of carbohydrate, protein and lipid metabolism; Termination of hormone action.

**Unit IV Hormones and Reproduction** **11 Hours**

Biosynthesis of sex hormones; Role of androgens in male reproductive and sexual development; Role of sex hormones in female reproductive and sexual development- puberty, menstruation, pregnancy, parturition, lactation and menopause.

**Recommended Books**


1. Barrett. 2019. Ganong's Review of Medical Physiology. Mcgraw Hill, New York, US.
2. Christopher D. Moyes, patricia M. Schulte, 2016. Principles of Animal Physiology, Pearson Education.
3. Eckert, R and D. Randall, 2005. Animal physiology – Mechanisms and adaptations, CBS Publishers and Distributors Pvt Ltd, New Delhi.
4. Herkat, P.C. and Mathur, P.N.1976. Text Book of Animal Physiology. S. Chand Co. Pvt, Ltd., New Delhi.
5. Hoar, W.S.1991. General and Comparative Physiology. Prentice Hall ; New Delhi.
6. John. E. Hall and Arthur C. Guyton. 2020. Text book of Medical Physiology. Saunders Elsevier.
7. Knut Schmidt - Nielsen.2008. Animal Physiology: Adaptation and Environment. Cambridge University Press, New Delhi
8. Lauralle Sherwood, Human Physiology- 2015. From cells to Systems. Brooks/Cole, Cengage Learning, US.
9. Richard Hill, Gordon A. Wyse, Margaret Anderson 2021. Animal Physiology. Sinauer. Oxford University Press, Oxford.
10. Schmidt Neilsen, K.2007. Animal Physiology. Adaptation and Environment. Cambridge University Press, London. UK.
11. Verma, P.S. B S Tyagi, V K Agarwal, Animal Physiology. 2000. S. Chand, New Delhi, India.
12. Mac E.Hadley, 1997. Endocrinology. Pearson Education, Indian Reprint.
13. Turner, C.D. and J.T. Bangara. 1986. General endocrinology. Saunders International Student edition. Toppan Company Limited. Tokyo. Japan.
14. Berry, A.K. 2011, A Textbook of Endocrinology, Emkay publications. Delhi, India.
15. Franklyn F. Bolander, 2004, Molecular Endocrinology 3rd Edition, Elsevier, Netherlands.

**II Semester**

**Code: ZOOHP212 - PRACTICAL II**

**(Papers covered ZOOHC207 - ZOOHC209)**

**6 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To learn techniques involved in estimations
2. To understand various stages of cell division
3. To familiarize with ECG and blood parameters
4. To learn about the estimation of the physiological parameters of man
5. To study the architecture of endocrine glands

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- perform laboratory procedures in Biochemistry and Cell Biology
- assess biochemical parameters that regulate metabolism.
- acquire knowledge on endocrine functions

**Biomolecules and Structural Biology**

1. Estimation of serum glucose.
2. Estimation of serum protein.
3. Estimation of serum cholesterol.

**Cell and Molecular Biology**

4. Observation of cell and sub cellular organelles.
5. Measurement of cell dimensions.
6. Study of various stages of Mitosis in onion root tip.
7. Mounting of Polytene chromosome in Chironomous larva / Drosophila.

**Animal Physiology and Endocrinology**

8. Measurement of blood pressure – sphygmomanometer.
9. Estimation of haemoglobin content in the blood.
10. Differential count of WBC.
11. Recording and interpretation of ECG (Demo).
12. Quantitative estimation of ammonia/ urea/ uric acid/ creatine.
13. Study on enzyme activity – temperature/substrate concentration.
14. Study on oxygen consumption /salt loss or salt gain by fish.
15. Histological study of endocrine glands.
16. Dissect and display the endocrine glands in a fish

**III Semester**
**Code: ZOOHC313- GENETICS**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To understand the basic concept of genetics, Mendel's rule, principles and mechanisms of inheritance and sex determination in human beings.
2. To know the various genetic disorders and anomalies of chromosomes
3. To collect an in-depth understanding on the principles and techniques of recombinant DNA technology.

**COURSE OUTCOME**
**On successful completion of the course students will be able to**

- understand the concepts of genetics and its importance in human health
- understand the DNA structure and chromosomal assembly
- familiar with reasons for syndromes and malignancy
- learn the advancement of genetics and its applications for mankind

**Unit I Heredity and variation** **12 Hours**

Concept of heredity and variation; Classical and Modern concept of Gene: Cistron, muton, recon, alleles and split gene; Genomic imprinting, penetrance and expressivity, Phenocopy. Chromosomal theory of inheritance; Evolution of sex chromosomes; Maternal Inheritance; Mendelian and non- Mendelian traits in man.

**Unit II Linkage and inheritance** **11 Hours**

Linkage maps, lod score for linkage testing, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids; Polygenic inheritance, heritability and its measurements, Quantitative trait locus (QTL) mapping; vertical and horizontal gene transfer; Structural and numerical alterations of chromosomes; Haplodiploidy.

**Unit III Chromosomal abnormalities and Population genetics** **12 Hours**

Karyotype**;** Chromosomal abnormalities: translocation (Chronic Myeloid Leukemia) and deletion ("cry of cat" syndrome); gene mutation (sickle cell anemia); Sex chromosomes and their evolution, Concepts in Sex determination; Lyon's hypothesis; Population genetics: Hardy-Weinberg equilibrium; Factors affecting Hardy Weinberg equilibrium; Pedigree analysis.

**Unit IV Mutation** **10 hours**

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Mutagens, mutagenesis and carcinogenesis.

**Recommended Books**


1. Benjamin A. Pierce 2001. Genetics: A Conceptual Approach, W H Freeman Publishers, New York, US
2. Gardner, E. J.,Simmons, M.J. D.P. Snustad Principles of Genetics (2006).Wiley Publishers. UK.
3. Griffith AF 2003. An introduction to Genetic Analysis, - W H Freeman Publishers, New York, US
4. Hartle D.L. and Jones E.W. 2010. Genetics: Analysis of Genes and Genomes, Jones and Bartlett
5. Mange E.J. and Mange A.P. 1997. Human genetics, Rastogi Publications, Meerut.India
6. Peter Snustad, D Michael J. Simmons.2003. Principles of Genetics, – John Wiley & Sons, US
7. Veer Bala Rastogi. 2019. Genetics. Medtech Publishers, New Delhi.
8. Verma.P.S. and Agarwal. 2012. Genetics. S.Chand Ltd. New Delhi, India
9. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian. 2019. Concepts of Genetics 11th Edition. Pearson Education. USA

**III Semester**
**Code: ZOOHC314- DEVELOPMENTAL BIOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To study the structure, development and maturation of germ cells.
2. To understand the process of fertilization and development of embryo.
3. To introduce the concepts and process in developmental biology
4. To understand about the genetic mechanisms of organogenesis and to learn about the post embryonic development.

