POST GRADUATE AND RESEARCH DEPARTMENT OF ZOOLOGY
NATIONAL COLLEGE (Autonomous)

UNDER GRADUATE AND POST GRADUATE PROGRAMME STRUCTURE AND SYLLABI

(FOR CANDIDATES TO BE ADMITTED FROM THE ACADEMIC YEAR 2022 ONWARDS)

A brief history of the College

National College, Tiruchirapalli was founded on 11th June, 1919, thanks to the munificence of the late Diwan Bahadur S.Rm.CT.Pethachi Chettiar, Zamindar of Andipatti and the collective initiative and zeal of Justice T.V.Seshagiri Iyer, Sir.T.Desikachariar, N.D.Subbarama Iyer, Sri.Sivarama Krishna Iyer and a galaxy of social reformers and nationalists. The College celebrated its Golden Jubilee in the year 1969 under the presidentship of Shri. N.R.Sundararaja Iyer. The College had the privilege of celebrating its Diamond Jubilee during the year 1980-81, under the presidentship of Hon'ble Shri.R.Venkataraman, the most distinguished alumnus and the then Minister for Finance, Government of India. The celebration of the Platinum Jubilee in February 1995 under the presidentship of the esteemed Vice-Chancellor of Bharathidasan University Dr. V. R. Muthukaruppan was an important event to commemorate the remarkable services of the institution to the underprivileged sections of the society. The College celebrated its Centenary Year with all grandeur and splendour under the presidentship of Dr. V. Krishnamurthy. Honourable M. Venkaiah Naidu, Vice President of India, formally inaugurated the celebrations on the 10th of January 2020. As on date, the College offers nineteen Postgraduate Programmes and twenty-one Undergraduate Programmes. Truly the College has been recognised as one of the Centres of Advanced Learning and has been accorded permission for registering candidates for research leading to the award of PhD degree in fourteen departments. The College was first accredited by National Assessment and Accreditation Council (NAAC) at 'A' level in 2005 and Re-Accredited in III Cycle at 'A+' Grade in 2016. The University Grants Commission, New Delhi, conferred Autonomous status on the College in 2010. The College has also been conferred the rare distinction of 'College with Potential for Excellence' status in 2011. The College has been identified by MHRD, Government of India under Study in India (SII) programme to admit foreign students in various programmes. Currently, the College has 265 dedicated teaching staff, 100 non-teaching staff and about 5000 students on its rolls. It continues to march forward with relentless vigour, keeping its vision and mission clear.

Vision

To offer quality Higher Education to the younger generations, especially from rural India, who are economically and socially backward, to liberate themselves from prejudice, oppression and ignorance and to gain knowledge for their bright future

Mission

- To ignite the young minds with lofty ideals and inspire them to achieve excellence in the chosen field.
- To facilitate individual growth of students, with accent on character building, through co-curricular and extra-curricular activities.
- To encourage the students to take-up research and help them reach global standards.
- To provide a congenial atmosphere to study and learn, with infrastructural facilities of the highest order.
- To instill in the minds of the students, the sense of Nationalism and to train them in social awareness.

POST GRADUATE AND RESEARCH DEPARTMENT OF ZOOLOGY

Zoology makes a huge impact on our world through the scientific study of the evolution, genetics, physiology, behavior, habitats, and health of animals and humans. It includes diverse approaches such as electron microscopy, molecular genetics, and field ecology. By studying zoology as a whole, one can develop a better understanding about oneself and environment which in turn makes one function and interact in a scientific manner with the environment. Many Colleges offer excellent zoology courses. We at National College trust that we are one of the best, and hard to beat. The fact that National College is second oldest college in Tiruchirapalli may not be so important (though it impresses many), but the academic quality is arguably unsurpassed elsewhere. The Department provides an immense amount of care, support, encouragement and sense of belonging in such a way that zoology graduates would be extremely well prepared for life after college. Zoology at National College is taught through the media of lectures, practical (lab and field) and classes or seminars to improve the ability of the students to critically review and comment on both scientific literature and more controversial current affairs. In addition, every graduate is under the personal guidance of a college mentor, who takes a keen interest in the welfare and intellectual development of the students to ensure that student gets the best teaching.

Vision

Inculcating the highest values of life, science education, respect for nature and concern for ethical values among students through good and scientific educational practices.

Mission

- To impart the contemporary advancements to students in the field of Zoology.
- To impart a eco-conservation attitude among students that benefit humanity

Timeline of the Zoology Department

1983 - Started initially as Department of Environmental Zoology
1996 - Recognized for part-time Ph.D Programme in Zoology
2005 - Rechristened as Department of Zoology.
2010 - M.Sc., Zoology (Unaided Programme) was started
2011 - Recognized for Ph.D Programme (Part- and Full-Time)
2016 - Recognized for M.Phil Programme (Full time & Part time)
2016 - B.Sc. Zoology (Unaided Programme- Shift II) was started.

JOB PROSPECTS

Several career options are open for zoology students due to the need of conservation and management of the fauna and their associated habitat in the world. The list follows:

- SCIENTIST
- RANGER
- DISTRICT FOREST OFFICER
- TEACHER/ASSISTANT PROFESSOR
- WILDLIFE DOCUMENTARY MAKER
- FORENSIC EXPERT
- WILDLIFE BIOLOGIST
- CONSERVATIONIST
- MEDICAL CODING EXECUTIVE
- ANIMAL BEHAVIOURIST
- ANIMAL AND WILDLIFE EDUCATORS
- SCIENTIFIC ILLUSTRATOR
- ANIMAL CARETAKER
- ANIMAL BREEDER
- ZOO CURATOR
- AQUACULTURIST
- VERMICULTURIST
- SERICULTURIST
- MUSEUM CURATOR
- APICULTURIST
- EIA OFFICER ETC

PROGRAMME DETAILS

PG Programme: Course and Credit details			
Course	**Credits**	**Number of Courses**	**Total Credits**
Major	5	10	50
Elective	4	5	20
Practical	5	3	15
Project	5	1	5
Total		**19**	**90**
Total credits = 90			
Total marks=1900			

UG PROGRAMME : COURSE AND CREDIT DETAILS			
Course	**Credit**	**Number of Courses**	**Total Credits**
Major	5	9	45
Major Based Elective	4	3	12
Non Major Elective	2	2	4
Major Practical	6*3, 5*1	4	23
Allied Course	3	4	12
Allied Practical	3	2	6
Tamil	3	4	12
English (I & III)	3	2	6
English (II & IV)	3	2	6
Skill Based Elective (SBE)	2	3	6
Soft Skills (SS)	2	1	2
Value Education (VE)	2	1	2
Environmental Studies (EVS)	2	1	2
Gender Studies (GS)	1	1	1
Extension activities	1		1
Total		**39**	140
Total credits = 140			
Total marks=3900			

UG PROGRAMME –PARTS

PARTS	SUBJECTS	Number of Papers
PART-I	Tamil / Hindi/ / Sanskrit	4
PART-II	English	4
PART - III	Major and Allied	22
PART-IV	EVS, NME, SBE, VE, SS, GS	9
	TOTAL	**39**
PART-V	Extension activities- Club activities	-

QUESTION PAPER PATTERN

The general pattern for the question paper (Major and Allied Theory) for the semester Examinations:

Section A
Question Numbers 1 to 20
Multiple Choice Questions, each question having four answers under the choice:
20 x 1= 20 Marks

Section B
Question Numbers 21 to 25
One of the two Questions, under each subdivision. (Either /or pattern): 5 x 5 = 25Marks

Section C
Question Numbers 26 to 30
Internal Choice Questions (Three out of Five Questions): 3 x 10 = 30 Marks

This pattern is subject to change, depending upon the needs of the Courses or Programmes. The students are advised to consult the Faculty member and / or the Head of the Department.

Major and Allied question pattern for Practical Exam

Major	-	30 Marks
Minor	-	20 Marks
Spotters	-	20 Marks
Viva	-	05 Marks
Internal	-	25 Marks
Total	-	100 Marks

SBE - Practical Exam question pattern

Submission: Aquarium tank & honey comb or Vermicompost tank and silkworm cocoon	-	20 marks
Field visit	-	10 marks
Spotters	-	40 marks
Oral	-	05 marks
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		75 marks

B.Sc. ZOOLOGY DEGREE PROGRAMME

Programme include increased critical thinking abilities, higher order thinking and deeper learning, mastery of content, problem solving, team work and communication skills besides general engagement and enjoyment of learning including systematic research in Zoology. The overall objectives of the learning outcomes-based curriculum framework help to formulate graduate attributes and qualification descriptors and enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values).

Programme Educational Objectives (PEOs):

PEO1Higher Education	:	Empower students to pursue higher studies in Zoology
PEO2 Career	**:**	Enable students to pursue careers in zoology
PEO3 Social responsibility	**:**	Enable students to exhibit professionalism, ethical attitude, Communication skills and team work in their profession.

GENERAL CURRICULAR ACTIVITIES

Lecturer-based

1) Class-room activities: Organization of group discussions, question-answer sessions, scientific observations, use of audio-visual aids, guidance programme, examination and evaluation work (scheduled and surprise tests), quizzes, preparation of question banks, student study material, material for PG entrance examinations etc.

2) Library activities: Reading books and magazines, taking notes from prescribed and reference books and preparation of notes on lessons as per the syllabus; Reading journals and periodicals pertaining to different subjects of study; Making files of news- paper cuttings etc.

3) Lab activities: Organization of practicals, maintenance of lab attendance registers/log registers, maintenance of glassware and chemicals.

4) Activities in the seminars, workshops and conferences: Organization of at least one seminar/workshop/conference per academic year either on academic/research aspects and inculcate research spirit among students.

5) Research activities: Student study projects, minor or major research projects, Research guidance to research scholars, publication of research articles/papers in UGC-recognized journals, registration in Vidwan/Orcid/Scopus/Web of Science, Smart Classroom Activities: Organization of departmental whatsapp groups, Ed Modo groups/Google class rooms/Adobe Spark groups for quick delivery of the subject; Preparation of Moocs content & presentation youtube lessons by trained lecturers; Using smart/digital/e- class rooms (mandatory) wherever present; utilization of youtube videos (subject to copy rights) etc.

Student-based

1) Class-room activities: Power point presentations, seminars, assignments
2) Library activities: Visit to library during library hour and preparation of notes
3) Lab activities: Maintenance of observation note book and record, keeping lab clean and tidy
4) Activities in the Seminars, Workshops and Conferences: Participation/presentation in Seminar/ Workshop/Conference

CO-CURRICULAR ACTIVITIES OBJECTIVES

The co-curricular activities are aimed at strengthening the theoretical knowledge with an activity related to the content taught in the class room. The aesthetic development, character building, spiritual growth, physical growth, moral values, and creativity of the student are focused. The different types of co-curricular activities relevant to Zoology domain are listed below: Academic - based Preparation of Charts/Clay or Thermocol Models Debates, Essay Writing, Competitions, Group Discussions, Departmental (Zoology) magazine, Formation of Book clubs, Animal album-making, Viva-Voce Lab/Research based Digital dissections, Field Visit/Excursions/Zoological Tours and submission of report, Training at research centres (aquaculture/apiculture/sericulture etc.). Exposure to scientific instruments and hands-on experience, first-aid camp, swachhbharat, cleanliness week, girl-child importance, nutrition and health awareness etc.

Observation of Days of National/International Importance

World Cancer Day (February 4th), International Biological Diversity Day (May 22nd), Darwin Day (February 12th), World Turtle Day (May 23rd), National Science Day (Feb 28th), World blood Donor Day (June 14th), World Wildlife day (March 3rd), World Zoonoses Day (July 6th), National Vaccination Day (March 16th), World Mosquito Day (August 20th), World Health Day (April 7th), World Turtle Day (May 23rd), Earth Day (April 22nd), World Mosquito Day (August 20th), Malaria Day (April 25th), World Animal day (October 4th), World Hepatitis Day (May 19th), World Immunization Day (November 10th).

Graduate Attributes (GA)

The graduate attributes reflect the knowledge, skills, attitudes and values etc that are expected to be acquired by a graduate through Zoology programme at National College, Tiruchirappali-1, Tamil Nadu. The following graduate attributes are expected from the students after the successful completion of the Zoology programme:

1. ***Disciplinary knowledge:*** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of Zoology programme.
2. ***Communication skills:*** Ability to express thoughts and ideas related to Zoology effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.
3. ***Critical thinking:*** Capability to apply analytic thought to a body of knowledge; analyze and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories in zoology by following scientific approach to knowledge development.
4. ***Problem solving:*** Capacity to extrapolate from what one has learned in the Zoology programme and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.
5. ***Analytical reasoning****:* Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesise data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.
6. ***Research-related skills:*** A sense of inquiry and capability for asking relevant/appropriate questions, problematising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability

to plan, execute and report the results of an experiment or investigation.

7. ***Cooperation/Team work****:* Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.

8. ***Scientific reasoning:*** Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open- minded and reasoned perspective.

9. ***Reflective thinking:*** Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

10. ***Information/digital literacy:*** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

11. ***Self-directed learning:*** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

12. ***Multicultural competence:*** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

13. ***Moral and ethical awareness/reasoning:*** Ability to embrace moral/ethical values in conducting one's life, formulates a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work.

14. ***Leadership readiness/qualities:*** Capability for mapping out the tasks of a team organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

15. ***Lifelong learning:*** Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self- directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge and skill development.

PROGRAMME – B.Sc. ZOOLOGY

(PEO)- Programme Educational Objectives, PO-Programme Outcomes, PSO-Programme Specific Outcomes, CO- Course Outcomes, Cognitive Level: K1- R-remembering, K2 – U-understanding, K3 - Ap-applying, K4 - An-analyzing, K5 – E-evaluating, and K6 - C-creating

PEO	**Programme Educational Objectives (PEO)** Upon Completion of the B.Sc., Degree Programme the Graduate will be able to
PEO 1	Able to identify and classify the fauna with basis of systematics
PEO 2	Able to understand the molecular aspects of fauna
PEO 3	Able to understand embryological aspects of fauna
PEO 4	Able to understand the evolutionary aspects of fauna
PEO 5	Able to explore the entrepreneurial opportunities in the field of zoology

PO	**Programme Outcomes (PO)** The Programme Outcomes of the Graduates of our College would be the following:
PO 1	Disciplinary knowledge
PO 2	Communication Skills
PO 3	Critical thinking, problem solving and analytical reasoning
PO 4	Reflective thinking and scientific reasoning
PO 5	Moral and ethical awareness, and team work with leadership qualities
PO 6	Multicultural sustainability and self-directed lifelong learning

PSO	**Programme Specific Outcomes (PSO)** Upon Completion of B.Sc., Zoology Programme, the students would have
PSO 1	**Understood basic concepts, fundamental principles of zoology** and their relevance in day to day life.
PSO 2	**Developed an ease to express scientific thoughts and ideas** in National and International forums with effective communication skills.
PSO 3	**Explored analytical approach, critical thinking,** understanding and interpretation of the data, facts, related to biological sciences as well relevant technologies in zoology in conducting experimental investigation
PSO 4	**Explored scope for research** using various scientific tools and theories
PSO 5	Emerged as **socially responsible individuals with adequate leadership qualities** to work for betterment of society.
PSO 6	Acquired the ability to pursue an independent and **life-long learning as academicians, wildlife biologists, scientists** and **entrepreneurs**.

Course Title	Core Course (CC1) - FAUNAL DIVERSITY-INVERTEBRATES		
Code	U22ZY1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate the diverse groups of invertebrate organisms around us.	PSO 1,2,3,4, 6	K1
CO 2	Infer the evolutionary significance of various invertebrate fauna	PSO 1,2,3,4, 6	K2
CO 3	Categorize different levels of biological diversity through the systematic classification of invertebrate fauna	PSO 1,2,3,4,5,6	K3
CO 4	Distinguish animals based on their taxonomic classification.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate on the physiological and anatomical features of some invertebrate phyla through type study.	PSO 1,2,3,4, 6	K5
CO 6	Establish measures to conserve invertebrate organisms.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC2) - MAJOR PRACTICAL – I FAUNAL DIVERSITY (INVERTEBRATES & CHORDATES)		
Code	U22ZY2P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	List Invertebrate and Chordate specimens with precision	PSO 1,2,3,4,6	K1
CO 2	Illustrate scientific drawing of specimens	PSO 1,2,3,4, 6	K2
CO 3	Make use of dissections and mounting techniques to study invertebrates and chordates	PSO 1,2,3,4,5	K3
CO 4	Compare various groups of Invertebrates and Chordates	PSO 1,2,3,4,6	K4
CO 5	Assess the ecological importance of invertebrates and chordate species.	PSO 1,2,3,4,5,6	K5
CO 6	Build awareness of the economic importance of invertebrates and chordates.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC3) - FAUNAL DIVERSITY - CHORDATES		
Code	U22ZY3		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the diversity of Chordates and the relationship among the different Chordate groups	PSO 1,2,3,4,6	K1
CO 2	Demonstrate understanding on the concept of classification of Chordates	PSO 1,2,3,4,6	K2
CO 3	Classify comparative anatomy and development systems of Chordates	PSO 1,2,3,4,6	K3
CO 4	Examine ecological importance of some fishes, amphibians' reptiles, birds and mammals.	PSO 1,2,3,4,5,6	K4
CO 5	Recommend conservation and management strategies for Chordate fauna	PSO 1,2,3,4,5,6	K5
CO 6	Develop molecular technique for identifying Chordate taxa.	PSO 1,2,3,4,5,6	K6

Course Title	Skill Based Elective Course-I (SBE:1) - APICULTURE AND SERICULTURE		
Code	U22ZYSBE1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define Silk Worm and Honey Bee types	PSO 1,2,3,4,6	K1
CO 2	Demonstrate on beehives, bee keeping equipment, methods of extraction of honey and processing of honey, mulberry cultivation	PSO 1,2,3,6	K2
CO 3	Categorize pests and diseases associated with silk worm and Honey Bee	PSO 1,2,3,4,6	K3
CO 4	Explicate steps involved in silk production and various types of silk produced from different silk moths	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate Economic importance of Apiculture	PSO 1,2,3,4,5,6	K5
CO 6	Build entrepreneurship opportunity in Apiculture and Sericulture	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC4) - CELL AND MOLECULAR BIOLOGY		
Code	U22ZY4		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall the composition of prokaryotic and eukaryotic cells	PSO 1,2,3,4	K1
CO 2	Infer the structure of cells and cell organelles in relation to the functional aspects	PSO 1,2,3,4,6	K2
CO 3	Categorize the structure and functions of chromosome	PSO 1,2,3,4,5	K3
CO 4	Analyze mitotic and meiotic cell divisions and their significance	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate the structure of DNA, mechanism behind DNA replication, RNA and protein synthesis	PSO 1,2,3,4,5,6	K5
CO 6	Fabricate basic biotechnology tools and techniques for solving real world problems	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC5) - MAJOR PRACTICAL – II (Pertaining to Cell and Molecular Biology, Physiology and Biochemistry)		
Code	U22ZY5P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall basic analytical chemistry relating to preparation of solution	PSO 1,2,3,4, 6	K1
CO 2	Infers about the mounting of buccal epithelium and identification of various cell types found in humans.	PSO 1,2,3,4,5	K2
CO 3	Utilize various biotechnological and physiological tools	PSO 1,2,3,4,5,6	K3
CO 4	Explicate steps involved in enumeration of blood cells , qualitative estimation of biomolecules and histological techniques	PSO 1,2,3,4,5,6	K4
CO 5	Estimate nitrogenous waste from different samples and DNA isolation and amplification	PSO 1,2,3,4,5,6	K5
CO 6	Elaborate the operation of high end instruments like SEM, HPLC, AAS	PSO 1,2,3,4,5,6	K6

Course Title	Second Allied Course –1 (2AC1) – BIOLOGY OF INVERTEBRATES AND CHORDATES		
Code	U22AZY1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the diversity of Invertebrates and Chordates.	PSO 1,2,3,4,6	K1
CO 2	Trace Invertebrates and Chordates to their respective classes based on their concepts of evolutionary ancestry	PSO 1,2,3,4,6	K2
CO 3	Utilize skills on anatomy and development systems of certain species of Invertebrates and Chordates	PSO 1,2,3,4,5,6	K3
CO 4	Analyze ecological importance of some Invertebrate and Chordate species	PSO 1,2,3,4,5,6	K4
CO 5	Deduce conservation and management strategies of the Invertebrate and Chordate fauna	PSO 1,2,3,4,5,6	K5
CO 6	Construct Phylogenetic tree for Invertebrate and chordate species	PSO 1,2,3,4,5,6	K6

Course Title	Second Allied Course 2 – (2AC2) - ALLIED PRACTICAL - (Pertaining to Biology of Invertebrates & Chordates and Economic Zoology)		
Code	U22AZY2P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	List Invertebrate and Chordate specimens with precision	PSO 1,2,3,4,6	K1
CO 2	Illustrate scientific drawing of specimens	PSO 1,2,3,4,6	K2
CO 3	Make use of dissections and mounting techniques to study invertebrates and chordates	PSO 1,2,3,4,5	K3
CO 4	Compare various groups of Invertebrates and Chordates	PSO 1,2,3,4,6	K4
CO 5	Assess the ecological importance of invertebrates and chordate species.	PSO 1,2,3,4,5,6	K5
CO 6	Build awareness of the economic importance of some animal products	PSO 1,2,3,4,5,6	K6

Course Title	Skill Based Elective course-II (SBE:2) – AQUARIUM FISH KEEPING AND VERMICULTURE		
Code	U22ZYSBE2		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	List the economic importance of ornamental fishes and earth worms.	PSO 1,2,3,4,6	K1
CO 2	Trace different types of ornamental fishes and to apply modern methods on aquarium culture	PSO 1,2,3,4,6	K2
CO 3	Make use of earthworm in organic farming and Solid waste Management	PSO 1,2,3,4,5,6	K3
CO 4	Explicate learning environment for Vermiculture	PSO 1,2,3,4,5,6	K4
CO 5	Appraise branches of applied Zoology with skill and knowledge.	PSO 1,2,3,4,5,6	K5
CO 6	Build entrepreneurship opportunities through products derived from animals.	PSO 1,2,3,4,5,6	K6

Course Title	Skill Based Elective course-III (SBE:3) - PRACTICAL: APICULTURE, SERICULTURE, AQUARIUM FISH KEEPING AND VERMICULTURE		
Code	U22ZYSBE3P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate steps involved in bee keeping with different types of Honey Bee	PSO 1,2,3,4,6	K1
CO 2	Demonstrate different types of Silkworms, and methodologies involved in Silkworm rearing	PSO 1,2,3,4,5,6	K2
CO 3	Apply vermitechnology for sustainable agriculture	PSO 1,2,3,4,5,6	K3
CO 4	Distinguish aquarium fishes and to maintain natural habitat of aquarium fishes.	PSO 1,2,3,4,5,6	K4
CO 5	Appraise sustainable agricultural practice using vermi products.	PSO 1,2,3,4,5,6	K5
CO 6	Develop commercialization for byproducts of beekeeping	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC6)- PHYSIOLOGY AND BIOCHEMISTRY		
Code	U22ZY6		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define concepts of digestion, respiration, excretion and the functioning of nerves and muscles	PSO 1,2,3,4,6	K1
CO 2	Demonstrate on neurophysiology, receptors and hormones.	PSO 1,2,3,4	K2
CO 3	Identify various bio molecules and their role in metabolism.	PSO 1,2,3,4	K3
CO 4	Explicate steps involved in metabolism of carbohydrates, protein, lipid and various biochemical pathways.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate classification of enzymes, their mode of action and diseases caused due to their deficiency.	PSO 1,2,3,4,5,6	K5
CO 6	Devise therapy for various metabolic syndromes of body.	PSO 1,2,3,4,5,6	K6

Course Title	Second Allied Course 3 – (2AC3) - ECONOMIC ZOOLOGY		
Code	U22AZY3		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall freshwater prawn culture and management.	PSO 1,2,3,4,5,6	K1
CO 2	Demonstrate economic importance of pearls and methodologies involved in pearl producing oyster culture	PSO 1,2,3,4,5,6	K2
CO 3	Apply knowledge on culture of Indian major carps with live feeds, fishery by-products and fish diseases	PSO 1,2,3,4,5,6	K3
CO 4	Analyze different types of Silkworm, diseases encountered by Silk moths during their life cycle and economic importance of silk.	PSO 1,2,3,4,5,6	K4
CO 5	Discover learning environment for indigenous and exotic poultry birds with their economic importance and diseases associated with poultry farming.	PSO 1,2,3,4,6	K5
CO 6	Create self-employment in field of applied Zoology	PSO 1,2,3,4,5,6	K6

Course Title	Non Major Elective Course -1 (NME:1) - COMMUNICABLE DISEASES		
Code	U22ZYNME1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate health awareness to the people.	PSO 1,2,3,4,5,6	K1
CO 2	Trace the causative agents for the communicable disease like air, food, water and microbes with their preventive measures.	PSO 1,2,3,4,6	K2
CO 3	Utilize knowledge on the importance of vaccines in disease prevention.	PSO 1,2,3,4,5,6	K3
CO 4	Explicate Sexually Transmitted Disease (STD) and their preventive measures.	PSO 1,2,3,4,5,6	K4
CO 5	Deduce learning environment for vector borne diseases and their preventive measures.	PSO 1,2,3,4,5,6	K5
CO 6	Formulate biological control methods for disease causing vectors.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC7) - DEVELOPMENTAL BIOLOGY		
Code	U22ZY7		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate the process of spermatogenesis, oogenesis and fertilization	PSO 1,2,3,4,6	K1
CO 2	Infer the developmental stages of embryogenesis	PSO 1,2,3,4	K2
CO 3	Categorize the process of organogenesis.	PSO 1,2,3,4,6	K3
CO 4	Explicate on extra embryonic membranes	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate different types of placentation	PSO 1,2,3,4,5,6	K5
CO 6	Formulate artificial reproduction methods with reference to reproductive cycle	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC 8) - MICROBIOLOGY AND IMMUNOLOGY		
Code	U22ZY8		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall basic microbial structure and function	PSO 1,2,3,4,6	K1
CO 2	Trace comparative characteristics of Bacteria and Virus	PSO 1,2,3,4,6	K2
CO 3	Make use of knowledge in the general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae	PSO 1,2,3,4,5,6	K3
CO 4	Explicate food, soil, industrial and medical microbiology	PSO 1,2,3,4,5,6	K4
CO 5	Substantiate concepts in immunology, organization of the immune system, the salient features of antigen antibody reactions with different types of antibodies	PSO 1,2,3,4,5,6	K5
CO 6	Build deep insight on humoral and cell mediated immunity	PSO 1,2,3,4,5,6	K6

Course Title	Major Based Elective Course -I (MBE 1) - ECONOMIC ENTOMOLOGY		
Code	U22ZY9E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall basic concept of classification of insects with thorough knowledge on their external anatomy.	PSO 1,2,3,4,5,6	K1
CO 2	Demonstrate different types of insects like beneficial, harmful and household pests.	PSO 1,2,3,4,5	K2
CO 3	Make use of pest control and management.	PSO 1,2,3,4,5	K3
CO 4	Explicate the harmful and beneficial effects of using pesticides on agricultural fields.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate Biological control methods in agricultural field for pest control and management.	PSO 1,2,3,4,5,6	K5
CO 6	Formulate Eco friendly insecticides and pesticides	PSO 1,2,3,4,5,6	K6

Course Title	Major Based Elective Course -II (MBE 2) - AQUACULTURE		
Code	U22ZY10E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the basic concept of the aquaculture, and fisheries.	PSO 1,2,3,4	K1
CO 2	Demonstrate different forms of aquaculture and advanced techniques used in it.	PSO 1,2,3,4	K2
CO 3	Apply knowledge on live feed aquaculture, fish pathogens.	PSO 1,2,3,4,5,6	K3
CO 4	Analyze economic importance of aquaculture	PSO 1,2,3,4,5,6	K4
CO 5	Evaluate economic importance of pearls and methodologies involved in pearl producing oyster culture.	PSO 1,2,3,4,5,6	K5
CO 6	Develop insight on marine prawn culture and management, fishery products marketing agencies in India.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC 9) - MAJOR PRACTICAL – III - (Pertaining to Developmental Biology and Microbiology and Immunology)		
Code	U22ZY11P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define various developmental stages of chick and frog embryo.	PSO 1,2,3,4,5	K1
CO 2	Demonstrate experimental knowledge in identifying the blood group.	PSO 1,2,3,4,5,6	K2
CO 3	Apply knowledge on remembering and distinguishing the lymphoid organs.	PSO 1,2,3,4	K3
CO 4	Analyze differentiating bacteria using simple staining method.	PSO 1,2,3,4,5	K4
CO 5	Substantiate knowledge on basic biotechnological tools and techniques.	PSO 1,2,3,4,5,6	K5
CO 6	Formulate new methods for vaccine production using antigen- antibody interaction.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course (CC 10) - MAJOR PRACTICAL – IV - (pertaining to Core Courses Genetics and Evolution, Environmental Biology and Management, Biophysics and Biostatistics)		
Code	**U22ZY12P**		
Course Outcomes		**PSOs Addressed**	**Cognitive Level**
CO 1	Recall genetic importance by studying simple Mendelian traits.	PSO 1,2,3,4,5	K1
CO 2	Demonstrate on sex differentiation in drosophila and chromosomal aberrations in man	PSO 1,2,3,4,6	K2
CO 3	Apply knowledge in understanding and identification of Fossils	PSO 1,2,3,4, 6	K3
CO 4	Analyze the evolutionary importance of mimicry and coloration	PSO 1,2,3,4,5,6	K4
CO 5	Appraise on estimation of dissolved oxygen and mounting of different planktons species.	PSO 1,2,3,4,5,6	K5
CO 6	Develop expertise on basic statistical analysis	PSO 1,4,5,6	K6

Course Title	Non Major Elective Course -II (NME:II) – VERMICULTURE & APICULTURE		
Code	**U22ZYNME2**		
Course Outcomes		**PSOs Addressed**	**Cognitive Level**
CO 1	Recall different types of Honey Bees and Earthworms	PSO 1,2,3,4,6	K1
CO 2	Demonstrate on beehives, bee keeping equipment, methods of extraction of honey, processing of honey	PSO 1,2,3,4, 6	K2
CO 3	Make use of earthworm in organic farming and solid waste management	PSO 1,2,3,4,5,6	K3
CO 4	Explicate vermitechnology for sustainable agriculture and to understand primary, secondary degradation and vermibed preparation.	PSO 1,3,4,5,6	K4
CO 5	Determine the economic, legal and social contexts associated with vermiculture	PSO 2,3,4,5,6	K5
CO 6	Build self-employment opportunities for rural people	PSO 1,2,4,5,6	K6

Course Title	Core Course (CC 11) - GENETICS AND EVOLUTION		
Code	U22ZY13		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall knowledge on molecular genetics	PSO 1,2,3,4	K1
CO 2	Demonstrate the concepts of linkage, recombination, and crossing over.	PSO 1,2,3,4	K2
CO 3	Categorize mutation and its effects on chromosome.	PSO 1,2,3,4,5,6	K3
CO 4	Analyze the fine structure of genetic material, molecular basis of heredity and gene regulation	PSO 1,2,3,4,5,6	K4
CO 5	Substantiate knowledge about the evolutionary history of earth and theories of evolution.	PSO 1,3,4,5,6	K5
CO 6	Adapt the distribution of animals on earth, its pattern, evolution and causative factors.	PSO 2,3,4,5,6	K6

Course Title	Core Course (CC 12) – ENVIRONMENTAL BIOLOGY AND MANAGEMENT		
Code	U22ZY14		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define interaction of biotic and abiotic resources in the environment	PSO 1,2,3,4,6	K1
CO 2	Demonstrate the components of ecosystem.	PSO 1,2,3,4,6	K2
CO 3	Apply types of interaction of animals in an ecosystem.	PSO 1,2,3,4,5,6	K3
CO 4	Analyze population characteristics and dynamics, community ecology and biogeochemical cycles.	PSO 1,2,3,4,5,6	K4
CO 5	Substantiate knowledge on global warming and pollution management.	PSO 1,2,3,4,5,6	K5
CO 6	Develop insight into United Nations steps towards sustainable environment and climate change worldwide.	PSO 1,3,4,5,6	K6

Course Title	Core Course (CC 13) - BIOPHYSICS AND BIOSTATISTICS		
Code	U22ZY15		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall basic terms and concepts of Biophysics.	PSO 1,2,3,4,6	K1
CO 2	Demonstrate about the principles and uses of various analytical instruments like spectrophotometer, chromatography, and electrophoresis.	PSO 1,2,3,4,6	K2
CO 3	Apply the details of radioisotope techniques and their application in biology.	PSO 2,3,4,5,6	K3
CO 4	Analyze biological data in a simplified and clarified way.	PSO 2,3,4,5,6	K4
CO 5	Deduce methods to represent the data in a well-organized and attractive style.	PSO 1,2,3,4,5,6	K5
CO 6	Develop skills to handle high end instruments like HPLC, GC-MS and AAS	PSO 1,2,3,4,5,6	K6

Course Title	Major Based Elective course-III (MBE 3) – NANOBIOLOGY AND WILDLIFE BIOLOGY		
Code	U22ZY16E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall the basic concept of nanobiology and wildlife biology with conservation measures	PSO 1,2,3,4,6	K1
CO 2	Infer on various applications of nano biotechnology.	PSO 1,2,3,4,6	K2
CO 3	Apply skills of Wildlife habitat studies to solve problems of conservation.	PSO 2,3,4,5,6	K3
CO 4	Discover conservation measures of wildlife and habitat management.	PSO 1,2,3,4,5,6	K4
CO 5	Determine measures of wildlife legislation in a systematically organized manner.	PSO 1,2,3,4,5,6	K5
CO 6	Formulate measures for protecting endangered species	PSO 1,2,3,4,5,6	K6

B.Sc. Zoology Degree Programme
Programme Articulation Matrix (PAM)

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Part I							
Part II							
Part III							
Part IV							
Part V							
Total							

Part – I

TAMIL

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Total Weightage Part I Course contributed to PO's								

Part – II

ENGLISH

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Total Weightage Part - II Course contributed to PO's								

Part – III

CORE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
U22ZY1	Faunal Diversity- Invertebrates	48	34	48	34	11	14	**189**
U22ZY2P	Major Practical – I Faunal Diversity (Invertebrates & Chordates)	54	26	48	34	19	21	**202**
U22ZY3	Faunal Diversity - Chordates	48	36	48	28	11	24	**195**
U22ZY4	Cell and Molecular Biology	40	46	48	42	12	14	**202**
U22ZY5P	Major Practical – II (Pertaining to Cell and Molecular Biology, Physiology and Biochemistry)	36	48	42	42	17	25	**210**
U22ZY6	Physiology and Biochemistry	54	30	48	42	11	12	**197**
U22ZY7	Developmental Biology	54	40	42	42	11	29	**218**
U22ZY8	Microbiology and Immunology	40	36	54	54	22	32	**238**
U22ZY11P	Major Practical – III - (Pertaining to Developmental Biology and Microbiology and Immunology)	40	40	54	54	21	19	**228**
U22ZY12P	Major Practical – IV - (pertaining to Core Courses Genetics and Evolution, Environmental Biology and Management, Biophysics and Biostatistics)	34	33	45	46	28	33	**219**
U22ZY13	Genetics and Evolution	29	37	46	46	20	36	**214**
U22ZY14	Environmental Biology and Management	34	29	54	30	28	46	**221**
U22ZY15	Biophysics and Biostatistics	28	40	54	38	14	38	**212**
Total Weightage of all Core Courses contributed to PO's		**539**	**475**	**631**	**532**	**225**	**343**	**2745**

Part – III

ALLIED COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Total Weightage of Allied Courses contributed to PO's								

Part – III

ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
U22ZY9E	Economic Entomology	32	42	38	48	24	36	**220**
U22ZY10E	Aquaculture	30	30	52	42	28	28	**210**
U22ZY16E	Nanobiology and Wildlife Biology	23	32	54	54	28	30	**221**
Total Weightage of all Elective Courses contributed to PO's		**85**	**104**	**144**	**144**	**80**	**94**	**651**

Part – IV

SKILL BASED MANDATORY COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
U22ES	Environmental Studies							
U22VE	Value Education							
U22SS	Soft Skills							
U22GS	Gender Studies							
Total Weightage of Skill Based Mandatory Courses contributed to PO's								

Part - IV

SKILL BASED COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
U22ZYSBE1	Apiculture and Sericulture	48	36	42	19	21	32	**198**
U22ZYSBE2	Aquarium Fish Keeping and Vermiculture	54	26	38	20	28	46	**212**
U22ZYSBE3P	Practical: Apiculture, Sericulture, Aquarium Fish Keeping and Vermiculture	46	24	48	20	45	54	**237**
Total Weightage of all Skill Based Courses contributed to PO's		**148**	**86**	**128**	**59**	**94**	**132**	**647**

Part – IV

NON – MAJOR ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Total Weightage of all Non – Major Elective Courses contributed to PO's								

Part – IV

EXTRA CREDIT COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
U22ZYECC1	Computational Biology	38	29	36	40	45	37	**225**
U22ZYECC2	Endocrinology	28	30	46	45	38	37	**224**
U22ZYECC3	Environment and Public Health	31	39	45	31	39	46	**231**
U22ZYECC4	Food, Nutrition and Health	37	28	54	46	31	37	**233**
Total Weightage of all Extra Courses contributed to PO's		**134**	**126**	**181**	**162**	**153**	**157**	**913**

Part – V

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
	NSS/NCC/YRC							

UNDER GRADUATE PROGRAMME STRUCTURE

(For Candidates to be admitted from the academic year 2022 onwards)

Practical Examinations will be held only in the even semester. There will be an oral test for all Practical Examinations and Communicative English Courses. The Oral test will carry 5 marks in the external component. Int= internal, Extension activities=NCC, NSS, Red Ribbon Club, etc. Programmes offered by the College, Inst. Hrs = instruction hours, Sem = semester.

FIRST – YEAR

Sem	Part	Course	Course Title	Inst.Hrs/ Week	Credits	Exam Hours	Marks			Total
							Int	External		
								W	O	
I	I	Language Course-U22T1/U22H1/U22S1	Tamil/Hindi/Sanskrit	6	3	3	25	75	-	100
	II	English – I (U22E1)	English	6	3	3	25	75	-	100
	III	Core Course-I (U22ZY1)	Faunal Diversity-Invertebrates	5	5	3	25	75	-	100
	III	Core Course-II (U22ZY2P)	Practical – I: Faunal Diversity: Invertebrates and Chordates	3	-	*	-	-	-	-
	III	First Allied Course – I (U22ACH1)	Chemistry	5	3	3	25	75	-	100
	III	First Allied Course – II (U22ACH2P)	Practical –(Chemistry)	3	-	*	-	-	-	-
	IV	Environmental Studies Course (U22ES)	Environmental Studies	2	2	3	25	75	-	100
		Total		**30**	**16**					**500**
II	I	Language Course-U22T2/U22H2/U22S2	Tamil	6	3	3	25	75	-	100
	II	English –(U22E2)	English	4	3	3	25	75	-	100
	III	First Allied Course – (U22ACH2P)	Practical –(Chemistry)	3	3	3	25	70	5	100
	III	Core Course – (U22ZY2P)	Practical – I (Faunal Diversity-Invertebrates, Faunal Diversity-Chordates)	3	6	3	25	70	5	100
	III	Core Course-(U22ZY3)	Faunal Diversity-Chordates	5	5	3	25	75	-	100
	III	First Allied Course – (U22ACH3)	Chemistry	5	3	3	25	75	-	100
	IV	Skill Based Elective course-I (U22ZYSBE1)	Apiculture and Sericulture	2	2	3	25	75	-	100
		Total		**30**	**25**					**700**

SECOND –YEAR

Sem	Part	Course	Course Title	Inst.Hrs/ Week	Credits	Exam Hours	Marks			Total
							Int	External		
								W	O	
III	I	Language Course-U22T3/U22H3/U22S3	Tamil	6	3	3	25	75	-	100
	II	English– (U22E3)	English	6	3	3	25	75	-	100
	III	Core Course-(U22ZY4)	Cell and Molecular Biology	4	4	3	25	75	-	100
	III	Core Course – V (U22ZY5P)	**Practical – II** (Cell and Molecular biology, Physiology and Biochemistry)	3	-	*	-	-	-	
	III	Second Allied Course-I (U22AZY1)	Biology of Invertebrates and Chordates (for Botany students)	4	3	3	25	75	-	100
	III	Second Allied Course-II (U22AZY2P)	**Practical-**Pertaining to 2AC1 & 2AC3 for Botany Students	3	-	-	-	-	-	-
	IV	Skill based Elective course-II (U22ZYSBE2)	Aquarium fish keeping and Vermiculture	2	2	3	25	75	-	100
	IV	Skill based Elective course-III (U22ZYSBE3P)	**Practical-**Apiculture and Sericulture &Aquarium fish keeping and Vermiculture	2	2	3	25	75	-	100
		Total		**30**	**17**					**600**
IV	I	Language Course-U22T4/U22H4/U22S4	Tamil	6	3	3	25	75	-	100
	II	English Language Course – (U22E4)	English	4	3	3	25	75	-	100
	III	Core Course – (U22ZY5P)	Practical – II (Cell and Molecular Biology, Physiology and Biochemistry)	3	5	3	25	70	5	100
	IV	Core Course-(U22ZY6)	Physiology and Biochemistry	4	4	3	25	75		100
	IV	Second Allied Course –(U22AZY2P)	Practical - (Pertaining to 2AC1 & 2AC3)	3	3	3	25	70	5	100
	IV	Second Allied Course – (U22AZY3)	Economic Zoology (for Botany students)	5	3	3	25	75	-	100
	IV	Non Major Elective course-I (U22ZYNMEI)	Communicable Diseases	2	2	3	25	75	-	100
	IV	Value Education course (U22VE)	Value Education	1	2	3	25	75	-	100
		Total		**30**	**25**					**800**