**COURSE OUTCOME**
**On successful completion of the course students will be able to**

- understand the biological process involved in the development.
- understand the intricate process of fertilization.
- appreciate the events involved in the interaction of gametes and embryogenesis
- understand the embryonic induction, development and post embryonic changes.

**Unit I Gametogenesis and early Development** **12 Hours**

Outlines of Potency, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; cytoplasmic determinants; Germ cell specification; Spermatogenesis: Spermatogenic waves; Spermiogenesis and spermiation; Oogenesis: follicle formation, development, selection, oocyte maturation and ovulation.

**Unit II Fertilization and embryogenesis** **11 Hours**

Fertilization: surface molecules in sperm-egg recognition in animals; sperm attraction; acrosome reaction, gamete fusion and prevention of polyspermy; amphimixis, activation of egg metabolism, rearrangement of egg cytoplasm; Cleavage: Types, Planes, and laws; Blastula of frog and mammal.

**Unit III Morphogenetic movements** **10 Hours**

Fate maps; Germ layer differentiation and tubulation. Morphogenetic movements: Epiboly, Emboly, Invagination, Ingression, Delamination; Gastrulation in Frog and Mammal; Axes formation in *Drosophila* and chick.

**Unit IV Induction and organogenesis** **12 Hours**

Organizer concept; Embryonic induction: primary and secondary; mechanism and regional specificity; Regeneration in vertebrates: Epimorphic, morphallactic and compensatory regeneration; Organogenesis – Brain and eye lens induction in vertebrates; Formation of extra embryonic membranes (Chick). Placentation – Types, structure and functions; Hormonal regulation of metamorphosis: insect and amphibian.

**Recommended Books**


1. Balinsky B.I.2012. An Introduction to Embryology, W.B. Saunders Co, Philadelphia
2. Berrill, N.J. 1986, Developmental Biology, TATA McGraw-Hill Publishing Company Ltd, New Delhi, India
3. Fred H. Wilt and Sarah C. Hake, 2001. Principles of Developmental Biology, W.W. Norton & Comp. Inc. New York.
4. Lewis Wolpert, 2012. Principles of Development, Oxford Univ. Press, US
5. Mary S. Tyler, 2000. Developmental Biology: A guide for experimental study, 2nd Edition, Sinauer Assoc. Inc. Sunderland, MA.
6. Richard M. Twyman, 2001. Instant notes on Developmental Biology, Springer Verlag, BIOS Scientific. England.
7. Scott F. Gilbert. 2017. Developmental Biology, 11th Edition, Sinauer Assoc. Inc. Sunderland, MA.
8. Slack J. M.W. 1992. 2nd Edition. From Egg to Embryo, Cambridge.
9. Slack J. M.W. 2003, Essential Developmental Biology, Blackwell, US.
10. Subramanian T, 2013. Molecular Developmental Biology. Narosa publishing House. New Delhi

**III Semester**
**Code: ZOOHC315-IMMUNOLOGY**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To provide a foundation in immunological processes
2. To provide knowledge on how the immune system works.
3. To help the students to understand the role of immunology in human health and well-being
4. To familiarize the students in the field of antigen and antibody types and interactions.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- distinguish various cell types involved in immune responses
- characterize antibody isotypes, development, and functions.
- understand the role of MHC in transplantation
- understand the concept of hypersensitivity and immunisation

**Unit I Introduction to Immune system** **10 Hours**
Ontogeny of the immune system; Types of immunity: innate and acquired; Components of immune system: Structural organization of primary and secondary lymphoid tissues; cells of immune system.

**Unit II Antigen and Antibody** **12 Hours**
Antigen: nature, properties and types; Antibody: structure, properties and types; Hybridoma and monoclonal antibodies; Antigen and antibody interactions; Major Histocompatibility Complex (MHC)- haplotypes; Types and mechanism of antigen presentation.

**Unit III Immune cells and immune response** **13 Hours**

T cell- types, maturation, activation, differentiation and receptors. B cell- maturation, activation, differentiation and receptors. Cell mediated and humoral immune response; Cytokines; Complement system- Classical and alternate pathway.

**Unit IV Immunity and Human Health** **10 Hours**
Hypersensitivity reactions: Types with examples. Autoimmunity and its disorders. Vaccines: Properties, types and immunization. Immuno-deficiency disorders- AIDS, SCID.

**Recommended Books**

1. Champion, M. D. and Cooke, A.1987. Advanced Immunology. J. B. Lippincott Ltd.,Philadelphia.
2. Coligan JE, Kruisbeek AM, Margulies DH, 1997, Current Protocols in Immunology, Wiley, New York, US.
3. Janeway,C.A and Travers,P. 1997. Immunobiology. Current Biology Ltd., London.

4. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen 2018. Kuby Immunology. WH.Freeman and Co., New York. US.
5. Kannan,I. 2007. Immunology. MJP Publishers, Chennai, India.
6. Paul, W.E.M.1989. Fundamentals of Immunobiology. Raven Press, New York, US.
7. Rao.C.V., 2005. Immunology. Narosa Publications. New Delhi, India.
8. Roitt, I.M.1994. Essential Immunology. Blackwell Scientific, Oxford, US.
9. Srivastava, R. Ram,B.P. & Tyle,P.1991. Molecular Mechanism of Immune Regulation. VCH Publishers, New York.
10. Stites, D.P., Terr,A.I. and Parsloio,T.G. 1997.Medical Immunology. Prentice Hall, New Jersey.US.

**III Semester**
**Code: ZOOHP318- PRACTICAL III**
**(Papers covered ZOOHC313 - ZOOHC315)**

**6 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To familiarize with karyotype and mutant forms
2. To understand the chromosomal abnormalities
3. To study the developmental stages of frog and chick
4. To familiarise with various lymphoid organs
5. To understand agglutination reaction

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- acquire knowledge on mutation
- understand the chromosomal abnormalities
- understand the developmental stages of frog and chick
- learn various blood groups of man

**Genetics**

1. Study of wild and mutant forms of *Drosophila melanogaster*
2. Preparation of Karyotype / ideogram of normal and syndromes (Human).
3. Identification of Barr body.
4. Estimation of frequency of genetic traits in human population.
5. Temporary mounting of polytene chromosome

**Developmental Biology**

5. Different stages in development - frog (egg, cleavage, blastula, gastrula and neural stages of Frog)
6. Observation of various stages in development - chick (18, 24, 33, 48, 72, 96 hours).
7. Vital staining of chick blastoderm.
8. Development of chick stage - slide showing C.S. of heart, kidney, lens and limb.