THIRD - YEAR

Sem	Part	Course	Course Title	Inst. Hrs/Week	Credits	Exam Hours	Marks			Total
							Int	External		
								W	O	
V	III	Core Course-(U22ZY7)	Developmental Biology	5	5	3	25	75	-	100
	III	Core Course -(U22ZY8)	Microbiology and Immunology	5	5	3	25	75	-	100
	III	Major Based Elective Course – (U22ZY9E)	Economic Entomology	5	4	3	25	75	-	100
	III	Major Based Elective Course – (U22ZY10E)	Aquaculture	5	4	3	25	75	-	100
	III	Core Course – (U22ZY11P)	**Practical – III** pertaining to Core Courses U22ZY7 and U22ZY8 (Developmental Biology, Microbiology and Immunology)	3	-	*	-	-	-	-
	III	Core Course-(U22ZY12P)	**Practical – IV** pertaining to Core Courses U22ZY13,14 and 15 (Genetics and Evolution, Environmental Biology and Management, Biophysics and Biostatistics)	3	-	*	-	-	-	-
	IV	Non Major Elective course-(U22ZYNME2)	Sericulture& Apiculture	2	2	3	25	75	-	100
	IV	U22SS	Soft skill	2	2		25	75		100
		Total		**30**	**22**					**600**
VI	III	Core Course – (U22ZY11P)	**Practical – III** pertaining to Core Courses U22ZY7 and U22ZY8	3	5	3	25	70	5	100
	III	Core Course- – (U22ZY12P)	**Practical – IV** pertaining to Core Courses U22ZY13, U22ZY14 andU22ZY15	3	6	3	25	70	5	100
	III	Core Course- – (U22ZY13)	Genetics and Evolution	6	6	3	25	75	-	100
	III	Core Course-– (U22ZY14)	Environmental Biology and Management	6	6	3	25	75	-	100
	III	Core Course-– (U22ZY15)	Biophysics and Biostatistics	6	6	3	25	75	-	100
	III	Major Based Elective (U22ZY16E)	Nanobiology and Wildlife Biology	5	4	3	25	75	-	100
	IV	Gender Studies Course –(U22GS)	Gender Studies	1	1	3	25	75	-	100
	V	Extension Activities		-	1	-	-	-	-	-
		Total		**30**	**35**					**700**
		Grand Total		**180**	**140**					**3900**

EXTRA CREDIT COURSES NOT INCLUDED IN THE TOTAL CREDITS

Code	Title	Credit	Exam Hrs	Marks		Total
				Int.	Ext.	
U22ZYECC 1	Computational Biology	4	3	25	75	100
U22ZYECC 2	Endocrinology	4	3	25	75	100
U22ZYECC 3	Environment and Public health	4	3	25	75	100
U22ZYECC 4	Food, Nutrition and Health	4	3	25	75	100

Changes made - B.Sc Zoology

Theory Papers

S.No.	Course Code	Course Title	Percentage of change made in the course content (%)
1	U22ZY1	Faunal Diversity (Invertebrates)	20
2	U22ZY3	Faunal Diversity (Chordates)	15
3	U22ZY4	Cell and Molecular Biology	25
4	U22ZY6	Physiology and Biochemistry	45
5	U22AZY1	Biology of Invertebrates and Chordates	25
6	U22AZY3	Economic Zoology	50
7	U22NMZY1	Communicable Diseases Non Major Elective Course –(NME-I) (Other than Zoology Students)	5
8	U22NMZY2	Vermiculture & Apiculture Non Major Elective Course –(NME-II) (Other than Zoology Students)	25
9	U22ZY7	Developmental Biology	0
10	U22ZY8	Microbiology and Immunology	0
11	U22ZY9E	Economic Entomology	25
12	U22ZY10E	Aquaculture	0
13	U22ZY13	Genetics and Evolution	0
14	U22ZY14	Environmental Biology and Management	20
15	U22ZY15	Biophysics and Biostatistics	0
16	U22ZY16E	Nanobiology and Wildlife Biology	0

Practical Papers

S.No.	Course Code	Course Title	Percentage of change made in the course content (%)
1	U22ZY2P	Major Practical – I Faunal Diversity (Invertebrates and Chordates)	5
2	U22ZY5P	Major Practical – II(Cell and Molecular Biology, Physiology and Biochemistry)	5
3	U22AZY2P	Allied Practical (Biology of Invertebrates & Chordates andEconomic Zoology)	5
4	U22ZY11P	Major Practical – III (Developmental Biology, andMicrobiology and Immunology)	0
5	U22ZY12P	Major Practical – IV(Genetics and Evolution, Environmental Biologyand Management, Biophysics and Biostatistics)	10

SBE Papers

1	U22ZYSBE1	Apiculture and Sericulture	100
2	U22ZYSBE2	Aquarium fish keeping and Vermiculture	100
3	U22ZYSBE3P	Practical related to U22ZYSBE1and U22ZYSBE2	100

In Total, 24.2% ofthe course content of the B.Sc., Programme has been revised and approved for the academic year 2022 to 2025 by the Board of Studies.

Class	**I-B.Sc., Zoology**	
Semester	**I**	
Course and Code	**Core Course (CC1)**	**Code:U22ZY1**
Course Title	**FAUNAL DIVERSITY - INVERTEBRATES**	
Hours : 5	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives

CEO1.To understand the basis of life processes in Protozoa.
CEO2.To understand the basis of life processes in Porifera and Coelenterata.
CEO3.To understand the basis of life processes in Platyhelminthes and Aschelminthes.
CEO4.To understand the basis of life processes in Annelida and Arthropoda.
CEO5.To understand the basis of life processes in Mollusca and Echinodermata.

UNIT - I: ANIMAL KINGDOM AND PROTOZOA

Outline classification of animal kingdom, General characters and classification up to class level with examples for Protozoa.
Detailed Study: *Paramecium caudatum* (Slipper Animalcule).
General Topics: Reproduction in Protozoans, Protozoan diseases in humans

UNIT - II: PORIFERA AND COELENTERATA

General characters and classification up to class level with examples for Porifera and Coelenterata
Detailed study: *Obelialongissima* (Sea fur).
General topics: Skeleton in sponges, Corals and coral reefs

UNIT - III: PLATYHELMINTHES AND ASCHELMINTHES

General characters and classification up to class level with examples for Platyhelminthes and Aschelminthes
Detailed study :*Taenia solium* (Tape worm).
General topics: Parasitic adaptations of helminthes, Helminth parasites in man(*Ancylostoma duodenale*, *Enterobius vermicularis*, *Trichocephalus trichiuris*, *Taenia solium*, *Schistosoma haematodium*, *Hymenolepis nana*).

UNIT - IV : ANNELIDA AND ARTHROPODA

General characters and classification up to class level with examples for Annelida and Arthropoda.
Detailed study: *Penaeus monodon* (Black tiger shrimp).
General topics: Metamerism in Annelids, Mouth parts of insects.

UNIT - V: MOLLUSCA AND ECHINODERMATA

General characters and classification up to class level with examples for Mollusca and Echinodermata.
Detailed study: *Pila globosa* (Apple Snail).
General topics: Larval forms of Echinoderms (Dipleurula, Bipinnaria, Brachiolaria, ophiopluteus, echinopluteus, Auricularia, Doliolaria of Holothuroidea, Doliolaria of Crinoidea, pentacrinoid), Foot pattern in Molluscs.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Enumerate the diverse groups of invertebrate organisms around us.

CO2: Infer the evolutionary significance of various invertebrate fauna.

CO3: Categorize different levels of biological diversity through the systematic classification of invertebrate fauna.

CO4: Distinguish animals based on their taxonomic classification.

CO5: Elucidate on the physiological and anatomical features of some invertebrate phyla through type study.

CO6: Establish measures to conserve invertebrate organisms.

Textbooks

1. Ayyar, E. K. and T. N. Ananthakrishnan, 1992. A Manual of Zoology, Vol-I (Invertebrata) Parts I & II, Viswanathan Pvt. Ltd.,
2. Nair. N.C., S. Leelavathy, N. Sundarapandiyan, T. Murugan and N. Arumugam 2014.A Text book of Invertebrates. SARAS Publication, Nagercoil.

Reference Books

1. Barrington, E.J.W. 1979, Invertebrates Structure and Function. Ed ELBS and Nelson.
2. Hyman, L.H., 1940-1955, The Invertebrates, Vol – I to VII McGraw Hill Book Co.
3. Jordon, E.L. and P.S. Verma 1995, Invertebrate Zoology, 12th Edn. S.Chand & Co.
4. Kotpal, R.L., S.K. Agarwal, R.P.R.Khetarpal. 1989. Modern Text Book of Zoology, Rostogi Publications.
5. R.S.K. Barnes, P. Calow, P.J.W. Olive & D.W. Golding, 1988. The Invertebrates, A New Synthesis. Blackwell Scientific Publications, Oxford, London.
6. P.S. Dhami & J.K. Dhami, 2021. Invertebrate Zoology. R. Chand & Co., New Delhi, India.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	1	0	1
CO 2	3	9	9	9	0	1
CO 3	9	3	9	9	1	1
CO 4	9	9	9	3	1	1
CO 5	9	3	9	9	0	1
CO 6	9	1	3	3	9	9
Weightage	**48**	**34**	**48**	**34**	**11**	**14**
Weightage percentage of Course contribution to POs						

Class	**I-B.Sc., Zoology**	
Semester	**I and II**	
Course and Code	**Core Course (CC2)**	**Code:U22ZY2P**
Course Title	**MAJOR PRACTICAL – I** **FAUNAL DIVERSITY:(INVERTEBRATES & CHORDATES)**	
Hours : 6 (3+3)	**Credits : 6**	**Max Marks: 75**

Course Educational Objectives
CEO1. Gain experience in anatomy through simple dissections (commercially available dead animals) and virtual mode.
CEO2. Learn the mounting techniques and organ system through prepared-slides.
CEO3. Lear the organ systems through preserved specimen.
CEO4. Learn the organ system through commercially available animals.
CEO5. Learn the economically important invertebrates and vertebrates.

Dissection
Earthworm : Nervoussystem
Fish/ Frog/Chicken/: Various systems through virtual mode

Invertebrates mounting
Earthworm : Body setae, Pineal setae
Prawn : Appendages

Spotters and slides
Protozoa: Paramecium
Porifera: Sycon,Spicules in sponges
Coelenterata: Obelia (entire), Physalia (*Physalia physalis*), Sea anemone (*Metridium senile)*.
Platyhelminthes: Liver fluke, Planaria, Tapeworm, and Scolex
Nemathelminthes: Ascaris (Male and Female).
Annelida: Nereis (*Neries vexillosa*), Parapodium, Heteronereis, Trochophore larva, Arenicola (*Arenicola marina*), Leech (*Hirudinaria granulosa*). Arthropoda: Peripatus, Limulus, Alima larva, Mysis, Cyclops.
Molluscs: Pila
Echinodermata: Starfish (*Asterias rubens*), Pedicillaria

Chordates mounting
Placoid, cycloid, and ctenoid scales

Spotters
Prochordate : Amphioxus (*Branchiostoma lanceolatus*),Balanoglossus (*Balanoglossus gigas*).
Fishes : *Catlacatla*, Shark (*Scoliodon sorrakowah*), Echeneis (*Echeneis naucrates*), Hippocampus (*Hippocampus kuda*), Exocoetus (*Exocoetus volitans*).
Amphibia: Bufo (*Duttaphrynus melanostictus*), Hyla (*Polypedates maculatus*).
Reptilia : *Naja naja*, Monitor Lizard (*Varanus varius*)
Aves : Pigeon (*Columba livia*), Types of Feathers
Mammalian : Rabbit (*Oryctolagus cuniculus*), Bat
Dentition : Rabbit, Man (*Homo sapien*)

Field study

- Collection and Submission of different insects
- Collection and submission of different mollusc varieties
- Collection and submission of different types of feathers in birds
- Collection and Preservation of Invertebrates and vertebrate specimens – Demonstration
- Photographic Documentation and submission of Animal diversity in surrounding

A record of lab work should be maintained and submitted at the time of practical exam.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: List Invertebrate and Chordate specimens with precision.
CO2: Illustrate scientific drawing of specimens.
CO3: Make use of dissections and mounting techniques to study invertebrates and chordates.
CO4: Compare various groups of Invertebrates and Chordates.
CO5: Assess the ecological importance of invertebrates and chordate species.
CO6: Build awareness of the economic importance of invertebrates and chordates.

Textbooks

1. P.S. Verma and P.C.Srivastava 2007. Advanced Practical in Zoology (Chand & Co.)
2. S.S. Lal 2004. Practical Zoology : Chordates (Rastogi Publications)

Web References

1. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/zoology_lab/labs/exp3/theory.php
2. https://www.faunafondness.com/fish-slides/
3. https://www.biologydiscussion.com/fisheries/fish/dissection-and-structures-of-different-types-of-fishes-zoology/45377
4. https://www.wildlifewatch.org.uk/wildlife-explorer/invertebrates
5. https://www.adfg.alaska.gov/index.cfm?adfg=abalone.main
6. https://www.mlsu.ac.in/econtents/758_PRACTICAL%20ZOOLOGY%20%20VERTEBRATE%20(%20PDFDrive%20).pdf
7. http://rltsc.edu.in/wp-content/uploads/2020/09/Digital-Gallery-of-Museum-Specimens-Chordates.pdf

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	1	0	1
CO 2	9	9	9	9	0	1
CO 3	9	1	9	9	1	0
CO 4	9	1	9	9	0	1
CO 5	9	3	9	3	9	9
CO 6	9	3	3	3	9	9
Weightage	**54**	**26**	**48**	**34**	**19**	**21**
Weightage percentage of Course contribution to POs						

Class	**I-B.Sc., Zoology**	
Semester	**II**	
Course and Code	**Core Course (CC3)**	**Code:U22ZY3**
Course Title	**FAUNAL DIVERSITY - CHORDATES**	
Hours : 5	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives

CEO1. Learn the diversity in form, structure and habits of Prochordates.
CEO2. Learn the diversity in form, structure and habits of Pisces.
CEO3. Learn the diversity in form, structure and habits of Amphibians and Reptiles.
CEO4. Learn the diversity in form, structure and habits of Birds.
CEO5. Learn the diversity in form, structure and habits of Mammals.

UNIT-I: PROCHORDATA
General characters and classification of Chordates upto order level with examples.
Detailed Study: Amphioxus-*Branchiostoma lanceolatus*
General Topics: Retrogressive metamorphosis in Ascidia, Affinities of Balanoglossus.

UNIT-II: PISCES
General characters and classification up to sub-classes with examples.
Detailed Study: - Shark- *Scoliodon sorrakowah* (Excluding endoskeleton)
General Topics: Parental care in fishes, Migration in fishes.

UNIT- III: AMPHIBIA AND REPTILIA
General characters and classification up to order with examples for Amphibia.
General characters and classification up to order with examples for Reptilia.
Detailed Study: Frog – *Rana hexadactyla* (Excludingendoskeleton)
General Topics: Neoteny in Amphibia, Poisonous snakes of South India

UNIT-IV: AVES
General characters and classification up to order with examples.
Detailed Study: Pigeon- *Columba livia* (Excluding endoskeleton)
General Topics: Beak and feet adaptation in birds, flight adaptation in birds.

UNIT- V: MAMMALIA
General characters and classification up to sub-classes with examples.
Detailed Study: Rabbit- *Oryctolagus cuniculus* (Excluding endoskeleton)
General Topics: Dentition in mammals, Adaptations of aquatic mammals.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define the diversity of Chordates and the relationship among the different Chordate groups.
CO2: Demonstrate understanding on the concept of classification of Chordates.
CO3: Classify comparative anatomy and development systems of Chordates.
CO4: Examine ecological importance of some fishes, amphibians' reptiles, birds and mammals.
CO5: Recommend conservation and management strategies for Chordate fauna.
CO6: Develop molecular technique for identifying Chordate taxa.

Textbooks

1. Ekambaranathan Ayyar, I,1993 –Outlines of Zoology–Vol–II Viswanathan Pvt.Ltd.
2. Nair. N.C., S. Leelavathy, N. Sundarapandiyan, T. Murugan and N.arumugam 2014. A Text book of Invertebrates.SARASPublication,Nagercoil.

Reference Books

1. Kardong, K.V.(2005) Vertebrates Comparative Anatomy, Function and evolution.IV Edition. McGraw Hill HigherEducation.
2. Kent,G.C.and CarrR.K.(2000). Comparative Anatomy of theVertebrates.IX Edition. The McGraw Hill Companies.
3. Young,J.Z.(2004).The life of vertebrates.III Edition.Oxford university press.
4. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers, Inc.
5. Newman, H. H., 1981. The Phylum Chordata: Biology of Vertebrates and their Kin. Satish Book Enterprise, Agra India.
6. Jeffery Parker, T.J. & William A. Haswell, 1977. Textbook of Zoology, Vertebrates (Vol II) (7th Edition). The Macmillian Press Ltd., London.
7. Robert T. Orr, 1976. Vertebrate Biology (4th Edition).W.B. Saunders Company, London.
8. Harish C. Nigam, 2017. Biology Of chordates (A Composite Volume). Vishal Publishing Co., India.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	3	0	1
CO 3	9	3	9	9	0	1
CO 4	9	3	9	3	1	9
CO 5	9	3	3	1	9	9
CO 6	3	9	9	9	1	3
Weightage	**48**	**36**	**48**	**28**	**11**	**24**
Weightage percentage of Course contribution to POs						

Class	**I-B.Sc., Zoology**	
Semester	**II**	
Course and Code	**Skill Based Elective course-I (SBE:1)**	**Code:U22ZYSBE1**
Course Title	**APICULTURE AND SERICULTURE**	
Hours : 2	**Credits : 2**	**Max Marks: 75**

Course Educational Objectives

CEO1. To learn about the external morphology of Silkworm and Honey.
CEO2. To learn about beehives, bee keeping equipment, methods of extraction of honey and processing of honey, mulberry cultivation.
CEO3. To acquire knowledge on Pests and diseases associated with Silkworm and Honey Bee.
CEO4. To learn about steps involved in silk production and various products from Apiculture
CEO5. To make them entrepreneurs in Apiculture and Sericulture.

APICULTURE

UNIT – I

Introduction to Apiculture –Scope and importance. History of bee keeping: Definition, Bee keeping in worldwide, In India. Traditional bee keeping, Modern beekeeping, Urban or backyard beekeeping.

UNIT – II

Honey Bee species and their identification: Origin, systematic and distribution of honey bees. Caste system in honey bee, Types of honey bees, Species of honey bees. Bee identification.

UNIT – III

Bee keeping tools and equipment: Bee keeping equipment - introduction to types of bee boxes - BIS standard tools used in Apiculture. Bee breeding multiplication of colonies, Economic importance of Apiculture

SERICULTURE

UNIT IV

Definition, history and present status; Types of silkworms, Distribution and races - Exotic and indigenous races. Mulberry and non-mulberry. Biology and lifecycle of *Bombyx mori*

UNIT V

Silk fibre formation- Properties of cocoon filament – Pre reeling- process- cocoon boiling. Reeling and Re-reeling technology- raw silk industry-by-products of silk industries. Entrepreneurship in Sericulture.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define Silk Worm and Honey Bee types.
CO2: Demonstrate on beehives, bee keeping equipment, methods of extraction of honey and processing of honey, mulberry cultivation.
CO3: Categorize pests and diseases associated with silk worm and Honey Bee.
CO4: Explicate steps involved in silk production and various types of silk produced from different silk moths.

CO5: Elucidate Economic importance of Apiculture.
CO6: Build entrepreneurship opportunity in Apiculture and Sericulture.

Textbooks

1. Shukla, G.S. and V.B. Upadhyay 2003 Economic Zoology, Rastogi publications.
2. Ahsan, J. and S.P. Shiha 2005 A hand book of Economic Zoology, S. Chand & Co.
3. Arumugam, N. 2013. Economic Zoology, Saras Publication.

References

1. Dewey M. Caron, 2013. Honey Bee Biology and Beekeeping, Revised Edition. Wicwas Press, Kalamazoo.
2. Pradip V Jabde, 1993. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests and their Controls. Discovery Publishing House, New Delhi.
3. Eva Crane, 1999. The World History of Beekeeping and Honey Hunting. Routledge, India.
4. Ted Hooper, 2010. Guide to Bees & Honey: The World's Best Selling Guide to Beekeeping. Northern Bee Books, Oxford
5. Laidlaw, H.H., 1997. Contemporary queen rearing.Published by Dadant and Sons.
6. R. A. Morse, Rearing queen honey bees. Wicwas press, NY.
7. Alison Benjamin, By (author) Brian McCallum, 2008. Keeping Bees and Making Honey. David &Charles, Newton Abbot.
8. Kim Pezza, 2013. Backyard Farming: Keeping Honey Bees: From Hive Management to Honey Harvesting and More. Hatherleigh Press, U.S
9. Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Books.
10. Sreerama Reddy, G. 1998. Silkworm Breeding, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
11. Otsuki et.al. 1987. Silkworm Egg Production (Translated from Japanese language), Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
12. Yasuji Hamamura 2001 Silkworm Rearing on Artificial Diet (Translated from Japanese language), Oxford and IBH publishing Co. Pvt Ltd, New Delhi.
13. Mahadevappa, D. Halliyal, V.G., Sankar, D.G and I Bhandiwad R. 2000. Mulberry Silk Reeling Technology, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
14. Tazima 1978. The Silkworm an Important Laboratory Tool, Kodansha publication, Tokyo, Japan.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	0	0	3
CO 3	3	9	9	9	0	1
CO 4	9	3	3	3	9	9
CO 5	9	3	9	3	3	9
CO 6	9	3	3	1	9	9
Weightage	**48**	**36**	**42**	**19**	**21**	**32**
Weightage percentage of Course contribution to POs						

Class	**II-B.Sc., Zoology**	
Semester	**III**	
Course and Code	**Core course (CC4)**	**Code:U22ZY4**
Course Title	**CELL AND MOLECULAR BIOLOGY**	
Hours : 4	**Credits : 4**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the structure of Prokaryotic cell and Eukaryotic cell.
CEO2. To understand the structure and function of Golgi complex, Lysosomes and Mitochondria.
CEO3. To understand the structure and function of Chromosomes, Nucleus and RNA.
CEO4. To understand the DNA, mitosis, meiosis and gene
CEO5. To understand the basics of biotechnology.

UNIT – I

Cell structures: Prokaryotes and Eukaryotes.
Plasma membrane: Fluid mosaic model, structure, and functions. Endoplasmic reticulum: Structure, types, and functions.

UNIT – II

Golgi complex: Ultra structure and functions. Lysosome: Origin, ultra structure, and functions. Mitochondria: Origin, ultrastructure and functions.

UNIT – III

Ribosome: Structure and functions. Nucleus: Ultrastructure and functions. Chromosomes: Ultra structure and functions. RNA: Types structure and function.

UNIT – IV

DNA: Molecular structure, types and functions
DNA replication, Enzymes involved in DNA damage and repair mechanisms.
Cell Division: Mitosis and Meiosis regulation and steps in cycles. Genetic code and Protein synthesis.

UNIT – V

Principles and methods of gene cloning and its application.
Gene Cloning Vectors**:** Plasmids- pBR322, Cosmids pJB8, SV 40.
Recombinant DNA Technology: Gene library, Transformation, Transduction
Blotting techniques: Southern, Northern, and Western. RFLP, RAPD and AFLP, Gene therapy

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall the composition of prokaryotic and eukaryotic cells.
CO2: Infer the structure of cells and cell organelles in relation to the functional aspects.
CO3: Categorize the structure and functions of chromosome.
CO4: Analyze mitotic and meiotic cell divisions and their significance.
CO5: Elucidate the structure of DNA, mechanism behind DNA replication, RNA and protein synthesis.
CO6: Fabricate basic biotechnology tools and techniques for solving real world problems.

Textbooks

1. Verma, P.S. and V.K. Agarval.2009. Cell biology, genetics, molecular biology, evolution and ecology. S. Chand & Co
2. Meyyan R.P. 2005. Cell Biology, Saras Publications.
3. James D. Watson 1977. Molecular biology of the Gene: The Benjamin Cummings Publications III Ed.
4. Arumugam, N. 2005. Biotechnology. Saras Publications.

Reference Books

1. De Roberties, E.P.P. and E.M.F. De Roberties 1987. Cell and Molecular Biology
2. Power, C.B., 1989. Essentials of Cytology. Himalaya Publishing House.
3. Tomar & Singh, 1999. Cell Biology. Rastogi Publication, Meerut.
4. Darner, Lodish and Baltimore 1990. Molecular Cell Biology, IIEd.
5. Watson *et al*., 1987. Molecular Biology of the Gene.
6. Shukla 2005. Histological Techniques
7. Balasubramanian, D. 1996. Concepts of Biotechnology. University Press (India) Ltd.Hyderabad.
8. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California,USA.
9. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington,USA.
10. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis.IX
11. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley and SonsInc.
12. Dubey, R.C. 2008. A Text Book of Biotechnology, S. Chand & Co, NewDelhi.
13. Kumaresan, V., 2006. Biotechnology, Saras Publication, Nagercoil.
14. Gupta, P.K. 2006. Elements of Biotechnology, Rastogi Publications, Meerut.
15. Lewin, B. 2002. Gene XI, Oxford University Press, NewYork.
16. Rastogi, S.C 2011 A Text book Cell Biology, Age International (P) Publishers. New Delhi.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	0
CO 2	9	9	9	3	0	1
CO 3	3	9	9	9	1	0
CO 4	1	9	9	9	1	1
CO 5	9	9	9	9	1	3
CO 6	9	1	3	9	9	9
Weightage	**40**	**46**	**48**	**42**	**12**	**14**
Weightage percentage of Course contribution to POs						

Class	**II-B.Sc., Zoology**	
Semester	**III and IV**	
Course and Code	**Core course (CC5)**	**Code:U22ZY5P**
Course Title	**MAJOR PRACTICAL – II (Pertaining to Cell and Molecular Biology, Physiology and Biochemistry)**	
Hours : 6 (3+3)	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives
CEO1. To understand the microtechniques.
CEO2. To distinguish different cells & muscle types.
CEO3. To enumerate RBC, WBC and measure pH.
CEO4. To perform physiological and biochemical tests.
CEO5. To understand the functional aspects of SEM, HPLC, and AAS.

Cell and Molecular Biology
Preparation of solution: Molarity, Normality and Percentage.
Mounting of buccal epithelium and observing epithelial cells.
Spotters : Columnar, Ciliated, Squamous epithelium, Cardiac, Striated,Non-striated muscle, Nerve cell, Blood of frog and man, Compound microscope, Centrifuge, Micrometer, Camera Lucida,Microtome.
Experimental
Isolation of DNA (Demonstration only)
DNA amplification (Demonstrationonly)
Spotters: Bioreactor, Plasmid (pBR322, SV 40), PCR.

Physiology
Experimental
Enumeration of RBC and WBC.
Qualitative tests for ammonia, urea and uricacid.
Spotters: Haemoglobinometer, Kymograph, Sphygmomanometer.

Biochemistry
Experimental
Qualitative tests for proteins, carbohydrates and lipids
pH measurement of various samples using pH meter and pHpaper
Estimation of Hemoglobin

Demonstration: SEM, HPLC, AAS at NCIF
Demonstration: Whole mount preparation-Killing, fixing, staining, permanent/temporary mounting.Histological preparation-Collection of tissue, washing, Dehydration, clearing, infiltration, sectioning, staining.

A record of lab work should be maintained and submitted at the time of the practical examinations.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Recall basic analytical chemistry relating to preparation of solution.
CO2: Infers about the mounting of buccal epithelium and identification of various cell types

found in humans.

CO3: Utilize various biotechnological and physiological tools.

CO4: Explicate steps involved in enumeration of blood cells, qualitative estimation of biomolecules and histological techniques.

CO5: Estimate nitrogenous waste from different samples and DNA isolation and amplification.

CO6: Elaborate the operation of high end instruments like SEM, HPLC, and AAS.

Textbooks

1. P.S. Verma and P.C.Srivastava 2007. Advanced Practical in Zoology (S. Chand &Co.)
2. K.C.Ghose and B.Manna 2004. Practical Zoology : New central book agency

Web References

1) https://mgscience.ac.in/wp-content/uploads/2021/02/protocol-blood-cell-count.pdf
2) https://www.klimud.org/public/atlas/idrar/web/www.irvingcrowley.com/cls/fund.htm
3) https://www.mayoclinic.org/tests-procedures/complete-blood-count/about/pac-20384919
4) https://www.youtube.com/watch?v=7AWu4Qb_Emk
5) https://www.bbc.co.uk/bitesize/guides/z3wr2nb/revision/3
6) https://bio.libretexts.org/Learning_Objects/Laboratory_Experiments/General_Biology_Labs/General_Biology_Labs/Carbohydrates_Lipids_Proteins
7) https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/dna-isolation-gel-electrophoresis-and-pcr/
8) https://www.cleaverscientific.com/applications/agarose-gel-electrophoresis-of-dna/
9) http://www.bch.cuhk.edu.hk/synbio/manuals/1-Plasmid-DNA-extraction-agarose-gel-electrophoresis.pdf
10) http://dhiantika.staff.ugm.ac.id/files/2011/04/DNA-ISOLATION-LDW.pdf

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	3	1	0
CO 3	3	9	9	9	3	3
CO 4	3	9	3	9	1	9
CO 5	3	9	9	9	3	9
CO 6	9	3	3	9	9	3
Weightage	**36**	**48**	**42**	**42**	**17**	**25**
Weightage percentage of Course contribution to POs						

Class	**II – B.Sc., Allied Zoology (For Allied Students)**	
Semester	**III**	
Course and Code	**Second Allied Course –1 (2AC1)**	**Code: U22AZY1**
Course Title	**BIOLOGY OF INVERTEBRATES AND CHORDATES**	
Hours :4	**Credits : 3**	**Max Marks: 75**

Course Educational Objectives

CEO1. Understand the Invertebrates and Vertebrates on basis of systematic classification.
CEO2. Understand the life processes of Paramecium.
CEO3. Understand the life processes of Earthworm.
CEO4. Understand the life processes of Frog.
CEO5. Understand the life processes of Rabbit.

UNIT – I

General characters of Invertebrates.
Outline classification of Invertebrates up to class.
General characters of Chordates.
Outline classification of Chordates up to order.

UNIT – II

Detailed study of *Paramecium caudatum*–(Slipper animalcule): External features, Nutrition, mechanism of locomotion and reproduction: Sexual reproduction- conjugation, Asexual – Binary fission

UNIT – III

Detailed study of Earthworm (*Megascolex mauritii*)
External features, digestive system, nervous system and reproductive system

UNIT – IV

Detailed study of Frog (*Rana hexadactyla*): External features, respiratory system, Digestive System, circulatory system and urinogenital system.

UNIT – V

Detailed study of Rabbit (*Oryctolagus cuniculus*): External features, digestive system, respiratory system, circulatory system and urinogenital system.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define the diversity of Invertebrates and Chordates.
CO2: Trace Invertebrates and Chordates to their respective classes based on their concepts of evolutionary ancestry.
CO3: Utilize skills on anatomy and development systems of certain species of Invertebrates and Chordates .
CO4: Analyze ecological importance of some Invertebrate and Chordate species.
CO5: Deduce conservation and management strategies of the Invertebrate and Chordate fauna.
CO6: Construct Phylogenetic tree for Invertebrate and chordate species.

Textbooks

1. Ekambaranatha Ayyar, M. 1988. Outlines of Zoology. Viswanathan Publications.
2. Ekambaranatha Ayyar, M. 1988. A Manual of Zoology, Vol. I & II. Viswanathan
3. Nair, N.C. 2006. A Text Book of Invertebrates, Saras Publications, 3rdEd.
4. Jordan, E.L. 2000. Invertebrate Zoology. S.Chand and Co.
5. Jordan, E.L. 2000. Chordate Zoology. S.Chand and Co.
6. Arumugam. N. Outlines of Zoology, 1998. Saras Publications.
7. Arumugam. N. A Text Book of Chordates, 2020. Saras Publications.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	9	0	1
CO 3	3	9	9	9	1	1
CO 4	9	3	1	9	9	9
CO 5	9	3	3	3	9	9
CO 6	9	3	3	9	9	9
Weightage	**48**	**36**	**34**	**42**	**28**	**30**
Weightage percentage of Course contribution to POs						

Class	**II – B.Sc., Allied Zoology (For Allied Students)**	
Semester	**III and IV**	
Course and Code	**Second Allied Course 2 – (2AC2)**	**Code: U22AZY2P**
Course Title	**ALLIED PRACTICAL - (Pertaining to Biology of Invertebrates & Chordates and Economic Zoology)**	
Hours : 6 (3+3)	**Credits : 3**	**Max Marks: 75**

Course Educational Objectives
CEO1. To learn the simple dissection technique.
CEO2. To learn the virtual dissection technique.
CEO3. To learn the mounting technique.
CEO4. To learn the organ system through preserved specimen and permanent slides.
CEO5. To learn the importance of animal products.

Dissections (commercially available dead animals)
Earthworm : Nervous system

Mountings
Earthworm : Body and Pineal setae
Shark : Placoid scale

Spotters

Paramecium, Sponge - Ascon, Obelia colony, Sea anemone, Ascaris, Liver fluke, Tape worm, Earthworm, Leech, Prawn, Scorpion, Grass hopper, Freshwater mussel, Pila, Starfish, Amphioxus, Shark, *Catla catla*, Frog, Calotes, *Naja naja*, Pigeon, Rat and Bat.
Species of animals used in Vermiculture, Apiculture, Lac-culture, Sericulture, Aquaculture and Poultry farming.

Products: Honey, Beewax, Silk, Cod liver oil, Pearl, Bird's egg.

A record of lab work should be maintained and submitted at the time of practical exam

Course Outcomes
Upon Completion of the course student would be able to:
CO1: List Invertebrate and Chordate specimens with precision.
CO2: Illustrate scientific drawing of specimens.
CO3: Make use of dissections and mounting techniques to study invertebrates and chordates.
CO4: Compare various groups of Invertebrates and Chordates.
CO5: Assess the ecological importance of invertebrates and chordate species.
CO6: Build awareness of the economic importance of some animal products.

Textbooks
1. P.S. Verma and P.C.Srivastava 2007. Advanced Practical in Zoology (S.Chand &Co.)
2. S.S. Lal 2004. Practical Zoology: Chordates (Rastogi Publications).

Web References
1. http://vlabs.iitb.ac.in/vlabs-dev/labs_local/zoology_lab/labs/exp3/theory.php

2. https://www.faunafondness.com/fish-slides/
3. https://www.biologydiscussion.com/fisheries/fish/dissection-and-structures-of-different-types-of-fishes-zoology/45377
4. https://www.wildlifewatch.org.uk/wildlife-explorer/invertebrates
5. https://www.adfg.alaska.gov/index.cfm?adfg=abalone.main
6. https://www.mlsu.ac.in/econtents/758_PRACTICAL%20ZOOLOGY%20%20VERTEBRATE%20(%20PDFDrive%20).pdf
7. http://rltsc.edu.in/wp-content/uploads/2020/09/Digital-Gallery-of-Museum-Specimens-Chordates.pdf

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	1	0	1
CO 2	9	9	9	9	0	1
CO 3	9	1	9	9	1	0
CO 4	9	1	9	9	0	1
CO 5	9	3	9	3	9	9
CO 6	9	3	3	3	9	9
Weightage	54	26	48	34	19	21
Weightage percentage of Course contribution to POs						

Class	**II-B.Sc., Zoology**	
Semester	**III**	
Course and Code	**Skill Based Elective course-II (SBE:2)**	**Code:U22ZYSBE2**
Course Title	**AQUARIUM FISH KEEPING AND VERMICULTURE**	
Hours : 2	**Credits : 2**	**Max Marks: 75**

Course Educational Objectives

CEO1. Learn the basic principles, themes and steps needed to set-up and maintain an aquarium.
CEO2. Learn the maintenance techniques of an aquarium.
CEO3. Learn the basic principles, themes and steps needed for vermiculture.
CEO4. Learn the techniques involved in vermiculture.
CEO5. Learn the entrepreneurial opportunities in Aquarium fish keeping and Vermiculture.

AQUARIUM FISH KEEPING

UNIT - I

Introduction to Aquarium fish, Exotic and Endemic species of Aquarium fishes, Common characters and sexual dimorphism of Freshwater and Marine aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, , Fighter fish, Zebra fish, Angel fish.

UNIT II

Food and feeding of aquarium fishes. Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Maintenance of Aquarium– budget for setting up an Aquarium, Fish farm as a Cottage industry.

VERMICULTURE

UNIT – III

Vermiculture – definition, scope and importance, common species for culture. Life cycle, growth of *Lampito mauritti*, *Perionyx excavatus*. Optimal conditions for vermiculture – temperature, pH, soil type, organic matter, protection from sun light, rain and predators.

UNIT-IV

Environmental requirements, culture methods – wormery – breeding techniques, indoor and outdoor cultures – monoculture and polyculture – Outline and ecological classification – Epigeic, Endogeic and Anecicspecies.

UNIT-V

Applications of Vermiculture, vermicomposting, use of vermicastings and vermiwash in organic farming: earthworms for management of municipal waste, selected biomedical solid wastes as feed, bait for capture, culture fisheries, forest regeneration. Medicinal importance.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: List the economic importance of ornamental fishes and earth worms.
CO2: Trace different types of ornamental fishes and to apply modern methods on aquarium culture.
CO3: Make use of earthworm in organic farming and Solid waste Management.

CO4: Explicate learning environment for Vermiculture.
CO5: Appraise branches of applied Zoology with skill and knowledge.
CO6: Build entrepreneurship opportunities through products derived from animals.

Textbooks

1. Sultan Ahmed Ismail, 2005. The Earthworm Book. Second Revised Edition. Other India Press, Goa, India.
2. Tripathi, G. Vermiresource Technology, 2003, Discovery Publishing House, New Delhi.
3. Shukla, G.S, and Upadhyay V.B., 2000. Economic Zoology, Rastogi Publications Meerut.

Reference Books

1. Aquarium : Fish Keeping C B L Srivastava Published by Kitab Mahal.
2. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie.
   Published by Chelsea House Publications (1998).
3. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R.
   Published by Chelsea House Publications (1998)
4. The Tropical Freshwater Aquarium Problem Solver: Practical and Expert Advice on Keeping fish and Plants Sand ford, Gina Published by Voyageur Press (MN) (1998)
5. Thierry Maitre-alain and Chrisitan Piednoir 2009. Aquariums: The Complete Guide to Freshwater and Saltwater Aquariums.
6. Mary Violet Christy, A. Vermitechnology, 2008, MJP Publishers.
7. Arvind Kumar, Verms & Vermitechnology, 2005. APH Publishing Cooperation.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	1	0	9
CO 3	9	1	1	3	9	9
CO 4	9	1	9	3	9	9
CO 5	9	3	9	9	1	9
CO 6	9	3	1	1	9	9
Weightage	**54**	**26**	**38**	**20**	**28**	**46**
Weightage percentage of Course contribution to POs						

Class	**I-B.Sc., Zoology**	
Semester	**III**	
Course and Code	**Skill Based Elective course-III (SBE:3)**	**Code:U22ZYSBE3P**
Course Title	**PRACTICAL: APICULTURE AND SERICULTURE & AQUARIUM FISH KEEPING AND VERMICULTURE**	
Hours : 2	**Credits : 2**	**Max Marks: 75**

Course Educational Objectives

CEO1. To know about steps involved in bee keeping with different types of honey bee and to commercialize the byproduct of beekeeping.
CEO2. To Learn Identification and Interpretation of different types of Silkworms, and comprehend the methodologies involved in Silkworm rearing.
CEO3. To deploy vermitechnology for sustainable agriculture and to understand primary, Secondary degradation and vermibed preparation.
CEO4. To impart knowledge on aquarium fishes and to artificially create and maintain natural habitat of aquarium fishes.
CEO5. To provide idea on entrepreneurial opportunities in fields of applied Zoology.

APICULTURE

Spotters: Identify, classify and describe Honey Bees: i. Rock bee, *Apis dorsata*. ii. Little bee, *A. florae* iii. Asian bee, *A.cerana*. iv. European bee, *A. mellifera*.
Spotters: Bee products –honey, pollen, royal jelly, bee wax

SERICULTURE

Life cycle of *Bombyx mori*- Morphology of egg, larva, pupa and adult of *Bombyx mori*.

AQUARIUM FISH KEEPING

Spotters: Identify, classify and describe aquarium fishes (Freshwater ornamental fishes - Guppy, Gold fish. Brackish water ornamental fishes - Black Molly, Sword tail. Marine ornamental fishes- Anemone fish & Butterfly fish.
Spotters: Identify and describe the aquarium accessories with their use and maintains: An aquarium tank.

VERMICULTURE

Spotters: Earthworm egg and vermicompost

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Enumerate steps involved in bee keeping with different types of Honey Bee.
CO2: Demonstrate different types of Silkworms, and methodologies involved in Silkworm rearing.
CO3: Apply vermitechnology for sustainable agriculture.
CO4: Distinguish aquarium fishes and to maintain natural habitat of aquarium fishes.
CO5: Appraise sustainable agricultural practice using vermi products.
CO6: Develop commercialization for byproducts of beekeeping

SBE Practical Exam question pattern

Submission: Aquarium tank & honey comb or Vermicompost tank and silkworm cocoon	20 marks
Field visit	10 marks
Spotters	40 marks
Oral	05 marks
	---
	75 marks

Textbooks

1. Aquarium : Fish Keeping C B L Srivastava Published by Kitab Mahal.
2. Sultan Ahmed Ismail, 2005. The Earthworm Book. Second Revised Edition. Other India Press, Goa, India.
3. Pradip V Jabde, 1993. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests and their Controls. Discovery Publishing House, New Delhi.
4. Sreerama Reddy, G. 1998. Silkworm Breeding, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.