**Immunology**

9. Observation of lymphoid organs – Thymus, Spleen, Bone marrow, Tonsil, Lymph node.
10. Agglutination reaction of ABO and Rh blood groups.
11. Widal test.
12. Haem-agglutination - Quantitative analysis – haem-agglutination titration.
13. Preparation of Antigen - RBC - Demonstration.

**IV Semester**

**Code: ZOOHC419- BIOLOGICAL TECHNIQUES AND BIOINFORMATICS**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To learn about the basics of most often used tools, techniques, methodologies and methods of analysis used in biological research.
2. To know about the basic statistics, variables, primary and secondary data, different kinds of data, presentation of data in the form of diagrams and various types of statistical applications.
3. To characterize and manage the different types of Biological data.
4. To introduce the basics of sequence alignment and analysis

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- learn principles, mechanism and applications of instruments used in biological science
- gain knowledge on application of statistical tools
- utilize the databases that provide information on biomolecules.
- infer evolutionary relationships

**Unit I Microscopy and Histochemistry** **10 Hours**

Light, Phase Contrast, Fluorescence TEM and SEM principle and applications; Histology: histochemical techniques; Autoradiography.

**Unit II Quantification and Separation Techniques** **12 hours**

Principle of Centrifugation; Ultra-centrifugation; UV – Spectrophotometer; Flame photometry, Molecular separation: GLC and HPLC; Electrophoresis: PAGE; PCR; DNA Sequencing; Microarray; ELISA; Chromosome painting and FISH; tracer technique; RIA.

**Unit III Biostatistics** **12 Hours**

Data: Collection and graphical representations; Measures of central tendency and dispersion; Probability distributions- Normal Distribution; Standard error; levels of significance; Regression and probit analysis; correlation; students t-test; ANOVA, Chi square test; Evaluation of biodiversity indices; Shannon-Weiner index, Dominance index.

**Unit IV Bioinformatics** **11 Hours**

Biological database- types and tools; Sequence alignments: dot matrix, pairwise and multiple sequence; Phylogenetic analysis- MEGA, dendrogram; DNA barcoding; Genomics; Proteomics; Molecular modelling and drug designing.

**Recommended Books**


1. Arora P.N and Malhan P.K., 2007. Biostatistics – Himalaya publishers House, Mumbai. India.
2. Arthur Lesk, 2014, Introduction to Bioinformatics, OUP Oxford.US.
3. David W. Mount, 2001. Bioinformatics-Sequence and Genome Analysis- CSHL Press, USA.
4. Gurumani, N. 2005. An Introduction to Biostatistics 2nd Ed., MJP Publishers, Chennai, India .
5. Lehninger A. L. Biochemistry 2nd Edition., Kalyani publishers, New Delhi, India.
6. Sharma, A.K., 2005. Text book of Biostatistics, Discovery Publishers House, New Delhi, India.
7. Upadhay and Upadhay, 2009. Biophysical chemistry- principles and techniques. Himalaya publishing House. India.
8. Wilson and Walker.2001. Practical biochemistry- Cambridge University Press, Low Price Edition. India
9. Zar. 2014.Biostatistical Analysis. Pearson Education Limited, India

**IV Semester**
**Code: ZOOHC420 - FISHERIES AND AQUACULTURE**

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To acquire the basic knowledge on biology of fishes
2. To gain in-depth knowledge on capture and culture fisheries of India and World
3. To learn the basic aspects of fish pond construction and management.
4. To understand the role of various institutions of India
5. To acquire knowledge on fish and shellfish diseases, pathogens and their control measures.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- acquire the basic knowledge about the biology, morphometry and meristic characters of fishes.
- learn the status of the culture and capture fisheries of India
- learn the modern culture techniques and diseases management
- become entrepreneurs and create employments

**Unit I Fish Biology** **10 Hours**

Classification and basic anatomy of fish and shrimp; Morphometric and Meristic characters; Food and feeding habits; Population dynamics; Length and weight relationship; Age and growth determination; Reproductive cycles: fertility and fecundity.

**Unit II Capture fisheries** **12 Hours**

Status and scope of inland and marine capture fisheries; Riverine, estuarine, off-shore and deep sea fisheries; Migration; Fish tagging and marking; Major fisheries of India- oil sardine, mackerel and Bombay duck. Stock recruitment.

**Unit III Culture fisheries of India** **12 Hours**

Status and scope of aquaculture in India and on a global scale. Types of culture: Extensive, semi intensive and intensive systems of fish culture. Criteria for selection of fishes for culture. Culture practices of carps, sea bass and shrimp. Water quality, feeding and disease management in aquaculture. Bio-economic traits, genetics and induced breeding in fish and prawn.

**Unit IV Fishing technology and survey of fishery resources** **11 Hours**

Principal methods of exploitation of fishes; Indigenous and modern gears and crafts; Methods of surveying the fishery resources: acoustic and aerial methods; Role of Research institutions in fisheries and aquaculture: CMFRI, CIBA, MPEDA, CIFRI, CIFNET, CIFE, NIO, NBFGR, FSI, CIFT.

**Recommended Books**


1. Alikunhi, 1957. Fish culture in India. Indian Council of Agricultural Research. New Delhi,
2. Ayyapan,S J.K.Jena, A.Gopalakrishnan. and A.K. Pandey(Editors) ,2006. Hand book of fisheries and Aquaculture.Indian Council of Agricultural Research. New Delhi,
3. Francis Day.1883. Indian Fish and Fishing. William Clowes and Sons Ltd, London.
4. Jhingran, 1991. Fish and Fisheries of India - Hindustan Pub. Corpn. New Delhi,
5. Karl F. Lagler. 1977. Ichthyology 2nd edition.: Wiley Publication. New York, US.
6. Pillay, T.V.R. 2005. Aquaculture: Principles and practices. Wiley Publication, New York,
7. Rajendra Kumar Rath, 1993. Freshwater Aquaculture, Scientific publishers, Jodhpur,
8. Santhanam, R., N. Sukumar, P. Natarajan, 1990. A Manual of Fresh Water Aquaculture. Oxford & IBH Publications, New Delhi,
9. Shailendra Ghosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi.
10. Shanmugam. K 1992. Fishery Biology and Aquaculture, LEO Pathippagam. Chennai.

**IV Semester**
**Code: ZOOHC421- PROJECT**

**12 Hours/ Week** **9 Credits**

**OBJECTIVES**

1. To promote independent research.
2. To inculcate research aptitude and skills in using various biological tools and techniques
3. To develop skills to pursue application oriented research.
4. To investigate relevant issues and problems.
5. To develop concepts and to apply them in real-life situations.