References

1. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie. Published by Chelsea House Publications (1998) .
2. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998).
3. Mary Violet Christy, A. Vermitechnology, 2008, MJP Publishers.
4. Arvind Kumar, Verms & Vermitechnology, 2005. APH Puiblishing Cooperation.
5. Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Books.
6. Yasuji Hamamura 2001 Silkworm Rearing on Artificial Diet (Translated from Japanese language), Oxford and IBH publishing Co. Pvt Ltd, New Delhi.
7. Mahadevappa, D. Halliyal, V.G., Sankar, D.G and I Bhandiwad R. 2000. Mulberry Silk Reeling Technology, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
8. Tazima 1978. The Silkworm an Important Laboratory Tool, Kodansha publication, Tokyo, Japan.

Web References

1. https://www.youtube.com/watch?v=5UVwmdRVJTk
2. https://www.selfstudys.com/sitepdfs/TV4vxynM0RbGev1TbydA
3. Applied and Economic Zoology (SWAYAM) web https://swayam.gov.in/nd2_cec20_ge23/preview
4. http://agritech.tnau.ac.in/fishery/fish_ifs.html
5. http://agropedia.iitk.ac.in/content/integrated-fish-cum-pig-farming
6. http://www.celkau.in/Fisheries/CultureFisheries/Intergrated%20Fish%20Farming/generl%20inform.aspx
7. http://www.fao.org/docrep/field/003/ac375e/AC375E04.htm

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	1	0	9
CO 2	9	1	9	3	9	9
CO 3	9	1	9	3	9	9
CO 4	9	1	9	3	9	9
CO 5	9	9	9	1	9	9
CO 6	1	3	3	9	9	9
Weightage	**46**	**24**	**48**	**20**	**45**	**54**
Weightage percentage of Course contribution to POs						

Class	**II-B.Sc., Zoology**	
Semester	**IV**	
Course and Code	**Core Course (CC6)**	**Code:U22ZY6**
Course Title	**PHYSIOLOGY AND BIOCHEMISTRY**	
Hours : 4	**Credits : 4**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the physiology of digestion, respiration and circulation.
CEO2. To understand the physiology of nerves and endocrine glands.
CEO3. To understand the physiology of muscle and excretion.
CEO4. To understand the metabolism of protein, carbohydrate and lipid.
CEO5. To understand the enzymes and vitamins.

UNIT – I

Nutrition: Types.
Digestion and absorption in Man.
Respiration: Transport of O_2 and CO_2 in man
Circulation: Blood composition, Origin and conduction of heart beat in man.

UNIT – II

Nerve physiology: Structure of Neuron, Types- Unipolar, Bipolar, Pseudo polar, Multipolar, Neurotransmitters, Impulse transmission, Synapse, Synaptic transmission, Reflex action.
Endocrine physiology: Endocrine glands in man, basic mechanism of hormone action, Hormones and diseases.

UNIT –III

Muscle physiology: Types of muscles, Ultrastructure of muscle fiber, Physiology of muscle contraction.
Excretion: Types of nitrogenous wastes -ammonia, urea and uric acid.
Structure of mammalian kidney and Urine formation.

UNIT – IV

Bio chemistry: Principles of physical chemistry, Thermodynamics law.
Acid –Base Balance: Acids and Base, pH Living Organisms and Buffer System and pH Regulation.
Classification: Carbohydrates, Proteins and Lipids, Krebs's cycle, Protein metabolism and Lipid metabolism.

UNIT – V

Enzymes: Classification, Characteristics, Mode of action, Theories, Factors affecting enzyme action.
Vitamins: Types, Sources, Functions and Deficiency diseases. Calorific values, Balanced diet.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define concepts of digestion, respiration, excretion and the functioning of nerves and muscles.

CO2: Demonstrate on neurophysiology, receptors and hormones.

CO3: Identify various bio molecules and their role in metabolism.

CO4: Explicate steps involved in metabolism of carbohydrates, protein, lipid and various biochemical pathways.

CO5: Elucidate classification of enzymes, their mode of action and diseases caused due to their deficiency.

CO6: Devise therapy for various metabolic syndromes of body.

Textbooks

1. Veerakumari. L. 2008. Biochemistry, MPJPublications.
2. Agarwal, R.A.A.K. Srivastava and Kaushal Kumar, 2005. Animal Physiology and Biochemistry. S. Chand & Co NewDelhi.
3. Sathiyanarayana , U and Chakarabani.U, 2017 Text Book of Biochemistry, Elsevier India Publication
4. Arumugam.N, 2005 Text Book of Biochemistry , Saras Publication

Reference Books

1. Berry A.K. 1998. A text book of Animal Physiology. Emkay Pub., New Delhi –51.
2. Hoar, W.S. 1983. General and Comparative Physiology. Printice Hall ofIndia.
3. Nagabushanam R. 1991. Animal Physiology. S. Chand &Co.
4. Harper, H.A. 1993. Review of Physiological Chemistry. Muruzen AscianEd.
5. Lehninger L.,1990. Biochemistry.W. H.Freeman & Co.
6. Agarwal .P.L 1980 Elements of Biochemistry, Goel Publishing House, Meerut,India.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	3	0	1
CO 2	9	1	9	9	0	0
CO 3	9	1	9	9	0	0
CO 4	9	9	9	9	1	1
CO 5	9	9	9	9	1	1
CO 6	9	1	3	3	9	9
Weightage	54	30	48	42	11	12
Weightage percentage of Course contribution to POs						

Class	**II – B.Sc., Allied Zoology (For Allied Students)**	
Semester	**IV**	
Course and Code	**Second Allied Course 3 – (2AC3)**	**Code: U22AZY3**
Course Title	**ECONOMIC ZOOLOGY**	
Hours : 5	**Credits : 3**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the prawn culture techniques.
CEO2. To understand the pearl culture techniques.
CEO3. To understand the sericulture techniques.
CEO4. To understand the fish culture techniques.
CEO5. To understand the poultry farming techniques.

UNIT – I

Freshwater prawn culture – Preparation of farm – Reproduction- Natural and Artificial– Seed collection and Transport. Management of production pond – stocking – supplementary feeding – methods of prawn fishing - Type of Nets.

UNIT – II

Pearl culture: Pearl producing oysters, Technical requirements, Process and methods: - selection of farm sites,construction of farm, seeding, caring the oyster,sorting the pearls, Types of pearls, Economic importance of pearls.

UNIT – III

Sericulture: Types of Silkworm-Mulberry Silkworm, Eri Silkworm, Muga Silkworm, Tasar Silkworm. Rearing techniques and Moriculture. Diseases: Viral Disease- Grasserie, Fungal Diseases -Muscardine, Protozoan disease -Pebrine.
Life cycle of silk worm (*Bombyx mori*). Economic importance of silk.

UNIT – IV

Fish culture: Indian major carps - Catla, Rohu, and Mrigal, Live feeds (Rotifers, Cladocerans, Artemia and Copepods), Induced breeding, Fish diseases: Bacteria- Furunclosis, Protozoan - White spot, Fungal- Gill Rot. Fish byproducts.

UNIT – V

Poultry farming: Types of fowl- Indigenous and Exotic fowl, Fowl house construction, poultry nutrition, Diseases: Fowl pox and Ranikhet, Economic importance of poultry farming.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall freshwater prawn culture and management.
CO2: Demonstrate economic importance of pearls and methodologies involved in pearl producing oyster culture.
CO3: Apply knowledge on culture of Indian major carps with live feeds, fishery by-products and fish diseases.
CO4: Analyze different types of Silkworm, diseases encountered by Silk moths during their life cycle and economic importance of silk.
CO5: Discover learning environment for indigenous and exotic poultry birds with their

economic importance and diseases associated with poultry farming.
CO6: Create self-employment in field of applied Zoology.

Textbooks

1. Jawaid Ahsan & Subhas Prasad Sinha, 2010. A hand book on Economic zoology. S. Chand Publishing.
2. Aminul Islam. 2016. A Textbook of Economic Zoology,I K International publication House.
3. Arumugam, N. 2008. Aquaculture, Saras Publications.
4. Arumugam, N. 2013. Economic Zoology, Saras Publication

Reference Books

1. Shukla, G.S. and V.B. Upadhyay 2003 Economic Zoology, Rastogi publications.
2. Ahsan, J. and S.P. Shiha 2005 A hand book of Economic Zoology, S. Chand &Co.
3. Pradip V Jabde, 2005. Text Book Applied Zoology. Discovery Publishing House, New Delhi.
4. Sardar Singh – Bees keeping inIndia.
5. Santhanam – 1991.Aquaculture
6. Sundarraj, V. 1997. Aquaculture, TANUVAS.
7. Singh – Live stock and poultry production.
8. Rama Rao, V., 2004, Poultry Science, Mangal DeepPublications.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	3	9	3	9	9
CO 2	9	3	9	3	9	9
CO 3	9	3	9	9	1	9
CO 4	9	3	9	9	1	9
CO 5	9	9	9	9	0	1
CO 6	9	1	3	1	9	9
Weightage	**54**	**22**	**48**	**34**	**29**	**46**
Weightage percentage of Course contribution to POs						

Class	**II – UG (Other than Zoology Students)**	
Semester	**IV**	
Course and Code	**Non Major Elective Course -1 (NME:1)**	**Code: U22ZYNME1**
Course Title	**COMMUNICABLE DISEASES**	
Hours : 2	**Credits : 2**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the air borne diseases.
CEO2. To understand the food and water borne diseases.
CEO3. To understand the insect borne diseases.
CEO4. To understand the sexually transmitted diseases.
CEO5. To understand the viral diseases.

UNIT – I

Air borne diseases: Measles, Mumps, Small pox, Tuberculosis, Pneumonia, Diphtheria, Meningitis – Symptoms, prophylaxis and control measures.

UNIT – II

Food and water borne diseases: Cholera, Botulism, Typhoid, Amoebiasis, Tetanus - Symptoms, prophylaxis and control measures.

UNIT – III

Vector borne diseases: Yellow fever, Dengue fever, Malaria, Elephantiasis, Sleeping sickness - Symptoms, prophylaxis and control measures.

UNIT – IV

Sexually transmitted diseases: Gonorrhea, Vaginitis, Syphilis, Chlamydia, Trichomoniasis - Symptoms, prophylaxis and control measures.

UNIT – V

Corona 19, viral hepatitis, Influenza, Polio, Rabies; Cold sores and AIDS - Symptoms, prophylaxis and control measures.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Enumerate health awareness to the people.
CO2: Trace the causative agents for the communicable disease like air, food, water and microbes with their preventive measures.
CO3: Utilize knowledge on the importance of vaccines in disease prevention.
CO4: Explicate Sexually Transmitted Disease (STD) and their preventive measures.
CO5: Deduce learning environment for vector borne diseases and their preventive measures.
CO6: Formulate biological control methods for disease causing vectors.

Textbooks

1. Mani. A. Narayanan, L.M. Selvaraj A.M. and Arumugam, N. 1996. Microbiology. Saras Publications.
2. Rajan S and V.Kumaresan, 2020. Virology, Saras Publication

3. Mani. A. Narayanan, L.M. Selvaraj A.M. and Arumugam, N. 2020. Microbiology. Saras Publications.

Reference Books

1. M.J. Pelezar and R.D. Reid. 1993. Microbiology, McGraw HillPub.
2. Roger Webber. 2019. Communicable Diseases. 6th Edition. Publisher: CABI
3. Brian Freeman. 2020. Ecological and Economic Entomology A Global Synthesis. Publisher:CABI
4. Leslie Beale, 2017. Human disease and health promotion. Wiley publication.
5. P.J. Quinn, B.K. Markey, F.C. Leonard, E.S. FitzPatrick, S. Fanning and P.J. Hartigan, 2011. Veterinary microbiology and Microbial Diseases. Wiley-Blackwell Publishing.2nd Edition.
6. Larry McKane and Judy Kandel. 2000. Microbiology. McGraw HillPub.
7. R.C. Dubey and D.K. Maheswari. 2005. A text book of Microbiology, S.Chand & Co. Ltd. NewDelhi.
8. Mani. A. Narayanan, L.M. Selvaraj A.M. and Arumugam, N. 1996. Microbiology. Saras Publications.
9. Ananthanarayanan, R. & C.K. Jayaram Panicker, 1990. Text Book of Microbiology. Orient Longman.
10. Sharma, P.D. 1998. Microbiology, Rastoji Publications.
11. Roger Webber. 2016. Communicable Diseases – A Global perspective. Fifth ed. CABI (www.cabi.org).

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	9	9
CO 2	9	9	9	9	0	1
CO 3	9	1	9	9	9	9
CO 4	9	1	9	9	9	3
CO 5	1	3	9	9	9	9
CO 6	3	1	9	9	1	9
Weightage	**40**	**24**	**54**	**48**	**37**	**40**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V**	
Course and Code	**Core Course (CC7)**	**Code:U22ZY7**
Course Title	**DEVELOPMENTAL BIOLOGY**	
Hours : 5	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives
CEO1.To understand the structure and function of sperm and egg, and fertilization.
CEO2. To understand Cleavage.
CEO3. To understand Gastrulation.
CEO4. To understand the foetal membranes.
CEO5. To understand the reproductive cycles and basics of biotechnology.

UNIT – I
Spermatozoon: Spermatogenesis, shape and structure of sperm in different chordates.
Egg: Oogenesis. Structure of Hen's egg. Types of eggs based on yolk distribution.
Fertilization: External and internal fertilization. Physical and Chemical perspectives.
Parthenogenesis: natural and artificial. Theories of development- Theory of Preformation, The Biogenetic Law (Recapitulation Theory) and The Germ Plasm Theory.

UNIT – II
Cleavage: Salient features, Morula, Blastula, Blastocyst. Cleavage: Planes of cleavage (Meridional, Vertical, Equatorial, Latitudinal),
Patterns of cleavage: Holoblastic (Bilateral, Radial, Spiral), Meroblastic (Superficial).
Factors affecting cleavage, Molecular changes during cleavage.

UNIT – III
Gastrulation: Salient features, metabolic and molecular changes during gastrulation. Fate maps: construction of fate map.
Morphogenic movements: Types of morphogenetic movements.
Organogenesis: Development of brain in Frog, Development of eye in Frog,

UNIT – IV
Development of extraembryonic membranes in chick: Chorion, Amnion, Yolk sac, Allantois.
Placenta: Development, Characters, classification (Yolk sac, Chorio- allantoic, Diffuse, Haemochorial, Haemoendothelial).

UNIT – V
Reproductive cycles: Human menstrual cycle, Puberty, ovulation, pregnancy, Parturition.
Infertility: Types, causes, artificial insemination. Test Tube Baby, Parthenogenesis: natural and artificial.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Enumerate the process of spermatogenesis, oogenesis and fertilization.
CO2: Infer the developmental stages of embryogenesis
CO3: Categorize the process of organogenesis.
CO4: Explicate on extra embryonic membranes.
CO5: Elucidate different types of placentation.

CO6: Formulate artificial reproduction methods with reference to reproductive cycle.

Textbooks

1. Berry. A.K. 2007. An introduction to Embryology. Emkay publications, NewDelhi.
2. Subramaniam T. 2002. Developmental Biology. Alpha ScienceInternational.
3. Michael J.F. Barresi & Scott F. Gilbert, 2019. Developmental Biology (12th Edition). Sinaeur Associates Inc., Massachusetts, United States.
4. Arumugam, N. 2005. A Text Book of Embryology, Saras Publications,Nagarcoil

Reference Books

1. Gilbert, S.F. 2010. Developmental Biology, 9th Edn. Sinamer Associates Inc. Publishers. Massachusetts, USA.
2. Balinsky, B.I. 1981. An introduction to Embryology. W.B. Saunderscompany.
3. Slack, J.M. W., 2006. Essential Developmental Biology (2nd Edition). Blackwell Publishing Co., Oxford, London
4. Lewis Wolpert, 2002.Principles of Development (2nd Edition). Oxford University Press, London.
5. Mohan P. Arora, 1997. Embryology. Himalaya Publishing House, India.
6. Banerjee, S., 2015. A Textbook Of Developmental Biology. Dominant Publishers and Distributors, Pvt., Ltd., New Delhi, India

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	1
CO 2	9	9	9	9	0	0
CO 3	9	9	9	9	0	1
CO 4	9	3	9	9	1	9
CO 5	9	9	3	9	1	9
CO 6	9	1	3	3	9	9
Weightage	**54**	**40**	**42**	**42**	**11**	**29**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V**	
Course and Code	**Core Course (CC 8)**	**Code:U22ZY8**
Course Title	**MICROBIOLOGY AND IMMUNOLOGY**	
Hours : 5	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the scope and basics of microbiology.
CEO2. To understand the food, industrial, soil and medical microbiology.
CEO3. To understand the scope and basics of immunology.
CEO4. To understand antigen and antibody.
CEO5. To understand immune response.

UNIT – I

Introduction: History and scope of microbiology, Classification of Bacteria and Viruses, General structure of microbes (Bacteria and Viruses), Bacterial Culture techniques (Agar Plate and Broth cultures).

UNIT – II

Food microbiology: Food poisoning, Food spoilage, Food preservation. Industrial microbiology: Production of antibiotics (Penicillin).
Soil microbiology: Role of soil microbes in Nitrogen fixation.
Medical microbiology: Diseases caused by Bacteria - Cholera, Tuberculosis. Diseases caused by viruses – AIDS, Polio.

UNIT – III

Scope of Immunology – Immunity: Innate and Acquired, Humoral and Cell mediated.
Lymphoid Organs: Structure and functions of Primary Lymphoid Organs (Thymus, Bone marrow, Bursa) and Secondary lymphoid organs (Lymph node, Spleen, Tonsil, Payer's patches).

UNIT – IV

Antigens: Structure, Types, Properties, Adjuvant.
Antibodies: Structure of Immunoglobulin, types of Immunoglobulin, functions of Immunoglobulin, biological properties.

UNIT – V

Immune response: factors causing immune response, mechanism of immune response, types.
Humoral immune response: mechanisms, types.
Cell mediated immune response: Mechanism
Comparison of humoral immunity and cell mediated immunity

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall basic microbial structure and function .
CO2: Trace comparative characteristics of Bacteria and Virus.
CO3: Make use of knowledge in the general bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae.
CO4: Explicate food, soil, industrial and medical microbiology.

CO5: Substantiate concepts in immunology, organization of the immune system, the salient features of antigen antibody reactions with different types of antibodies.
CO6: Build deep insight on humoral and cell mediated immunity.

Textbooks

1. Ananthanarayanan, R. and Jayaram Panickar, C.K. 1999. A Text Book of Microbiology. OrientLongman.
2. Mani. A. Narayanan, L.M. Selvaraj A.M. and Arumugam, N. 1996- Microbiology. SarasPublications.
3. Chakravarthy. A.K. 1996. Immunology, Tata McGraw Hill Publishing CoLtd.

Reference Books

1. Sharma P.D. 1995. Microbiology, Rastogi & Company,Meerut.
2. Berry. A.K. 2005. A text book of Immunology. Emkay publications, NewDelhi-
3. Kuby J. 1994. Immunology, W.H. Freeman & Co. NewYork.
4. Roitt, M.I. 1994. Essential Immunology, Blackwell Science Lyd.UK.
5. Sells, S. 1987. Basic Immunology, Elsevier Science Publishing Co. NewYork.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	0	1
CO 3	9	3	9	9	1	9
CO 4	9	9	9	9	3	3
CO 5	3	3	9	9	9	9
CO 6	1	3	9	9	9	9
Weightage	**40**	**36**	**54**	**54**	**22**	**32**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V**	
Course and Code	**Major Based Elective course-I (MBE 1)**	**Code:U22ZY9E**
Course Title	**ECONOMIC ENTOMOLOGY**	
Hours : 5	**Credits : 4**	**Max Marks: 75**

Course Educational Objectives

CEO1.To understand the classification of insects.
CEO2.To understand the destructive insects.
CEO3.To understand the beneficial insects.
CEO4.To understand household pests.
CEO5.To understand insect pest management.

UNIT – I

Classification of Insects up to order: Key characteristics with South Indian Examples. External anatomy of a typical Insect (Grass hopper) – Exoskeleton, Head, Thorax and Abdomen.Mouth parts of Insects.

UNIT – II

Destructive insects: Insect Pest of Crops and their control measures: Paddy (*Leptocorisa varicornis, Pachydiplosis oryzae*), Coconut (*Oryctes rhinoceros*, Rhynchophorus), Cotton (*Dysdercuscingulatus, Platyendra gossypiellas*), Sugarcane (*Chilo infuscatellus, Emmalocera depressella*).

UNIT – III

Beneficial Insects: Productive and helpful insects.
Economic importance of Honeybee, Silkworm and Lac-insect.
Insects as pollinators, predators, parasites, weed killers, soil builders and scavengers.
Commercial products of insects: honey, bee-wax, silk, lac, galls, cochineal dye, cantheridine, insect- food, medicines.

UNIT – IV

Household insect pests: Mosquito, Cockroach, Housefly, Termites, damages caused and their control measures.

UNIT – V

Pest Control Management: Conventional Methods: Prophylactic – Curative – Cultural, Mechanical, Physical & Biological method. Non conventional methods: Plant products – Chemosterilants, Antifeedants, Pheromones, Insect repellants and Attractants.
Integrated Pest Management (IPM).

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall basic concept of classification of insects with thorough knowledge on their external anatomy.
CO2: Demonstrate different types of insects like beneficial, harmful and household pests.
CO3: Make use of pest control and management.
CO4: Explicate the harmful and beneficial effects of using pesticides on agricultural fields.
CO5: Elucidate Biological control methods in agricultural field for pest control and management.

CO6: Formulate Eco friendly insecticides and pesticides.

Textbooks

1. Vasantharaj David, B., Murali Rangan. M.C. and Meera Murali Rangan 1992. Harmful and Insects, Popular BookDepot,Chennai.
2. VasantharajDavid, B. 2001. Elements of economic Entomology, Popular Book Depot, Chennai.
3. D.B Tembhare, Modern Entomology, Himalaya Publishing House.
4. Nalina Sundari, MS, Santhi, R MJP PUBLISHERS; 1st edition (June 3, 2008)
5. B.V. David, V.V. Ramamurthy, 2017 . Elements of Economic Entomology. Brillion Publishing. 8th Edition.
6. K. D. Upadhyay , Y. K .Mathur. 2015. A Textbook of Entomology.

References

1. Chapman R.F., 1993. The Insects Structure and Functions. ELBSLondon.
2. Chandler A.C. and Read C.P. 1961. Introduction to Parasitology. John Wiley and Sons, New York.
3. David, B.V. and Muralirangam, N.C. and Meera Muralirangam.1992. Harmful and beneficial Insects. Popular BookDepot.
4. David, B.V 1992. Pest Management and Pesticides. Indian Scenario, Namrutha Publications.
5. Krishnan. N.T. 1993. Economic Entomology. JJ Publications,Madurai.
6. Richards, O.W. and Davies, R. G., 1984. A General Text Book of Entomology Vol. I & II, 10th Edition, Chapman Hall, LaneLondon.
7. Vasantharaj David; T. Kumaraswami. 1988. Elements of Economic Entomology. 1988 4th ed. Madras : Popular Book Depot
8. Vasantharaj David; V V Ramamurthy. 2015. Elements of economic entomology. 2015 8thed. New York : Brillion Publishing.
9. Vasantharaj David; V V Ramamurthy. 2012. Elements of economic entomology. 7th ed. Chennai: Namrutha Publications.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	3	9
CO 2	9	9	9	9	1	0
CO 3	9	9	9	9	1	0
CO 4	3	9	9	9	1	9
CO 5	1	3	1	9	9	9
CO 6	1	3	1	9	9	9
Weightage	**32**	**42**	**38**	**48**	**24**	**36**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V**	
Course and Code	**Major Based Elective Course -II (MBE 2)**	**Code:U22ZY10E**
Course Title	**AQUACULTURE**	
Hours : 5	**Credits : 4**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the scope of aquaculture.
CEO2. To understand the fish farming techniques.
CEO3. To understand ornamental fish culture and its techniques.
CEO4. To understand edible oyster culture and its techniques.
CEO5. To understand marine prawn culture and the methods.

UNIT – I

Scope of Aquaculture in India.
Water quality parameters: Physical factors (Odor, Visibility, Temperature);
Chemical factors (O_2, CO_2, Salinity, pH, Biological Oxygen Demand, Nutrients;
Biological factors: Phytoplankton and Zooplankton, Aquatic weed.

UNIT – II

Fish culture : Cultivable species of fishes (Indian major carps - *Catla catla* , *Labeo rohita* (Rohu), *Channa punctatus*, Methods of fish farming (Fish farm design, Selection of site, Weed control, Stocking, and Feeding, Fish feed (Live and Artificial). Fish diseases (Bacterial, Viral and Protozoan) and control methods, Economic importance of fishes.

UNIT – III

Edible oyster culture: Biology of edible oyster (*Crossostreamadrasensis*), Needs for oyster culture, Essential condition for oyster culture, Farming operation (Spat collection, On bottom and off bottom culture methods, Economic importance of Oysters.

UNIT – IV

Pearl culture: Types of pearls, pearl producing animals, Mechanism of pearl formation, freshwater pearl culture. Economic importance of pearls.
Peneaus monodon: Life cycle, Hatchery technology, (Post Larval production). Induced breeding of marine prawns.

UNIT – V

Marine prawn culture: Common cultivable species, Seed collection, Culture methods (Extensive, Semi-intensive, Intensive culture of *Penaeus monodon*
Diseases: Bacterial, Viral, Commercial importance of Freshwater and Marine prawns.
Role of CIBA, MPEDA, FSI and CMFRI in the growth of Aquaculture in India

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define the basic concept of the aquaculture, and fisheries.
CO2: Demonstrate different forms of aquaculture and advanced techniques used in it.
CO3: Apply knowledge on live feed aquaculture, fish pathogens.
CO4: Analyze economic importance of aquaculture.
CO5: Evaluate economic importance of pearls and methodologies involved in pearl producing

oyster culture.

CO6: Develop insight on marine prawn culture and management, fishery products marketing agencies in India.

Textbooks.

1. Rath, R, .K. 2000. Freshwater Aquaculture. Scientific Publishers, PO No 91, Jodhpur, India
2. Khanna, S.S., 2009. An Introduction to Fishes. Silverline Publications, India.
3. Arumugam.N. 2008. Aquaculture, SarasPublications

References

1. Jhingran, AVG, 1991, Fish and Fisheries of India, Hindustan PublishingCo.
2. Baradach, JE, JH Ryther and WO McLarney, 1972, Aquaculture. The farming and Husbandary of Fresh water and Marine Organisms. Wiley Interscience, NewYork.
3. Shukla, G.S, and Upadhyay V.B., 2000. Economic Zoology, Rastogi PublicationsMeerut.
4. Kamaleswar Pandey and Shukla, J.P., 2005. Fish and Fisheries, RastogiPublications.
5. Hobler, E.R., and Noble, G.A., 1982. Parasitology 2nd Edition, Lea & FebiegerU.S.A
6. Smit. D.G., 1997. Introduction Animal Parasitology 2nd Edition, Johns Willey Sons New York.
7. Soulsby, E.J.L., 1969. Helminths, Arthropods & Protozoa of Domesticated Animals, ELBS Publication LondonEd.
8. Peter B. Moyle & Joseph J. Cech, Jr., 2014. Fishes, An Introduction to Ichthyology (5th Edition). PHI Learning Pvt. Ltd., New Delhi, India.
9. Pamela Bristow, 1987. The Illustrated Book Of Fishes. Octopus Books Ltd., London.
10. Santhosh Kumar & Manju Tembhre, 2010. Fish & Fisheries. New Central book Agency (P) Ltd., London.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	0	0
CO 2	9	9	9	3	0	0
CO 3	9	9	9	9	1	1
CO 4	1	1	9	9	9	9
CO 5	1	1	9	9	9	9
CO 6	1	1	9	9	9	9
Weightage	**30**	**30**	**52**	**42**	**28**	**28**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V and VI**	
Course and Code	**Corecourse (CC 9)**	**Code:U22ZY11P**
Course Title	**MAJOR PRACTICAL – III - (Pertaining to Developmental Biology andMicrobiology and Immunology)**	
Hours : 6 (3+3)	**Credits : 5**	**Max Marks: 75**

Course Educational Objectives
CEO1. To understand the various developmental stages of chick embryo.
CEO2. To identify the blood group.
CEO3. To understand the lymphoid organs.
CEO4. To differentiate bacteria using stains.
CEO5. To understand the basic biotechnological methods.

Developmental Biology
Observation of the structure of spermatozoa of cattle from a cattle farm/ breedingcentre.

Spotters
Egg, cleavage, blastula and yolk plug stages in Frog.
Egg, 24, 48, and 72 hrs developmental stages inChicks

Immunology
ABO Blood grouping, RhType.
Vidal Test-Agglutination(Demonstration).
Observation of lymphoid organs in rat (Chart,Virtual)

Spotters
Immunoelectrophoresis (from picture), lymphoid organs inrat.

Microbiology
Fixing and staining of bacteria using simplestain.
Bacteria culture(demonstration)
Differentiation of bacteria in a smear using gramstaining.

Spotters
Autoclave, Petri plate, Micropipette, Laminar air flow chamber, Inoculation loop.

A record of lab work should be maintained and submitted at the time of the practical examination.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Define various developmental stages of chick and frog embryo.
CO2: Demonstrate experimental knowledge in identifying the blood group.
CO3: Apply knowledge on remembering and distinguishing the lymphoid organs.
CO4: Analyze differentiating bacteria using simple staining method.
CO5: Substantiate knowledge on basic biotechnological tools and techniques.
CO6: Formulate new methods for vaccine production using antigen- antibody interaction.

Textbooks

P.S. Verma and P.C.Srivastava 2007. Advanced Practical in Zoology (S. Chand & Co.)

Web References

1. http://www.surendranathcollege.org/new/upload/SUBHADRA_ROYABO%20blood%20grouping2020-03-27Practical%20-ABO%20blood%20grouping-converted.pdf
2. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiz1IXnsdn3AhWlR2wGHcILCFEQwqsBegQINhAB&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DjKzLLHjRfs&usg=AOvVaw0yDdZVjGhSmUGYSyzNtQ1a
3. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiz1IXnsdn3AhWlR2wGHcILCFEQwqsBegQINRAB&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D3oUvqNuWzPg&usg=AOvVaw3i6SPC5-0f0QiZYtOMWJ3E
4. https://www.healthline.com/health/blood-typing
5. https://sealevel.jpl.nasa.gov/files/archive/activities/ts3ssac3.pdf
6. https://aslopubs.onlinelibrary.wiley.com/doi/pdf/10.1002/lob.200918485

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	1	0
CO 2	9	9	9	9	1	1
CO 3	9	9	9	9	0	0
CO 4	9	9	9	9	1	0
CO 5	1	3	9	9	9	9
CO 6	3	1	9	9	9	9
Weightage	**40**	**40**	**54**	**54**	**21**	**19**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**V and VI**	
Course and Code	**Core Course (CC 10)**	**Code:U22ZY12P**
Course Title	**MAJOR PRACTICAL – IV - (pertaining to Core Courses Genetics and Evolution, Environmental Biology and Management, Biophysics andBiostatistics)**	
Hours : 6 (3+3)	**Credits : 6**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the genetic importance by studying different chromosomal aberrations in man.
CEO2. Ability to understand simple Mendelian traits.
CEO3. Ability to Estimate dissolved oxygen.
CEO4. Ability to understand and identify the fossils.
CEO5. Ability to perform statistical analysis.

Genetics

Simple Mendelian traits in man – Sex linked traits.
Drosophila –Identification of Sex, Mutant forms (from pictures), Geneticimportance.
Human Karyotypes: Normal, Down's, Klinfelter's and Turner'ssyndromes.

Evolution

Fossils: Trilobite, Nautilus.
Mimicry: Leaf insects, Stick insects
Coloration: Chameleon

Environmental Biology

Estimation of Dissolved oxygen.
Mounting and Identification of Plankton (Freshwater orMarine)
Spotters: Animal association (parasitism, mutualism and commensalisms), Inter tidal fauna (rocky, sandy, and deep sea), Secchi disc, Thermometer and Foodweb.

Biodiversity: Field visit

Biophysics

Spotters: Spectrophotometer, pH meter and Electrophoresis unit. Demonstration of Infrared Spectrometer, Fluorescent spectrometer at NCIF.

Biostatistics

Construction of Bar and Pie diagram.
Calculation of Mean, Median and Mode, Standard deviation and Standard error.
Statistical packages – Training in any one package of SPSS/ PAST

Industrial-/Forest-/Zoo-visit (Educational Tour) report should be included in the practical record

A record of lab work should be maintained along with tour report and submitted at the time of the practical examination.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall genetic importance by studying simple Mendelian traits.

CO2: Demonstrate on sex differentiation in drosophila and chromosomal aberrations in man.

CO3: Apply knowledge in understanding and identification of Fossils.

CO4: Analyze the evolutionary importance of mimicry and coloration.

CO5: Appraise on estimation of dissolved oxygen and mounting of different planktons species.

CO6: Develop expertise on basic statistical analysis.

References

P.S. Verma and P.C.Srivastava 2007. Advanced Practical in Zoology (S. Chand& Co.)

Web References

1. https://bio.libretexts.org/Bookshelves/Human_Biology/Book%3A_Human_Biology_(Wakim_and_Grewal)/08%3A_Inheritance/8.4%3A_Simple_Inheritance
2. https://www.mlsu.ac.in/econtents/2191_expriment%204.pdf
3. https://serc.carleton.edu/microbelife/research_methods/environ_sampling/oxygen.html
4. https://www.sciencedirect.com/science/article/pii/S0026265X21002137
5. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiC_cdtNn3AhVbSmwGHR21DGIQwqsBegQIIBAB&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DXPxVpjM1XCU&usg=AOvVaw2-fM7i0fkH1-ONgR5ab-mJ
6. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiC_cdtNn3AhVbSmwGHR21DGIQwqsBegQIQhAB&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D0MC5OBblol0&usg=AOvVaw2IOI4R5b2Zl7tyy5ACJjit
7. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiC_cdtNn3AhVbSmwGHR21DGIQwqsBegQIORAB&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DgoQf5p64xRk&usg=AOvVaw165EH4EnJBMRyxKs1cc1WY
8. https://www.ucl.ac.uk/~ucbhdjm/courses/b242/Mimic/Mimic.html
9. https://nhpbs.org/wild/mimicry.asp

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	1	1	0
CO 2	9	9	9	9	0	3
CO 3	9	9	9	9	0	3
CO 4	3	3	9	9	9	9
CO 5	3	3	9	9	9	9
CO 6	1	0	0	9	9	9
Weightage	34	33	45	46	28	33
Weightage percentage of Course contribution to POs						

Class	**II – UG (Other than Zoology Students)**	
Semester	**V**	
Course and Code	**Non Major Elective Course -II (NME:II)**	**Code: U22ZYNME2**
Course Title	**VERMICULTURE & APICULTURE**	
Hours : 2	**Credits : 2**	**Max Marks: 75**

Course Educational Objectives

CEO1.To understand the scope and importance of Vermiculture.
CEO2.To understand the techniques involved in Vermiculture.
CEO3.To understand the economic, legal and social contexts associated with Vermiculture.
CEO4.To understand the scope and importance of Apiculture.
CEO5.To understand the economic, legal and social contexts associated with Apiculture.

VERMICULTURE

UNIT – I

Vermiculture –definition, scope and importance, common species for culture.Taxonomic position and diversity of earthworms, Life cycle, growth of *Lampito mauritti*, *Perionyx excavatus*. Food preference- Culture practices – Optimal conditions for vermiculture – temperature, pH, soil type, organic matter, protection from sun light, rain and predators.

UNIT – II

Environmental requirements, culture methods – wormery – breeding techniques, indoor and outdoor cultures – monoculture and polyculture – Outline and ecological classification – Epigeic, Endogeic and Anecicspecies.

UNIT – III

Applications of Vermiculture – Vermiculture in biotechnology, vermi composting, use of vermicastings and vermiwash in organic farming: horticulture, earthworms for management of municipal waste, selected biomedical solid wastes as feed, bait for capture, culture fisheries, forest regeneration. Medicinal importance.

APICULTURE

UNIT IV

Bee keeping down the ages - Present status of Apiculture in India - Species of Honey Bees.Bee colony, Castes.Natural colonies and their yield.Types of beehives - structure - location, care and management - Genetic studies - breeding of stocks – winterbroods. Bee foraging: Pollen and nectar yielding plants. Honey extraction, seasonal maintenance, swarming and pheromone.

UNIT V

Natural enemies and diseases of Honey Bees and control methods.Bee poisoning and utility of bees in toxicity studies.Economics of Apiculture and Management. Honey yield in national and international market. Prospects of apiculture as self employment venture. Preparing proposals (Layout and budget) for financial assistance and funding agencies. Uses of honey and beewax in Indian medicine.

Students must be exposed to Apiculture units and submit a report along with other practical records.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall different types of Honey Bees and Earthworms.

CO2: Demonstrate on beehives, bee keeping equipment, methods of extraction of honey, processing of honey.

CO3: Make use of earthworm in organic farming and solid waste management.

CO4: Explicate vermitechnology for sustainable agriculture and to understand primary, secondary degradation and vermibed preparation.

CO5: Determine the economic, legal and social contexts associated with vermiculture.

CO6: Build self-employment opportunities for rural people

Textbooks

1. Sultan Ahmed Ismail, 2005. The Earthworm Book. Second Revised Edition. Other India Press, Goa,India.
2. Tripathi, G. Vermiresource Technology, 2003, Discovery Publishing House, New Delhi.
3. Shukla, G.S, and Upadhyay V.B., 2000. Economic Zoology, Rastogi Publications Meerut.

Reference Books

1. Mary Violet Christy, A. Vermitechnology, 2008, MJP Publishers.
2. Arvind Kumar, Verms & Vermitechnology, 2005. APH Puiblishing Cooperation.
3. Sathe, T.V. Vermiculture and Organic farming.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	0	1
CO 3	9	3	9	3	9	9
CO 4	9	0	9	1	9	9
CO 5	0	1	9	9	1	9
CO 6	9	1	0	3	9	9
Weightage	**45**	**23**	**45**	**34**	**28**	**38**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**VI**	
Course and Code	**Core course (CC 11)**	**Code:U22ZY13**
Course Title	**GENETICS AND EVOLUTION**	
Hours : 6	**Credits : 6**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the genetic aspects of chromosomes.
CEO2. To understand the mutation and changes in chromosomal numbers.
CEO3. To understand the molecular genetics.
CEO4. To understand basic concepts of evolution.
CEO5. To understand the evolution of man.

UNIT – I

Human Chromosome: Karyotype (Male and Female), Barr Bodies, Linkage. Crossing-over: Definition and mechanism, Cytological evidence of crossing over, Drosophila as an example. Chromosome map.

UNIT – II

Chromosomal aberrations: Structural changes in Chromosome; Types – Addition, Deletion, Duplication, Inversion and Translocation.
Changes in chromosome number- Euploidy: Monoploidy, Polyploidy – Autopolyploidy, Allo polyploidy.
Aneuploidy: Monosomy, Nullisomy, Trisomy, Tetrasomy.

UNIT – III

Molecular Genetics: Fine structure of Gene, Cistron, Recon and Muton, Gene expression and regulation in Prokaryotes, Operon model- Lac and Trp operon, Gene Regulation in Eukaryotes. Britton and Davidson model. Gene amplification. Genetic basis of Cancer.

UNIT – IV

Evolutionary Theories: Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism, Modern synthetic theory. Hardy-Weinberg Law.

UNIT – V

Speciation, Isolating mechanisms, Adaptive radiation, Geological Timescale: Paleozoic, Mesozoic and Cenozoic era, Biological evolution of man.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall knowledge on molecular genetics.
CO2: Demonstrate the concepts of linkage, recombination, and crossing over.
CO3: Categorize mutation and its effects on chromosome.
CO4: Analyze the fine structure of genetic material, molecular basis of heredity and gene regulation.
CO5: Substantiate knowledge about the evolutionary history of earth and theories of evolution.
CO6: Adapt the distribution of animals on earth, its pattern, evolution and causative factors.

Textbooks

1. Verma, P.S. and Agarval, V.K. 1997. Genetics. S.Chand & Co., NewDelhi
2. Arumugam, N. 1989. Organic Evolution. Saras Publication.Nagarcoil

Reference Books

1. Lewin, B. 2009. Gene X. Wiley Eastern Ltd., NewDelhi.
2. Strickberger, M.W. 2002. Genetics. Prentice Hall of India, NewDelhi.
3. Rothwell, N.V. 1979. Human Genetics. Prentice Hall of India, NewDelhi.
4. Strickberger, M.W. 2000. Evolution. Jones and BarlettPublishers.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	0	0
CO 3	1	9	9	9	1	9
CO 4	1	9	9	9	1	9
CO 5	9	0	9	1	9	9
CO 6	0	1	1	9	9	9
Weightage	**29**	**37**	**46**	**46**	**20**	**36**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**VI**	
Course and Code	**Core Course (CC 12)**	**Code:U22ZY14**
Course Title	**ENVIRONMENTAL BIOLOGY AND MANAGEMENT**	
Hours : 6	**Credits : 6**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the scope and importance of our environment.
CEO2. To understand the components of an ecosystem.
CEO3. To understand the concepts of community and population ecology.
CEO4. To understand the biogeochemical cycles.
CEO5. To understand the global warming.

UNIT – I

Environmental Biology: Definition, Scope. Abiotic factors: Water, Soil, Temperature, Light. Biotic factors. Ecosystem: Definition, structure, pond ecosystem. Food chain, Food web.

UNIT – II

Trophic levels, Ecological pyramids (Pyramid of numbers, Pyramid of energy, Inverted pyramid), Energy flow in an ecosystem.
Animal relationship: Definition- Symbiosis, Commensalism, Mutualism, Antibiosis, Parasitism, Predation and Competition.