**COURSE OUTCOME**

**On successful completion of the project students will be able to**

- demonstrate a sound knowledge on selected topic.
- undertake problem identification, assessment and solution.
- identify suitable solutions to problems utilizing a systems approach.
- communicate research outcomes in written and oral forms.
- undertake research as a profession.

**Regulations of Project Work**

1. Student can take up individual project course during the IV semester.
2. Students are guided to select projects of their interest in consultation with the respective supervisors.
3. The project work should be carried out from January to April. 2 days per week (12 hours) is allotted in the IV semester.
4. Periodically the project work should be reviewed (minimum three times) by the advisory committee constituted for this purpose which includes the faculty of the department alone.

**Submission of Project Report**

The Students should prepare two copies of the project work and submit the same to the department during the IV semester university practical examination for the evaluation by an external examiner. The length of the project may be 40-50 pages typed in double space. After evaluation, one copy to be retained in the department library.

**Evaluation of Project Report**

Two examiners (one external and one internal) will be evaluating the project report for 200 marks. External evaluation is for a maximum of 150 marks (including viva-voce) and internal evaluation is for a maximum of 50 marks. As per CBCS regulations, nine (9) credits are awarded for project work.

**Semester IV**
**Code: ZOOHP422 - PRACTICAL IV**
**(Papers covered ZOOHC419 & ZOOHC420)**

**6 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To learn various tools of biostatistics
2. To understand the construction of phylogenetic tree
3. To identify common edible fishes and learn about the aquaculture aspects of cultivable fishes
4. To identify various ichthyo-planktons and aquatic weeds

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- understand the applications of biostatistics
- gain knowledge on isolation techniques
- gain knowledge on common edible fishes and their identification
- acquire knowledge on food and feeding behaviour of fish

**Biological Techniques and Bioinformatics**

1. Calculation of Rf values of selected Amino acids by Paper Chromatography.
2. Fractionation of lipid profiles by TLC (Demonstration).
3. Electrophoretic separation of haemolymph/serum protein(Demonstration).
4. Estimation of sodium in water/serum samples.
5. Estimation of Potassium in water/serum samples.
6. Estimation of Magnesium/ Calcium in water/serum samples.
7. Calculation of Correlation Coefficient.
8. Regression Analysis.
9. Analysis of Variance (Single Way).
10. Students‘t’ test.
11. Chi square test.
12. Numerical problems related to Shannon Index/Dominance.
13. Web based tools for sequence Searches (nucleic Acid & Protein Sequence data base).
14. Phylogenetic tree construction.
15. Usage of statistical package- SPSS.

**Fisheries & Aquaculture**

16. Observation of common edible fin and shell fishes.
17. Identification of aquatic weeds.
18. Observation of ichthyoplanktons.
19. Analysis of gut/stomach content in a fish.
20. Observation of fish parasites.
21. Mounting of scales in fishes.
22. Morphometric and meristic characteristics in fishes.
23. Fish or prawn farm visit.
24. Demonstration of hypophysation technique

# List of Soft Core Papers

## 1. EVOLUTION AND BEHAVIOUR

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To understand basic concepts and mechanisms of evolution
2. To explain the natural behaviour patterns, how the behaviour varies among individuals and species
3. To expose to the basics of behavioural studies

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Realize the complexity of evolutionary processes, speciation
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Evaluate behaviour of all animals, including humans, in the complex world

**Unit I Concepts of Evolution** **10 Hours**

Theories of evolution; Abiotic synthesis of organic monomers and polymers; Oparin and Haldane hypothesis; Experiment of Miller; Origin of cell; Origin of eukaryotic cells.

**Unit II Evolutionary Mechanisms** **10 Hours**

Theory of natural selection; Spontaneity of mutations; Role of mutation in evolution; Patterns of evolution; Mimicry and adaptive colouration; isolation mechanisms, Variation; Speciation: allopatric and sympatric speciation; Co-evolution.

**Unit III Development of Behaviour** **12 Hours**

Approaches and methods in study of behaviour; Proximate and ultimate causation; Altruism and evolution; Group selection; Kin selection; Reciprocal altruism; Learning and Memory: habituation instinct; conditioning: classical, operant.

**Unit IV Biological Clocks and Social Behaviour** **13 Hours**

Biological rhythms: Circadian, circannual rhythms; Development of behaviour; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behaviour; Habitat selection and optimality in foraging.

**Recommended Books**


1. Alcock, J. (2005) Animal Behaviour (8th edition) Sinauer Associate Inc., USA.
2. Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., 2007, Evolution, Cold Spring Harbor Laboratory Press, New York, USA
3. Dunlap, J. C.; Loros, J.J. and DeCoursey, P. J. (2009) Chronobiology Biological edition) Cambridge, University Press, UK
4. Edward Ottaway Dodson, 1976. Evolution: Process and Product. Van Nostrand Reinhold Company.New York, USA.
5. Ernst Mayr, 2001. What Evolution Is, Basic Books, New York, USA
6. Futuyma, D. J., Evolution, Sinauer Associates, Inc., Sunderland, USA
7. Kumar, V. (2002). Biological Rhythms: Narosa Publishing House, Delhi/ Springer London, UK.
8. Manning, A. and Dawkins, M. S. (2012) An Introduction to Animal Behaviour (6th
9. McFarland, D. (1999) Animal Behaviour (3rd edition) Pitman Publishing Limited,
10. Sherman, P. W. and Alcock, J. (2013) Exploring Animal Behaviour (6th edition)
11. Sinauer Associate Inc., Massachusetts, USA.
12. Theodosius Dobzhansky, Francisco J. Ayala, G. Ledyard Stebbins, James W. Valentine., 1977, Evolution, W.H. Freeman & Company, USA.
13. Timekeeping (1st edition) Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

## 2. GENETIC ENGINEERING AND BIOTECHNOLOGY

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To give an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way.
2. To envisage concepts, mechanisms, biological designs, functions and significance of genetic modification or manipulation
3. To discusses the advances in recombinant DNA technology.

**COURSE OUTCOME**

**After successfully completing this course, the students will be able to**

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through application oriented topics
- Develops future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

**UNIT I Introduction to Genetic Engineering** **12 Hours**

Scope; Tools of Genetic Engineering: Restriction Enzymes, DNA Polymerase, DNA-ligase, Taq polymerase, Reverse Transcriptase, RNA polymerases; Vehicles for DNA cloning: Plasmid DNA vectors, bacteriophage lambda derived vectors.

**UNIT II Cloning and Expression** **13Hours**

Molecular cloning of DNA fragments in bacteria; cDNA library, genomic library; Screening and identification of recombinant DNA clone from gene library. Expression of recombinant protein in bacteria; Recombinant proteins: Insulin, Streptokinase, vaccines; Animal cloning.

**UNIT III Techniques in Biotechnology** **10 Hours**

Polymerase Chain Reaction; Site-directed mutagenesis; Transgenic animals; Gene Targeting: Knock-ins and Knock-outs. Cybrids; cryopreservation; Role of DNA markers: RFLPs, RAPD STS, EST, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism);

**UNIT IV Applications of Genetic Engineering** **10 Hours**

Human Genome Project and Human Genome Sequences; Applications of Genetic Engineering and Biotechnology in fishery, poultry and medicine; IPR and ethical issues in biotechnology.

**Recommended Books**


1. A PBS Documentary entitled, “Playing God” [History of Genetic Engineering]
2. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
3. Gupta, P.K. 2007 Elements of Biotechnology: Rastogi and Co. Meerut,
4. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
5. Primrose, S.B. 2001 Molecular Biotechnology (2nd Edn.) Blackwell Scientific Publishers, Oxford,
6. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.
7. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.

## 3. BIOLOGICAL CONTROL OF PESTS

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To grasp the basics of natural enemies
2. To understand the scope of biological control
3. To understand the basics of various biocontrol organisms
4. To learn the mass production techniques

**COURSE OUTCOME**

- After successfully completing this course, the students will be able to:
- Acquire knowledge on natural enemies of crop pests
- Identify various biocontrol organisms
- Utilize the knowledge of mass production of biocontrol organisms and control of crop pests

**UNIT I Biology of common pests** **11 Hours**

Common natural enemies of crop pests; Aphids, scales, lepidopteran and coleopteran pests; nature of damage, life history and population dynamics.

**UNIT II Introduction to biocontrol** **11 Hours**

Scope of biological control; important groups of parasitoids, predators and pathogens; classical biological control- importation, augmentation and conservation.

**UNIT III Biocontrol organisms** **11 Hours**

Biology, adaptation, host seeking behaviour of predatory and parasitic insects; Insect pathogens: viruses, bacteria, fungi, protozoa, nematodes and their pathogenesis.

**UNIT IV Culture and ranching** **12 Hours**

Mass production of parasitoids, predators and microbes: techniques, formulations, economics, field release/application and evaluation; Trends and future possibilities of biological control

**Recommended Books**

1. Burges HD & Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London. De Bach P. 1964.
2. Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
3. Dhaliwal GS & Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
4. Gerson H & Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman & Hall, New York.

5. Huffaker CB & Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
6. Ignacimuthu SS & Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.

## 4. HUMAN HEALTH AND DISEASES

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To understand the importance of health
2. To understand the transmission of diseases and loss of health.
3. To study various diseases, causes, mode of transmission, symptoms of diseases and their control.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Acquire knowledge of the diseases outbreak
- Acquire knowledge on communicable and non-communicable diseases of man
- Understand the seriousness of disease outbreaks
- Learn about good living and occupational hazards

**UNIT I Introduction to health and disease** **12 Hours**

Concept of health**;** Importance of health in the current scenario; Role of WHO in public health; Concept of disease; Disease outbreaks: epidemics; endemics and pandemics; health emergencies including COVID-19

**UNIT II Communicable diseases and remedial measures** **12 Hours**

Water borne diseases: cholera, polio, jaundice; Air borne diseases: Chicken pox, tuberculosis; Vector borne diseases: malaria, filaria, chikungunya, dengue;

**UNIT III Non-Communicable diseases and remedial measures** **11 Hours**

Cancer, diabetes, obesity, blood pressure, Coronary Heart Diseases

**UNIT IV Sexually Transmitted Diseases and remedial measures** **10 Hours**

Syphilis, gonorrhoea, trichomoniasis, papilloma virus, AIDS.

**Recommended Books**

1. Charles M. D. Porter, 2016, Elements of Hygiene and Public Health a Textbook for Students and Practitioners of Medicine, Wentworth Press
2. Dunn, CL and D. D. Pandya, 2013, Indian Hygiene and Public Health Butterworth and Company.
3. George Moses Price, 2017, Hygiene and Public Health (Classic Reprint), Fb&c Limited.

4. Modi, J.P. 2015, Elements of Hygiene and Public health, Butterworth and Company.
5. Park M. Park's Textbook of Preventive and Social Medicine, 2015, M/s Banarsi Das Bhanot Publishers.
6. Roger. Detels 2009. Oxford Textbook of Public Health, Oxford University Press. UK
7. William Hallock 1863 – 1939 Park Public, Health and Hygiene (English, Paperback) Wentworth Press.
8. William Hobson, 2006. Theory and practice of Public Health. Oxford Medical Publishers. UK
9. William Hobson, 2006. Theory and Practice of Public Health. Oxford Medical Publishers. UK

## 5. BIODIVERSITY CONSERVATION AND SUSTAINABLE DEVELOPMENT

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To create environmental awareness among learners.
2. To enlighten the importance of bio diversity
3. To provide information regarding the status of environment, the depletion of its resources, the loss of biodiversity and the remedial measures undertaken
4. To create awareness about sustainable development

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Understand the consequences of bio-diversity loss
- Develop understanding for the environment which is largely degraded in the current scenario.
- Learn about the judicious utilisation of natural resources
- Adopt eco-friendly practices and other prospects of environment protection and sustainable development

**UNIT I Biodiversity** **10 Hours**

Concept**;** Types; Values; Threats; Hotspots, Protected areas; Invasive species; Effects of loss of Bio-Diversity; red data book; Extinction of Species: Types- natural, mass, anthropogenic.

**UNIT II Causes of Extinction** **11 Hours**

"The Evil Quartet"- habitat loss, fragmentation, over-exploitation, alien species invasion; Extinction through geological time scale: mass extinction and impact on flora and fauna- Current extinction trends- rarity and endangered species; Consequences of Extinction of Species;

**UNIT III Conservation of Biodiversity** **12 Hours**

Global conservation efforts- Earth Summit; UNESCO, Project Tiger, Biosphere reserves, *In situ* and *ex situ* conservation. IUCN, WWF, IBWL, BNHS, UNEP, UNDP; Contour farming, reforestation; Green technologies, Eco-cities; Social and Joint forestry.

**UNIT IV Sustainable Development** **12 Hours**

Concept; Role of Government; NGOs; Environmental movements; International treaties and conventions; organizations, International efforts (Vienna Convention, Montreal Protocol, UNFCCC, Kyoto Protocol, Copenhagen Summit, etc.; IPCC; Environmental laws and acts; National Environmental Policy; NBAGR, ZSI, WWF, IUCN, Ramsar Convention.