UNIT – III

Population Ecology: Definition- density, natality & mortality, age distribution, age pyramids, population growth.
Community Ecology: Definition, characteristics (Community independence, Community concepts, Ecotone & Edge effect, Ecological niche, Ecological succession).

UNIT – IV

Biogeochemical cycles: Oxygen, Nitrogen
Pollution and Management: Types (Air, Water, Land, Radioactive), Sources, Effects, Manmade nuclear disasters.

UNIT – V

Global warming, Green house effect, Ozone and its importance, Acid rain, Bioaccumulation, Biomagnifications.
Highlights of UN Conferences & Protocols on Environment, Sustainable Development, Climate Change.

1. UN Conference on Human Environment, Stockholm (1972),
2. UN Convention on Climate Change, New York (1992)
3. UN Conference on Environment and Development (Earth Summit) Rio de Janeiro, Brazil (1992).
4. World Summit on Sustainable Development, Johannesburg (2002),
5. United Nations Climate Change Conference, Doha, Qatar (2012),
6. Paris Agreement (2016)

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define interaction of biotic and abiotic resources in the environment.

CO2: Demonstrate the components of ecosystem.

CO3: Apply types of interaction of animals in an ecosystem.

CO4: Analyze population characteristics and dynamics, community ecology and biogeochemical cycles.

CO5: Substantiate knowledge on global warming and pollution management.

CO6: Develop insight into United Nations steps towards sustainable environment and climate change worldwide.

Textbooks

1. Odum, E.P., 1971. Fundamentals of Ecology. W.B. Saunders Company,Philadelphia.
2. Krishnamurthy, K.V. 2003. Introduction to Biodiversity. Oxford andIBH.
3. Bhatia, A.L. 2010. A Textbook of Environmental Biology. I.K. International PublishingHouse.

Reference Books

1. Clarke, G.L. 1954. Elements of Ecology, John Wiley & Sons.N.Y.
2. Kendeigh, S.C., 1961. Animal Ecology. PrenticeHall.
3. Rastogi, V.B. and M.S, Jayaraj,1989. Animal Ecology and Distribution ofAnimals.
4. Verma, P.S. and V.K. Agarwal, 1996. Principles of Ecology. S. Chand & Co NewDelhi.
5. Bharucha Erach. The Biodiversity of India. Mapin Publishing Pvt.. Ltd.,Ahmedabad.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	1	0	9
CO 2	9	9	9	1	0	9
CO 3	1	9	9	9	1	1
CO 4	3	1	9	9	9	9
CO 5	3	1	9	9	9	9
CO 6	9	0	9	1	9	9
Weightage	**34**	**29**	**54**	**30**	**28**	**46**
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**VI**	
Course and Code	**Core Course (CC 13)**	**Code:U22ZY15**
Course Title	**BIOPHYSICS AND BIOSTATISTICS**	
Hours : 6	**Credits : 6**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the colloids.
CEO2. To understand the laws of thermodynamics.
CEO3. To understand the principles involved in chromatography, electrophoresis, and spectrophotometer.
CEO4. To understand biological method of data collection.
CEO5. To understand basic statistical tests.

UNIT – I

Colloids - description and properties. Thermodynamic – three laws of thermodynamics, energy changes associated with living systems – Membrane biophysics – diffusion, active transport.Tyndall effect, Surface tension, Brownian movement, filtration, osmosis, dialysis.pH metry – principles and measurement of pH, Titration curve and pKa values. Spectroscopy – Principles and components of spectrophotometer, determination of absorption maximum and concentration of substances.

UNIT – II

Photobiology – nature and properties of light, wave and particle properties of light, different types of spectrums. Bioluminescence – types of bioluminescence, physical & biochemical characteristics of bioluminescence, significance of bioluminescence. Radiation Biology – radioactive isotopes, radioactive decay & half life, effects of radiation on biological systems, harmful and beneficial effects of radiation. Radiation Dosimeters – Geiger Muller counter, film, Luminescence, semiconductor and scintillation dosimeters.

UNIT – III

Centrifugation – ordinary centrifuges, methods of centrifugation – differential and density gradient, ultracentrifuge and its types, application and sedimentation coefficient. Principles and application of chromatography – Paper – Thin layer – Column – Ion – exchange – filtration – Gas liquid – HPLC.

Principles and applications of electrophoresis – Electrophoresis media, Paper and Agarose gel electrophoresis – PAGE – SDS-PAGE, Pulse field gel electrophoresis, electro focusing, transilluminator and Gel Doc

UNIT – IV

Data: Measurement of data, Primary and Secondary data Hypothesis: Null and Alternative, Type I error, Type II error.

Types of variables: Continuous and discontinuous variables, Qualitative and quantitative variables. Presentation of data: Tabulation of data, Histogram, Polygon, Pie diagram.

UNIT – V

Definition, illustration and significance: Mean, Median, Mode, Standard deviation, Standard Error, Variance and Co Variance.

Definition, illustration and significance: Chi square, t-test, Simple Correlation and regression.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall basic terms and concepts of Biophysics.

CO2: Demonstrate about the principles and uses of various analytical instruments like spectrophotometer, chromatography, and electrophoresis.

CO3: Apply the details of radioisotope techniques and their application in biology.

CO4: Analyze biological data in a simplified and clarified way.

CO5: Deduce methods to represent the data in a well-organized and attractive style.

CO6: Develop skills to handle high end instruments like HPLC, GC-MS and AAS.

Textbooks

1. Das, D. 1996. Biophysics and Biological Chemistry. Academic Publishers,Calcutta.
2. Snedecor, G.W. and W.G. Cochan 1967. Statistical methods, Oxford & IBH Publishing. New Delhi.
3. Veerakumari, L., 2006. Bioinstrumentation. MJP Publishers, India.
4. Kumaresan, V. & Arumugam, N., 2016. Biophysics and Bioinstrumentation. Saras Publication.
5. Veera Bala Rastogi, 2008. Fundamentals of Biostatistics. Anu Books, India.
6. Gurumni, N. (2010). An Introduction to Biostatistics (2nd Edition). MJP Publishers, India.

Reference Books

1. Daniel, M. 1992 – Basic Biophysics and Biologists. Wiley International, New Delhi.
2. Zar, J.H. 1974. Bio statistical analysis. Prentice Hall Inc., New Jersey, USA.
3. Comprehensive Statistical Software. SPSS South Asia, No. 20, 11th A Main, Millers Road, Vasanth Nagar, Bangalore – 560 052.
4. Das, M.N and N.C Giri, 1986. Design and Analysis of Experiments Wiley Eastern Ltd – New Delhi.
5. Keith Wilson and John Walker, 2010. Principles and Techniques of Biochemistry & Molecular Biology. Cambridge University Press, New York.
6. Norman T.J. Baily,1976. Statistical Methods in Biology. Hodder & Stoughton Publishers, London.
7. Dr. PranabKumar Banaerjee, 2012. Introduction to Biophysics. S. Chand & Co., Pvt., Ltd., India

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	1	0	1
CO 2	9	9	9	9	0	1
CO 3	0	9	9	9	1	9
CO 4	0	9	9	9	1	9
CO 5	9	3	9	1	3	9
CO 6	1	1	9	9	9	9
Weightage	28	40	54	38	14	38
Weightage percentage of Course contribution to POs						

Class	**III-B.Sc., Zoology**	
Semester	**VI**	
Course and Code	**Major based Elective course-III (EC3)**	**Code:U22ZY16E**
Course Title	**NANOBIOLOGY AND WILDLIFE BIOLOGY**	
Hours : 5	**Credits : 4**	**Max Marks: 75**

Course Educational Objectives

CEO1. To understand the basic concepts of nanobiology.
CEO2. To understand applications of nanobiology.
CEO3. To understand the values and importance of wildlife.
CEO4. To understand the conservation priorities.
CEO5. To understand various ongoing conservation projects in India.

NANOBIOLOGY

UNIT – I

Origins of concepts of Nano, Basic and Basis: size of Nano, The meaning of Nanotechnology, Four generations of Nanotechnology development, Technology of general Applicability, Multi- purpose Technology, Exponential Proliferation. Applications of Nanotechnology in biological field

UNIT – II

Basic concepts and applications: drug delivery, cancer diagnosis and therapy, surgery, *In vivo* therapy, Neuro-electronic Interfaces, cell repair machines.
Biosensors: definition, principles of detection, optical biosensor, electrochemical biosensor, nanobiosensor, DNA sensors, Quantum dots.

WILDLIFE BIOLOGY

UNIT – III

Wildlife concept: Importance of Wildlife conservation:-ecological, ethical, educational, scientific, commercial, aesthetic, and recreational. Conservation methods: *In situ* conservation- sanctuaries, national parks, biosphere reserves, *Ex situ* conservation-captive breeding, modern zoo, safari, nocturnal zoo.

UNIT – IV

Conservation priorities: IUCN classification - extinct, critically endangered, endangered, vulnerable, conservation dependent, low risk, data deficient, not evaluated.
Concepts: Flagship species, Umbrella species, Hotspots, Endemic Species, Important Bird Areas. Protected areas of Tamil Nadu - Sanctuaries, National Parks, and Tiger Reserves.

UNIT – V

Conservation project: A. Tiger project- Tiger biology, distribution, threats, conservation action taken, B. Elephant project: Elephants biology, distribution, threats, conservation action taken. C. Crocodile Project-crocodile biology, species, distribution, threats, conservation action taken. D. UNDP Sea Turtle Project- biology, species, distribution, threats, conservation action taken.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall the basic concept of nanobiology and wildlife biology with conservation measures.
CO2: Infer on various applications of nano biotechnology.
CO3: Apply skills of Wildlife habitat studies to solve problems of conservation.
CO4: Discover conservation measures of wildlife and habitat management.
CO5: Determine measures of wildlife legislation in a systematically organized manner.
CO6: Formulate measures for protecting endangered species.

Textbooks

1. Sutherland W.J.2000.The conservation hand book: research, management and policy Blackwell ScienceLtd.
2. Varadharajan Gokula 2013. Elementary Wildlife Biology, Lap Lambert Academic Publishing OmniScriptum GmbH & Co. KG. Germany. ISBN: 978-3-659-50085-5: 292pp.

References

1. Martin and Bateson, 2007. Measuring Behaviour. Cambridge UniversityPress.
2. Andrawartha, H.C. and L.C. Birch. 1974. The distribution and abundance of animals. The University of Chicago Press, London.
3. Agarwal, V.P. 1980. Forests in India. Oxford and IBH Publishing Co. NewDelhi.
4. Davis, M. 1981, Infectious diseases of wild mammals. The IOWAstate.
5. Giles, R.H. 1984. Wild life management techniques. The wild life society, Washington and Natraj Publishers, DehraDun.
6. Saharia, V.B. 1982. Wild life in India. Nataraj Publishers, DehraDun.
7. Foster, L.E. 2006. Medical Nanotechnology: science, innovation and Opportunity. Pearson Education. Upper SaddleRiver.
8. Ratner, M. and Ratner, D. 2002. Nanotechnology: A gentle introduction to the Next Big Idea. Pearson Education. Upper SaddleRiver.
9. Shanmugam.S. 2010. Nanotechnology. MJP Publishers.274pp.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	0	1
CO 3	0	9	9	9	1	1
CO 4	1	1	9	9	9	9
CO 5	3	1	9	9	9	9
CO 6	1	3	9	9	9	9
Weightage	23	32	54	54	28	30
Weightage percentage of Course contribution to POs						

MAJOR BASED ELECTIVE COURSES: CHOICES

Course Title	Elective Course -I (EC1) - ANIMAL BEHAVIOUR AND CHRONOBIOLOGY		
Code	U22ZYEC1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate animal behaviour and techniques of tracking animal behaviour	PSO 1,2,3,4,6	K1
CO 2	Demonstrate the various patterns of animal behaviour	PSO 1,2,3,4,6	K2
CO 3	Apply skills on the Social and sexual behaviour of animals.	PSO 1,2,3,4,5,6	K3
CO 4	Explicate chronobiology and animal behaviour with respect to chronobiology	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate biological rhythms and their role in regulation of reproduction in Vertebrates	PSO 3,4,5,6	K5
CO 6	Develop new methods to track animal behaviour and chronobiology	PSO 1,2,3,4,5,6	K6

Course Title	Elective Course -II (EC2) - BASICS OF NEUROSCIENCE		
Code	U22ZYEC2		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Relate knowledge on neuroscience	PSO 1,2,3,4,6	K1
CO 2	Demonstrate the nervous system, transmission of impulse and production of action potential in neurons.	PSO 1,2,3,4,6	K2
CO 3	Apply skills on the cellular and molecular neurobiology	PSO 1,2,3,4,6	K3
CO 4	Examine different types of neurotransmitters, receptors and ion gated channels	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate knowledge on Neurobiology & Neuropharmacology of behaviour	PSO 1,2,3,4,5,6	K5
CO 6	Develop insight on critical aspects of neuroscience	PSO 1,2,3,4,5,6	K6

Course Title	Elective Course -III (EC3) - BIOLOGY OF INSECTA		
Code	U22ZYEC3		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall taxonomy and classification of insects	PSO 1,2,3,4,6	K1
CO 2	Demonstrate on the external morphology of insects.	PSO 1,2,3,4,5,6	K2
CO 3	Apply skills on the physiology of insects.	PSO 1,2,3,4,5,6	K3
CO 4	Analyze the social behaviour of insects and insect society	PSO 1,2,3,4,5,6	K4
CO 5	Justify on insect plant interaction and insect as vectors.	PSO 1,2,3,4,5,6	K5
CO 6	Develop expertise on anatomy and social life of insects.	PSO 1,3,4,5,6	K6

Course Title	Elective Course -IV (EC4) - PARASITOLOGY		
Code	U22ZYEC4		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define general parasitology	PSO 1,2,3,4,5,6	K1
CO 2	Infer about morphology, lifecycle and epidemiology of parasitic protists	PSO 2,3,4,5,6	K2
CO 3	Utilize knowledge on the morphology, lifecycle and epidemiology of parasitic platyhelminthes.	PSO 1,2,3,4,5,6	K3
CO 4	Explicate morphology, lifecycle and epidemiology of parasitic nematodes.	PSO 1,2,3,4,5,6	K4
CO 5	Appraise on morphology, lifecycle and epidemiology of parasitic Arthropods and Vertebrates.	PSO 1,2,3,4,5,6	K5
CO 6	Formulate measures to prevent parasitic infections.	PSO 1,2,3,4,5,6	K6

EXTRA CREDIT COURSES- SELFSTUDY MODE

Course Title	Extra Credit Course -I (ECC1) - COMPUTATIONAL BIOLOGY		
Code	U22ZYECC1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall general bioinformatics.	PSO 1,2,3,4,5,6	K1
CO 2	Trace the biological databases	PSO 1,2,4,5,6	K2
CO 3	Apply skills on the data generation and data retrieval systems	PSO 1,2,3,4,5,6	K3
CO 4	Analyze on basic concepts of sequence alignment and applications of bioinformatics.	PSO 1,2,3,4,5,6	K4
CO 5	Substantiate knowledge on basic biostatistics and descriptive analysis tests	PSO 1,2,3,4	K5
CO 6	Develop expertise on computational biology	PSO 1,4,5,6	K6

Course Title	Extra Credit Course -II (ECC2) - ENDOCRINOLOGY		
Code	U22ZYECC2		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall concepts on general endocrinology.	PSO 1,2,3,5,6	K1
CO 2	Demonstrates on the structure and functions of pineal glands, hypothalamus and pituitary glands.	PSO 1,2,3,4,5	K2
CO 3	Apply skills on the structure and functions of peripheral endocrine glands	PSO 3,4,5,6	K3
CO 4	Explicate on regulation of hormonal action.	PSO 2,3,4,5,6	K4
CO 5	Elucidate on basic Invertebrate hormones.	PSO 1,2,3,4,5,6	K5
CO 6	Elaborate on various diseases caused by hormonal imbalance in humans.	PSO 1,3,4,5,6	K6

Course Title	Extra Credit Course -III (ECC3) - ENVIRONMENT AND PUBLIC HEALTH		
Code	U22ZYECC3		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define environmental hazards and their assessment.	PSO 1,2,3,5,6	K1
CO 2	Trace theclimate change and its impact on human life.	PSO 1,2,3,4,6	K2
CO 3	Identify different types of pollution and its management strategies.	PSO 1,2,3,4,5,6	K3
CO 4	Analyze on waste management technologies.	PSO 3,4,5,6	K4
CO 5	Elucidate on infectious diseases and control programmes.	PSO 1,2,4,5,6	K5
CO 6	Design technology for eco-friendly management of environmental wastes	PSO 1,2,3,4,5,6	K6

Course Title	Extra Credit Course -IV (ECC4) - FOOD, NUTRITION AND HEALTH		
Code	U22ZYECC4		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall basic concept of food and nutrition.	PSO 1,2,3,4,5,6	K1
CO 2	Demonstrate on nutritional biochemistry.	PSO 1,2,3,4	K2
CO 3	Utilize the concept of health and social health problems.	PSO 2,3,4,5,6	K3
CO 4	Explicate on Food and water hygiene, food and water borne infections, parasitic infections.	PSO 1,3,4,5,6	K4
CO 5	Elucidate on food adulterants, additives their impact assessment and regulation of food safety.	PSO 1,3,4,5,6	K5
CO 6	Formulate preventive measures for food spoilage	PSO 1,2,3,4,5,6	K6

ELECTIVE COURSES

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Elective Course -I (EC1)**	**Code:**
Course Title	**ANIMAL BEHAVIOUR AND CHRONOBIOLOGY**	
Hours: 5	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To learn about animal behavior and techniques of tracking animal behavior
CEO2. To acquire knowledge on various patterns of animal behavior
CEO3. To learn about the Social and sexual behavior of animals.
CEO4. To impart knowledge on chronobiology and animal behavior with respect to chronobiology
CEO5. To impart knowledge on Biological rhythms and their role in regulation of life.

UNIT-I: INTRODUCTION TO ANIMAL BEHAVIOUR

Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behavior, Methods and recording of a behavior

UNIT-II: PATTERNS OF BEHAVIOR

Stereotyped Behaviors (Orientation, Reflexes); Individual Behavioral patterns; Instinct vs. Learnt Behavior; Associative learning, classical and operant conditioning, Habituation, Imprinting.

UNIT-III: SOCIAL AND SEXUAL BEHAVIOR

Social Behavior: Concept of society; Communication and the senses; Altruism; Insects' society with Honey Bee as example; Foraging in Honey Bee and advantages of the waggle dance.

Sexual Behavior: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

UNIT-IV: INTRODUCTION TO CHRONOBIOLOGY

Historical developments in Chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks, relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

UNIT-V: BIOLOGICAL RHYTHM

Types and characteristics of biological rhythms: Short and Long term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of Vertebrates; Role of melatonin.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Enumerate animal behavior and techniques of tracking animal behavior.
CO2: Demonstrate the various patterns of animal behavior.
CO3: Apply skills on the Social and sexual behavior of animals.
CO4: Explicate chronobiology and animal behavior with respect to chronobiology.
CO5: Elucidate biological rhythms and their role in regulation of reproduction in Vertebrates.
CO6: Develop new methods to track animal behavior and chronobiology

Suggested Readings

1. David McFarland, Animal Behaviour, Pitman Publishing Limited, London,UK.
2. Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
3. John Alcock, Animal Behaviour, Sinauer Associate Inc.,USA.
4. Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts,USA.
5. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (Ed.). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA,USA
6. Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.)R.D. Lewis.(3rdEd)2002BarensandNobleInc.NewYork,USA
7. Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	0	1
CO 3	1	9	9	9	1	9
CO 4	1	9	9	9	1	9
CO 5	0	0	9	9	9	9
CO 6	9	3	3	9	9	9
Weightage	29	39	48	54	20	38
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Elective Course -II (EC2)**	**Code:**
Course Title	**BASICS OF NEUROSCIENCE**	
Hours : 5	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To impart knowledge on neuroscience.
CEO2. To learn about nervous system, transmission of impulse and production of action potential in neurons.
CEO3. To learn about cellular and molecular neurobiology.
CEO4. To learn about different types of neurotransmitters, receptors and ion gated channels.
CEO5. To learn about Neurobiology& Neuropharmacology of behavior.

UNIT-I: INTRODUCTIONTONEUROSCIENCE
Origins of Neuroscience; Neuroanatomy, Neurophysiology, and systems in Neurobiology

UNIT-II: THE NERVOUSSYSTEM-ANINTRODUCTION
Introduction to the structure and function of the nervous system: Cellular components: Neurons; Neuroglia; Neuro endocrine; the proto typical neuron–axons and dendrites as unique structural components of neurons. The ionic bases of resting membrane potential; the action potential - its generation and properties; the action potential conduction.

UNIT-III: CELLULAR AND MOLECULAR NEUROBIOLOGY
Molecular and cellular approaches used to study the CNS at the level of single molecules, Synapse: Synaptic transmission, Types of synapses; synaptic function; Principles of chemical synaptic transmission; Principles of synaptic integration; EPSPs and IPSPs. Ion channels, Neuraltransmission,

UNIT-IV: NEUROTRANSMITTERS
Different types of neurotransmitters– catecholamines, amino acidergic and peptidergic neuro transmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors.