**Recommended Books**


1. Andrew S. Pullin, Conservation Biology. 2002., Cambridge University Press, UK.
2. Chapman, J.L. and Reiss, M.J. (1999). Ecology: Principles and applications (2nd edition) Cambridge University Press.
3. Fred Van Dyke, 2008, Conservation Biology: Foundations, Concepts, Applications. McGraw-Hill Science/Engineering/Math, New York, USA.
4. Ghosh, S.K. and Singh, R. (2003). Social forestry and Forest Management. Global Vision Pub.
5. Joseph, B. (2008) Environmental studies, Tata McGraw Hill.
6. Martha J. Groom, Gary K. Meffe, C. Ronald Carroll, 2012, Principles of Conservation Biology, Sinauer Associates. Oxford University Press, USA.
7. Miller, G.T. (2002). Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
8. Richard B. Primack, 2016, An Introduction to Conservation Biology, Sinauer Associates. Oxford University Press, USA.
9. Wagher, R.H. (1974) Environment and Man. (Second Edition), Norton, New York.
10. Wilson, E.O. (1986) Biodiversity, Academic press Washington

## 6. GLOBAL ENVIRONMENTAL ISSUES

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To understand the fundamental issues of environment.
2. To analyse different sources of environmental problems and methods of measurement of pollution.
3. To evaluate the economy of quality of life.
4. To learn the management of pollution and environmental laws

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- explain the scientific basis of the global environmental issues.
- discuss on various measures of pollution mitigation
- realize the laws and acts of environment in India

**Unit I Basic concepts and issues** **11 Hours**

Global environmental problems: Climate Change, UV-B, ozone depletion, greenhouse effect, acid rain, Ocean acidification, fisheries depletion, eutrophication - Human Drivers and Solutions

**Unit II Environmental Pollution** **10 Hours**

Environmental pollution: land pollution, e-waste, industrial wastes, solid waste; sources; measurement of pollution, fate of pollutants in the environment; concept of biomagnification.

**Unit III Environmental Economics** **11 Hours**

Basic concept; methods of evaluation; Gross National Productivity and the quality of life, Tragedy of Commons, Economics of Pollution control, Cost-benefit ratio and cost effectiveness analysis.

**Unit IV Environmental Laws** **13 Hours**

Concepts of control – Principles and design of control measures –carbon sequestration; emissions trading; sanitary landfills, Treatment schemes for sewage; Environment Laws and Acts in India.

**Recommended Books**

1. Frances, H. (2012). Global Environmental Issues (2nd edition) Willey-Blackwell
2. Mahesh, R. (2007) Environmental Issues in India: A Reader. Pearson-Longman
3. Adger, N.; Brown, K. and Conway, D. (2012). Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.

4. Turekian, K.K. (1996). Global Environmental Change-Past, Present, and Future. PrenticeHall.
5. Santra, S.C. (2011). Environmental Science. New Central Book Agency.

## 7. RESEARCH METHODOLOGY AND ETHICS

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To familiarize the basics of research methodology
2. To give insight into various kinds research design and sampling.
3. To provide an introduction to research methods and report writing free from plagiarism

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Understand the concept of research and different types of research in the context
- of biology
- Develop knowledge on qualitative research techniques
- Develop competence on data collection and process of scientific documentation
- Evaluate the ethical aspects of scientific writing and reporting

**UNIT I Basic Concepts of Research** **10 Hours**

Research: Meaning, Objectives, Motivation, Utility and types (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical; field vs laboratory research). Research methods vs methodology: Literature-review and its consolidation.

**UNIT II Problem Identification & Formulation** **10 Hours**

Research Question; Investigation Question; Measurement Issues; Hypothesis; Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

**UNIT III Sampling and Data Analysis** **13 Hours**

Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size. Characteristics of a good sample; Determining size of the sample. Data Preparation; Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis; Cross tabulations and Chi-square test including testing hypothesis of association.

**UNIT IV Paper Writing and Ethics** **12 Hours**

Interpretation of Data; Layout of a Research Paper: Authors, acknowledgements, Numbers, units, abbreviations and nomenclature used in scientific writing; Writing references; Ethical issues related to publishing: reproducibility, plagiarism and self - plagiarism; Selection of Journals in Biological Science; Impact factor of Journals; h Index; citation index.

**Recommended Books**


1. Creswell, JW Creswell, JD. 2018. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications, Inc;
2. Dawson, C. 2002. Practical research methods. UBS Publishers, New Delhi.
3. Gurumani, N. 2011. Research Methodology: For Biological Sciences. MJP Publishers, Chennai
4. Kothari C.R. and Gaurav Garg. 2019. Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi.
5. Modern Language Association. 2008. MLA Style Manual and Guide to Scholarly Publishing (MLA Style Manual).
6. Ruzin, S. E. 1999. Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A

## 8. MICROBIOLOGY

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To understand the basic knowledge in Microbiology and microbial diversity

2. To enable students to understand the various microbes involved in food spoilage and nutrient cycling

3. To understand the microorganisms as potential bio-fertilizer organisms

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- know the history and development of Microbiology and to get fundamental knowledge about microbes
- understand and explore the world of microorganisms in different spheres of life

**Unit I History of Microbiology** **11 Hours**

Discovery of microorganisms (Robert Hooke & Leeuwenhoek) Contributions of Francesco Redi, Needham, Splallanzani, Pasteur, Robert Koch, Edward Jenner, Ehrlich, Fleming, Dubos and Winogradsky. Classification based on–Carolus Linnaeus, Carl Woese and Robert –H. Whittaker (Five Kingdom system)

**Unit-II Microbial Growth** **13 Hours**

Physical & Chemical requirements; Reproduction in microbes; Phases of growth of Prokaryotic cell –ultra structure and functions of bacterial cell wall, plasma membrane, flagella, pili, capsules, nuclear materials and spores. Morphology and structure of enveloped, non-enveloped virus and bacteriophages. General characteristics of Fungi –Filamentous, non-filamentous and dimorphic fungi; Morphology and structure of *Aspergillus niger* and *Saccharomyces cerevisiae*.

**Unit-III Food Microbiology** **11 Hours**

Types of foods –Microbial food Spoilage -souring, putrefaction, rancidity and soft rot. Food poisoning and Microbial toxins. Environmental Microbiology – Role of microorganisms in nutrient cycling -Nitrogen, Carbon, Sulphur and Phosphorous.

**Unit-IV Applied Microbiology** **10 Hours**

Sewage Treatment, Bio-fertilizer –Rhizobium and Azolla: Production of Penicillin and Single Cell Protein, Bio-pesticides.

**Recommended Books**

1. Pelczar, M.J., E.C.S. Chan and N.R. Kreig. 2009. Microbiology, 5th edition. Tata McGrawHill. Book Co. Singapore
2. Tortora, G.J., Funke, B.R. and Case, C.L. 2009. Microbiology: An Introduction. 9th edition, Pearson Education, Singapore
3. Alcamo, I.E. 2001. Fundamentals of Microbiology, 6th edition, Addison wesley Longman, Inc. California
4. Alexopoulos, C.J., C.W. Mims and Blackwell, M. 2000. Introductory Mycology. 5th edition, John Wiley & Sons. Chichester.
5. Atlas, R.A. and Bartha, R. 2000. Microbial Ecology. Fundamentals and Application, 4 th edition Benjamin Cummings, New York.
6. Black, J.G.2005. Microbiology-principles and explorations, 6th edition. John Wiley & Sons, Inc. New York
7. Dubey, R.C. and Maheswari, D.K. 2010. A Text Book of Microbiology. 3rd edition S. Chand, New Delhi.
8. Frazier, W.C., and Westhoff, D.C. 2005. Food Microbiology,sixth edition, Tata McGraw Hill Publishing Ltd., New Delhi.
9. Kanika Sharma, 2011. Textbook of Microbiology – Tools and Techniques. 1st edition, Ane Books Pvt. Ltd., New Delhi.

## 9. ENVIRONMENTAL TOXICOLOGY

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To acquire knowledge on types and composition of environmental contaminants.
2. To study and understand the impact of toxic chemicals and environmental standards.
3. To learn toxicity testing methods

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- classify hazardous contaminants.
- understand the assimilation and expression of xenobiotic.
- promote safe disposal and treatment of contaminants.
- Learn various methods of toxicity tests
- assess the impact of contaminants on biological systems.

**UNIT I Environment and Pollution** **10 Hours**

Renewable and non-renewable resources; environmental pollution: Causes, effects and control measures of air, water and noise pollution; Radioactive pollution; effects on human beings, Acid rain, PAN chemicals, Global warming, Eutrophication; Impact of Noise on human health.

**UNIT II Environmental Protection** **12 Hours**

Global deforestation rate and extinction crises. Causes for extinction: habitat loss, industrialization, hunting and invasive species. Soil and water conservation, Rain water harvesting, solid waste management. Role of information technology in environmental protection. Environmental policies - national and international; agencies, programmes. legislations for environmental protection- public awareness.

**UNIT III Toxicants** **12 Hours**

Scope of Environmental Toxicology. Toxic chemicals in the environment and their biological effects. Xenobiotic, Biomagnification, Bioaccumulation. Pesticides: Classification, mode of action. Heavy metal poisoning (Copper, Cadmium, Lead, Mercury, Arsenic and Chromium). Safety measures.

**UNIT IV Toxicity Assessment** **11 Hours**

Methods of Toxicology: Toxicity tests: types - acute, subacute and chronic toxicity tests. Dose - Response relationship; $LC_{50}$, $LD_{50,}$ Probit analysis; Insecticide resistance; Surveillance of pesticide poisoning; National policies for Pesticide regulation.

**Recommended Books**


1. Chapmann,J.L and Reiss,M.J. 1995. Ecology Principles and application. Cambridge Univ. Press.UK.
2. Clark, G.L., 1954. Elements of Ecology, John Wiley & Sons.US.
3. Ernest Hodgron, 2004. A textbook of modern toxicology, Wiley publisher. US
4. Gupta, P.K, and V. Ramprakash, 1985. Advance in Toxicology and Environmental Health. Jagmender Book Agency, New Delhi.
5. Mahesh Rangarajan. Pearson Longman, 2009. Environmental issues in India. Pearson Education India
6. Shelley Bhattacharya, 2011. Environmental Toxicology. Books and allied (p) Ltd. India.
7. Shyam Diwan. 2001. Environmental law and Policy in India. OUP India.
8. Subramanian, M.A, 2004. Toxicology Principles and Methods, MJP Publishers, Chennai, India.
9. Verma, P.S and Agarwal, V.K. 2000. Environmental Biology. S. Chand Publishers, India.
10. William, P. Cunningham and Mary Cunningham. 2011. Principles of Environmental Sciences, Tata McGraw Hill Publications, New Delhi, India.

## 10. ECONOMIC ZOOLOGY

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To get a thorough understanding about the beneficial and harmful animals to human welfare
2. To acquire the concept of animal farming
3. To identify the cultivable breeds of animals for sustainable growth.
4. To develop entrepreneurial skills through animal farming.
5. To learn about pest and their management.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Understand the role of insects on health of domestic animals and humans
- Know the economic importance of animal farming
- Apply the modern techniques in pearl culture, poultry farming, sericulture and apiculture.
- Pave the way for alternative livelihood.
- Become an entrepreneur and create employment

**UNIT I Medical Entomology** **13 Hours**

Parasites of domestic animals and humans, structures, life cycles, pathogenicity, diseases, symptoms and control. Insects as vectors, mode of disease transmission: Malaria, Filaria, Dengue, chikunguniya, Plague, Leishmaniasis - Surveillance, control measures: Biological, environmental, chemical, mechanical; Integrated Vector Management.

**UNIT II Veterinary Biology** **13 Hours**

Animal Breeding, Breeds of cattle, sheep, piggery and poultry. Heterosis, Economic importance and control of fleas, lice, bugs, mosquitoes, flies and parasitoids. Vector-parasite interaction; host-pathogen interaction, Insects transmitting bacteria and viruses of animals - control of insect vectors of animals.

**UNIT III Farming Practices** **9 Hours**

Pearl oyster culture, Poultry farming, Sericulture, Apiculture,

**UNIT IV Pest Management** **10 Hours**

Household pests, pests of crops (paddy, sugarcane). Classification of pesticides - mode of action - Integrated Pest Management (IPM): Physical, Chemical, Biological control- Resistance development in insects.

**Recommended Books**


1. Chapman, R.F,2013. The Insects: Structure and Functions. Cambridge University Press. UK.
2. Dinesh Kumar Naznee, Ashok Kumar Rathoure,2015, Applied and Economic Entomology, Daya Publishing House, Delhi. India.
3. Gullan, P.J. &Cranston, P.S.2004.The Insects: An Outline of Entomology. John Wiley & Sons. US.
4. Kamaleswar Pandey and Shukla, J.P., 2005. Fish and Fisheries, Rastogi Publications. Meerut, India.
5. Mani, M.S.1982. General Entomology. Oxford & IBH Publishing CO. UK.
6. Prasad, T.V.2014. Handbook of Entomology. New vishal Publishers. Delhi. India.
7. Shukla, G.S, Upadhyay V.B., 2000. Economic Zoology, Rastogi Publications Meerut, India.
8. Temphare, D.B, 1984. A text book of insect morphology, physiology and endocrinology. S.Chand &Co., New Delhi. India.
9. Vasantharaj David B.2012.Elements of Economic Entomology. Namrutha Publications, Chennai. India.
10. Yadav, M. 2010, Economic Zoology, Discovery Publishing House Pvt. Limited, Delhi. India.

## 11. FISH PRESERVATION AND VALUE ADDITION

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To impart skill-based knowledge and training to the students on different aspects of fish processing technologies
2. To learn related to production of about the value added quality fish products from freshwater and marine resources and their preservation.

**COURSE OUTCOME**

**On successful completion of the course students will be able to**

- Understanding on the nutritional importance current consumption patterns and gaps
- Comprehension of the spoilage mechanisms and causative factors in fish and shell fish
- Development of skill in fish processing technology and value addition
- Pave the way for alternative livelihood.
- Become entrepreneurs and create employments

**UNIT I Fish Biochemistry** **10 Hours**

Fish as healthy food. Major and minor constituents of fishes –Protein, Lipid, Carbohydrates, Vitamins, Minerals, Moisture. Toxins and toxic substances in fishes.

**UNIT II Fish Spoilage and Quality Management** **12 Hours**

Criteria for assessing the freshness of fishes and fish spoilage. Factors affecting spoilage of fish- Autolytic spoilage, Microbial spoilage, Auto-oxidation, Sources of contamination. Concepts of total quality management- HACCP, Hazards in seafood, Food safety and Standards Act of India 2006, Role of BIS and EIA.

**UNIT III Fish Processing Technology** **11 Hours**

Principles of fish preservation. Drying, Salting and Smoking, Chilling, freezing, accelerated freeze drying, Canning of fish and fish products, Modified Atmosphere Packaging (MAP) of fish and fish products.

**UNIT IV Fishery Products and Value Addition** **12 Hours**

Fishery products, by-products and value added products. Fish meal, fish oil, protein concentrate, fish wafers, ensilage, fish pickles, surumi, roe, chitin and chitosan, ready to cook and ready to eat products. Packaging and transportation of fish and fishery products. Marketing and economics.

**Recommended Books**


1. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute London
2. Ayyappan, 2012. Fisheries of India. Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi, India.
3. Burges, G.H.O., C.L. Cutting, J.A. Lovern and J.J. Waterman, 1965. Fish Handling and processing, Her majesty's Stationery Office, Edinburg, UK.
4. Chandran, K.K., 2000. Post-Harvest Technology of Fish and Fish Products. Daya publishing House, New Delhi.
5. Charles L. Cutting. 2002. Fish processing and preservation. Laurier Books Limited, Canada.
6. Gopakumar, K.1997. Tropical Fishery Products. Oxford & IBH Publications. New Delhi, India.
7. Govindan, T.K., 1985. Fish Processing Technology. Oxford and IBH publishing Company Private Ltd., New Delhi, India.
8. Kreuzer, R., 1965. The Technology of Fish Utilisation. Fishing News (Books) Ltd., London.
9. Kreuzer, R., 1974. Fishery Products. FAO Fishing Mews (Books) Ltd., England.
10. Venugopal, V. 2006. Seafood Processing: Adding Value Through Quick Freezing, Retortable Packaging and Cook- Chilling. CRC Press, Taylor and Francis group, US.

## 12. AQUARICULTURE

**3 Hours/ Week** **3 Credits**

**OBJECTIVES**

1. To have an understanding of the importance of Ornamental fish culture
2. To learn small and large scale levels of ornamental fish culture for domestic and export market.
3. To learn breeding techniques, nursery and grow out techniques in OFC.
4. To get comprehensive ideas on the maintenance of freshwater and marine aquaria.
5. To learn, water quality management, feeding and disease management in OFC.

**COURSE OUTCOME**

**On successful completion of the project students will be able to**

- Gain knowledge on ornamental fish culture
- Develop entrepreneurial skill on ornamental fish culture
- Develop techniques of fabrication of aquarium tanks
- Become entrepreneurs and create employments

**UNIT I Ornamental Fish Culture** **10 Hours**

Importance of ornamental fish culture; Major hotspots of ornamental fishes in global and Indian contexts; Aquatic ornamental plants in India/globe; National and international trade in ornamental fishes and plants. Major ornamental fish species of India. Regulations in ornamental fish trade in India.

**UNIT II Water Quality Management** **10 Hours**

Physico-chemical and Biological properties of water; Acclimatization of marine ornamental fishes to fresh water. Nitrification and conditioning of Aquaria; Aquarium fabrication and aquascaping; Implements in aquariculture and their uses.

**UNIT III Breeding Techniques** **13 Hours**

Selection of brood stock and rearing; Basic breeding techniques in ornamental fishes (live bearers and egg layers). Natural breeding facilitation; Induced breeding. Nursery rearing and care of hatchlings. Feed preparation and feeding – live feed and supplementary feed. Diseases management in aquariculture. Packing and transport of aquarium fishes and plants.

**UNIT IV Types of Aquaria** **12 Hours**

Marine aquarium – special features; Outdoor aquariculture ponds; planted aquarium, biotope aquarium, vivarium, insectarium, terrarium, paludarium, oceanarium, dolphinarium, reef aquarium,

**Recommended Books**


1. AmitaSaxena, Aquarium Management, 2013, Daya publishing House.,New Delhi.
2. Biju Kumar, A. & H.J. Alappat 1996. A Complete Guide to Aquarium Keeping. Books for All, Delhi,
3. David Alderton, 2011.Encyclopedia of Aquarium and Pond fish. Penguin UK Publishers.
4. Dholakia, A.D. 2009. Ornamental fish Culture & Aquarium Management. DayaPublishing House, Delhi.
5. Felix, S, T V Anna Mercy and Saroj Kumar Swain, 2013, Ornamental Aquaculture: Technology and Trade in India.
6. Gopakumar G. 2011. Marine Ornamental Fish Culture: Package of Practices. CMFRI Cochin.
7. Jagtap, H S, Mukherjee S. N. and V. K.Garad 2009. Textbook of Pisciculture and Aquarium Keeping, Daya publishing House, New Delhi.
8. Mary Bailey and Gina Sandford. 2015. Ultimate encyclopedia of Aquarium Fish and fish care. South Water Publishers.
9. Mills, D. 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, London.
10. Rataj, K. & R. Zukal 1971. Aquarium Fishes and Plants. The Hamlyn Publ. Group Ltd., London.