UNIT-V: NEUROBIOLOGY AND NEUROPHARMACOLOGY OF BEHAVIOUR
The principles of signal transduction and information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior; sensory systems, molecular basis of behavior including learning and memory. Molecular pathogenesis of pain and neurodegenerative diseases such as Parkinson's, Alzheimer's, psychological disorders, addiction, etc.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Relate knowledge on neuroscience.
CO2: Demonstrate the nervous system, transmission of impulse and production of action potential in neurons.

CO3: Apply skills on the cellular and molecular neurobiology.
CO4: Examine different types of neurotransmitters, receptors and ion gated channels.
CO5: Elucidate knowledge on Neurobiology & Neuropharmacology of behavior.
CO6: Develop insight on critical aspects of neuroscience.

Suggested Readings

1. Neuroscience:ExploringthebrainbyMarkF.Baer;BarryW.Connors.2015
2. From Molecules toNetworks: An Introduction to Cellular and Molecular Neuroscience by JohnH.Byrne.Ruth Heidelberg and M.NealWaxham
3. Neuroscience-Eds. Dale Purveset. al. (3rd Edn)-Sinauer Associates,Inc.-2004
4. Principles of NeuralScience-4thEdn-Eds.Kandel,Schwartz and Jessell -McGraw- Hill Companies-2000
5. Nerve Cells and Animal Behaviour-2nd Edn-Peter J Simmons and David Young-CUP-2003
6. Essential Psychopharamacology- Neuroscientific Basis and Practical Applications-2nd Edn.-Stephan M.Stahl-CUP-2000
7. Phantoms in the Brain-Vilayanur S.Ramachandran and Sandra Blakeslee-1998
8. The Human Brain Book - RitaCarter-2009

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	0	1
CO 3	3	9	9	9	0	1
CO 4	9	1	9	9	1	9
CO 5	1	3	3	9	9	9
CO 6	1	3	3	9	9	9
Weightage	**32**	**34**	**42**	**54**	**19**	**30**
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Elective Course -III (EC3)**	**Code:**
Course Title	**BIOLOGY OF INSECTA**	
Hours: 5	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To Learn about taxonomy and classification of insects.
CEO2. To Learn about the external morphology of insects.
CEO3. To Learn about the physiology of insects.
CEO4. To learn about the social behavior of insects and insect society.
CEO5. To learn about insect plant interaction and insect as vectors.

UNIT-I: INTRODUCTION & TAXONOMY
General Features of Insects
Distribution and success of Insects on the Earth
Basis of insect classification; Classification of insects up to orders

UNIT II: GENERAL MORPHOLOGY OF INSECTS
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitatabdominal appendages and genitalia

UNIT III: PHYSIOLOGYOFINSECTS
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive and nervous system, Sensory receptors, growth and metamorphosis

UNIT IV: INSECT SOCIETY
Group of social insects and their social life
Social organization and social behavior (w.r.t. any one example)

UNIT V: INSECT PLANT INTERACTION & INSECTS AS VECTORS
Theory of co-evolution, role of allele chemicals in host plant mediation, Host-plants election by phytophagous insects, Insects as plant pests
Insects as mechanical and biological vectors, Brief discussion on houseflies and mosquitoes as important insect vector.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Recall taxonomy and classification of insects.
CO2: Demonstrate on the external morphology of insects.
CO3: Apply skills on the physiology of insects.
CO4: Analyze the social behavior of insects and insect society.
CO5: Justify on insect plant interaction and insect as vectors.
CO6: Develop expertise on anatomy and social life of insects.

Suggested Readings

1. A general text book of entomology, Imms,A.D.,Chapman & Hall,UK
2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press,UK
3. Principles of Insect Morphology, Snodgrass,R.E.,Cornell Univ.Press,USA
4. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication,USA
5. The Insect Societies, Wilson, E. O., Harward Univ. Press,UK
6. Host Selection by Phytophagous insects, Bernays,E.A.,and Chapman,R.F., Chapman and Hall, New York,USA
7. Physiological system in Insects, Klowden, M. J., Academic Press,USA
8. The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell,UK
9. Insect Physiology and Biochemistry, Nation, J. L., CRC Press,USA

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	1
CO 2	9	9	9	9	1	3
CO 3	1	9	9	9	3	9
CO 4	1	9	9	9	3	9
CO 5	1	9	1	9	9	9
CO 6	9	0	3	9	9	9
Weightage	**30**	**45**	**40**	**54**	**25**	**40**
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Elective Course -IV (EC4)**	**Code:**
Course Title	**PARASITOLOGY**	
Hours: 5	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. Toknow about general introduction to parasitology.
CEO2. To learn about the morphology, lifecycle and epidemiology of parasitic protists.
CEO3. To gain knowledge on the morphology, lifecycle and epidemiology of parasitic Platyhelminthes.
CEO4. To know about the morphology, lifecycle and epidemiology of parasitic nematodes.
CEO5. To Impart knowledge on morphology, lifecycle and epidemiology of parasitic Arthropods and Vertebrates.

UNIT I: INTRODUCTION TO PARASITOLOGY

Brief introduction of parasitism, Parasite, Parasitoid and vectors (mechanical and biological vector) Host parasite relationship

UNIT II: PARASITIC PROTISTS

Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani, Plasmodium vivax*

UNIT III: PARASITIC PLATYHELMINTHES

Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski, Schistosoma haematobium, Taenia solium*and *Hymenolepis nana*

UNIT IV: PARASITIC NEMATODES

Study of Morphology, Life cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Study of structure, life cycle and importance of Meloidogyne (root knot nematode), Pratylencus (lesion nematode)

UNIT V: PARASITIC ARTHROPODA & PARASITIC VERTEBRATES

Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* and *Cimex lectularius*. A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define general parasitology.
CO2: Infer about morphology, lifecycle and epidemiology of parasitic protists.
CO3: Utilize knowledge on the morphology, lifecycle and epidemiology of parasitic Platyhelminthes.
CO4: Explicate morphology, lifecycle and epidemiology of parasitic nematodes.
CO5: Appraise on morphology, lifecycle and epidemiology of parasitic Arthropods and Vertebrates.
CO6: Formulate measures to prevent parasitic infections.

Suggested Readings

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications andDistributors
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007)Biology of Disease.
4. Taylor and Francis Group
5. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai,Delhi
6. RattanLalIchhpujaniandRajeshBhatia.MedicalParasitology,IIIEdition,Jaypee Brothers Medical Publishers (P) Ltd., NewDelhi
7. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. BrownPublishers
8. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P)Ltd.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	9	1
CO 2	0	9	9	9	1	9
CO 3	1	1	9	9	9	9
CO 4	1	1	9	9	9	9
CO 5	9	3	3	9	9	9
CO 6	9	1	9	1	9	9
Weightage	**29**	**24**	**48**	**40**	**46**	**46**
Weightage percentage of Course contribution to POs						

EXTRA CREDIT COURSES

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Extra Credit Course -I (ECC1)**	**Code:U22ZYECC1**
Course Title	**COMPUTATIONAL BIOLOGY**	
Self Study	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To learn about the general introduction to bioinformatics.
CEO2. To learn about the biological databases.
CEO3. To learn the Data generation and data retrieval systems.
CEO4. To get idea on basic concepts of sequence alignment and applications of bioinformatics.
CEO5. To Learnbasic biostatistics and descriptive analysis tests.

UNIT I: INTRODUCTION TO BIOINFORMATICS
Importance, Goal, Scope; Genomics, Transcriptomics, Systems biology, Functional genomics, Metabolomics, Molecular phylogeny; Applications and limitations of bioinformatics

UNIT II: BIOLOGICAL DATABASES
Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

UNIT III: DATA GENERATION AND DATA RETRIEVAL
Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

UNIT IV: Basic Concepts of Sequence Alignment
Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

UNIT V: APPLICATIONS OF BIOINFORMATICS
Structural bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)

UNIT VI: BIOSTATISTICS
Introduction, calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall general bioinformatics.
CO2: Trace the biological databases.
CO3: Apply skills on the data generation and data retrieval systems.
CO4: Analyze on basic concepts of sequence alignment and applications of bioinformatics.
CO5: Substantiate knowledge on basic biostatistics and descriptive analysis tests.
CO6: Develop expertise on computational biology.

Suggested Readings

1. Ghosh Z and Mallick B. (2008). Bioinformatics: Principles and Applications, Oxford UniversityPress.
2. Pevsner J. (2009). Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell.
3. Zvelebil, Marketa and Baum O.Jeremy (2008).Understanding Bioinformatics, Garland Science, Taylor and Francis Group,USA.
4. Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc.USA
5. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice.Tata McGraw Hill Education Private Limited, India.
6. Pagana,M.and Gavreau,K.(2000).Principles of Biostatistics,Duxberry Press, USA.
7. Attwood TK and Parry-Smith DJ. (2014) Introduction to bioinformatics, Pearson Education.
8. Baxevanis A., Ouellette F.B.F. (1998). Bioinformatics: a practical guide to the analysis of genes and proteins. John Wiley and Sons, New York.
9. Dunn and Clark. (2001). Basic Statistics: A Primer for the Biomedical Sciences, III
10. Edition. John Wiley & Sons, Inc, New York.
11. Moore and McCabe. (1999). Introduction to the Practice of Statistics, III Edition. Freeman and Co., New York.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	3	9	1
CO 2	9	9	0	1	9	9
CO 3	1	1	9	9	9	9
CO 4	1	1	9	9	9	9
CO 5	9	9	9	9	0	0
CO 6	9	0	0	9	9	9
Weightage	**38**	**29**	**36**	**40**	**45**	**37**
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Extra Credit Course -II (ECC2)**	**Code:U22ZYECC2**
Course Title	**ENDOCRINOLOGY**	
Self Study	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To learn about general introduction to endocrinology.
CEO2. To learn structure and functions of pineal glands, hypothalamus and pituitary glands.
CEO3. To learn structure and functions of peripheral endocrine glands.
CEO4. To have an idea on regulation of hormonal action.
CEO5. To learn basic Invertebrate hormones.

UNIT-I: INTRODUCTION TO ENDOCRINOLOGY
History of endocrinology, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones

UNIT-II: EPIPHYSIS, HYPOTHALAMO - HYPOPHYSIAL AXIS
Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.
Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms
Structure of pituitary gland, Hormones and their functions, Hypothalamo- hypophysial portal system, Disorders of pituitary gland.

UNIT-III: PERIPHERAL ENDOCRINE GLANDS
Structure, Hormones, Functions andregulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis
Hormones in homeostasis, Disorders of endocrine glands

UNIT-IV: REGULATION OF HORMONE ACTION
Hormone action at cellular level: Hormonereceptors, transduction and regulation. Hormone action at molecular level: Molecular mediators, Genetic control of hormone action and endocrine disturbances caused by xenobiotics.

UNIT-V: A GLIMPSE INTO INVERTEBRATE HORMONES
Peptide hormones – Invertebrate specific peptides and steroids – Myo relaxing factor, chromactive hormone, Adipokinetic hormone, Hypertrehalosemic hormones, cardioactive hormones. Presence of vertebrate related peptides and steroids in Invertebrates, Invertebrates specific hormones – ecdysteroids and juvenile hormones and their mechanism of action.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall concepts on general endocrinology.
CO2: Demonstrates on the structure and functions of pineal glands, hypothalamus and pituitary glands.
CO3: Apply skills on the structure and functions of peripheral endocrine glands.
CO4: Explicate on regulation of hormonal action.
CO5: Elucidate on basic Invertebrate hormones.

CO6: Elaborate on various diseases caused by hormonal imbalance in humans.

Suggested Readings

1. General Endocrinology C. Donnell Turner Pub- SaundersToppan
2. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead.
3. Oxford: BIOS Scientific Publishers;2001.
4. Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., NewJersey.
5. Vertebrate Endocrinology by David O.Norris.
6. Rene Lafont. (2000). The Endocrinology of Invertebrates. Ecotoxicology. Vol. 9; 41 - 57.
7. https://www.britannica.com/science/endocrine-system/Invertebrate-endocrine-systems.
8. WalterJ. Burdette. (1974). Invertebrate Endocrinology and hormonal heterophylly. Springer, Berlin, Heidelberg.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	0	9	1
CO 2	9	9	9	9	1	0
CO 3	0	0	9	9	9	9
CO 4	0	3	9	9	9	9
CO 5	1	9	9	9	1	9
CO 6	9	0	1	9	9	9
Weightage	**28**	**30**	**46**	**45**	**38**	**37**
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Extra Credit Course -III (ECC3)**	**Code:U22ZYECC3**
Course Title	**ENVIRONMENT AND PUBLIC HEALTH**	
Self Study	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To learn the general introduction to environmental hazards and their assessment.
CEO2. To learn about climate change and its impact on human life.
CEO3. To gain knowledge on different types of pollution and its management strategies.
CEO4. To learn about waste management technologies.
CEO5.To get an idea on infectious diseases and control programmes.

UNIT -I: Introduction

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose response evaluation, Exposure assessment.

UNIT -II: Climate Change

Green house gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

UNIT -III: Pollution

Air, water, noise pollution sources and effects, Pollution control

UNIT -IV: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.

UNIT- V: Infectious diseases and control programmes

General overview of infectious diseases and their impact in developing countries. Epidemiology of infectious diseases, Structure of prokaryotic cell, pathogenic modifications, Anti-microbial agents, drug resistance, Infectious disease control programmes (including biology of causative agent, epidemiology, pathogenesis and pathology, clinical presentation and management; public health strategies and mechanisms)

A.Vaccine preventable diseases: TB, polio, diphtheria, tetanus, measles.
b. Respiratory diseases: Tuberculosis, leprosy, Acute Respiratory tract Infections
c. Intestinal: Diarrhea, typhoid, worm infestations
d. Contact: STIs and AIDS
e. Vector borne: Malaria and Filaria, Dengue, Leptospirosis,
f. Zoonotic: Plague and Rabies.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define environmental hazards and their assessment.
CO2: Trace the climate change and its impact on human life.
CO3: Identify different types of pollution and its management strategies.
CO4: Analyze on waste management technologies.
CO5: Elucidate on infectious diseases and control programmes.
CO6: Design technology for eco-friendly management of environmental wastes.

Suggested Books

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-HallofIndiaPvt. Ltd., New Delhi, 1999.
2. KolluruRao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment andManagementHandbook", McGraw Hill Inc., NewYork, 1996.
3. Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
4. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N.University Press, New York, 2003.
5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysisfundamentalswithapplications, PrenticeHall, New Jersey1997.
6. Nelson K E. (1996). Infectious disease epidemiology: theory and practice. Jones and Bartlett Publishers.
7. Griesecke J. (1994).Modern infectious disease epidemiology. Boston: Edward Arnold Publishers, London.
8. National Disease Control Programmes websites.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	0	9	1
CO 2	1	9	9	9	0	9
CO 3	9	3	9	1	9	9
CO 4	0	0	9	9	9	9
CO 5	9	9	0	9	3	9
CO 6	3	9	9	3	9	9
Weightage	**31**	**39**	**45**	**31**	**39**	**46**
Weightage percentage of Course contribution to POs						

Class	**B.Sc., Zoology**	
Semester	**V AND VI**	
Course and Code	**Extra Credit Course -IV (ECC4)**	**Code:U22ZYECC4**
Course Title	**FOOD, NUTRITION AND HEALTH**	
Self Study	**Credits : 4**	**Max Marks: 100**

Course Educational Objectives

CEO1. To learn the basic concept of food and nutrition.
CEO2. To acquire an idea on nutritional biochemistry.
CEO3. To know the concept of health and social health problems.
CEO4. To learn about food and water hygiene, food and water borne infections, parasitic infections and preventive measures for food spoilage.
CEO5. To get an comparative idea on food adulterants, additives their impact assessment and regulation of food safety.

UNIT-I: BASIC CONCEPT OF FOODANDNUTRITION

Food components and food-nutrients

Concept of a balanceddiet, nutrient needs anddietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

UNIT-II: NUTRITIONAL BIOCHEMISTRY

Carbohydrates, Lipids, Proteins- Definition, classification, their dietary source and role.
Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance.
Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions.

UNIT-III: HEALTH

Introduction to health- Definition and concept of health

Major nutritional Deficiency diseases-Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.
Life style related diseases- hypertension, diabetes mellitus and obesity- their causes and prevention through dietary and lifestyle modifications.
Social health problems- smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS) - their causes, treatment and prevention.
Common ailments- cold, cough and fevers, their causes and treatment.

UNIT-IV: FOOD HYGIENE

Portable water- sources and methods of purification at domestic level

Food and Water borne infections: Bacterial infection: Cholera, typhoid fever, dysentery;
Viral infection: Hepatitis, Poliomyelitis, Protozoan infection: amoebiasis, giardiasis;
Parasitic infection: Taeniasis and Ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Brief account of food spoilage: Causes of food spoilage and their preventive measures.

UNIT V: FOOD ADULTERANTS CUM ADDITIVES & FOOD SAFETY

Food Adulteration, Contaminants& Detection, Basic Food Laws and Regulations, Nutrition Labeling and Food Laws, Food Additives and its application, genetically modified foods, Issues in GM foods, Food safety tools, Post harvest losses of fruits, Vegetables & its safety, Food safety hazards, Expiry date/Shelf life.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall basic concept of food and nutrition.

CO2: Demonstrate on nutritional biochemistry.

CO3: Utilize the concept of health and social health problems.

CO4: Explicate on Food and water hygiene, food and water borne infections, parasitic infections.

CO5: Elucidate on food adulterants, additives their impact assessment and regulation of food safety.

CO6: Formulate preventive measures for food spoilage.

Suggested Books

1. Mudambi,SRandRajagopal,MV.FundamentalsofFoods,NutritionandDietTherapy; Fifth Ed; 2007; New Age InternationalPublishers
2. Srilakshmi B. Nutrition Science; 2002; New Age International (P)Ltd.
3. SrilakshmiB.FoodScience;FourthEd;2007;NewAgeInternational(P)Ltd.
4. SwaminathanM.HandbookofFoodsandNutrition;FifthEd;1986;BAPPCO.
5. BamjiMS,RaoNP,andReddyV.TextBookofHumanNutrition;2009;Oxford&IBH Publishing Co. PvtLtd.
6. WardlawGM,HamplJS.PerspectivesinNutrition;SeventhEd;2007;McGrawHill.
7. Lakra P, Singh MD. Textbook of Nutrition and Health; First Ed; 2008; Academic Excellence.
8. ManayMS,Shadaksharaswamy.Food-FactsandPrinciples;1998;NewAge International (P)Ltd.
9. Gibney et al. Public Health Nutrition; 2004; BlackwellPublishing.
10. Carl J. Schaschke, (2012). Food Processing. Ventus Publishing ApS.James M. Jay, Martin J. Loessner, David A. Golden, (2005). Modern Food Microbiology. VII Edition.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	1	9	9
CO 2	9	9	9	9	0	0
CO 3	0	9	9	9	9	1
CO 4	9	0	9	9	1	9
CO 5	9	0	9	9	3	9
CO 6	1	1	9	9	9	9
Weightage	**37**	**28**	**54**	**46**	**31**	**37**
Weightage percentage of Course contribution to POs						

PROGRAMME – M.Sc., ZOOLOGY
M.Sc., ZOOLOGY PROGRAMME STRUCTURE
(For Candidates Admitted from the academic year 2022 onwards)

SEM	COURSE CODE	COURSE TITLE	Instr. Hours/ Week	Credit	Exam Hours	Marks		Total
						Int	Ext	
I	CC1 -P22ZY1	Biology of Invertebrates and Chordates and Paleontology	6	5	3	25	75	100
	CC2 -P22ZY2	Cell and Molecular Biology	6	5	3	25	75	100
	CC3 -P22ZY3	Genetics	6	5	3	25	75	100
	CC4-P22ZY4P	Practical – I - Pertaining to CC1, CC2 & CC3	6	5	3	25	75	100
	EC1-P22ZY5E	Bioinstrumentation and Bioinformatics	6	4	3	25	75	100
TOTAL			**30**	**24**				**500**
II	CC5-P22ZY6	Animal Physiology	6	5	3	25	75	100
	CC6-P22ZY7	Biotechnology	6	5	3	25	75	100
	CC7-P22ZY8	Microbiology	6	5	3	25	75	100
	CC8-P22ZY9P	Practical – II - Pertaining to CC5, CC6& CC7	6	5	3	25	75	100
	EC2-P22ZY10E	Entrepreneurial Zoology	6	4	3	25	75	100
TOTAL			**30**	**24**				**500**
III	CC9-P22ZY11	Developmental Biology and Evolution	6	5	3	25	75	100
	CC10-P22ZY12	Biochemistry and Biophysics	6	5	3	25	75	100
	CC11-P22ZY13P	Practical – III - Pertaining to CC11 and CC12	6	5	3	25	75	100
	EC3-P22ZY14E	Biostatistics and Research Methodology	6	4	3	25	75	100
	EC4-P22ZY15E	Environmental Biology and Management	6	4	3	25	75	100
	P22ZY20EC*	Ornithology		4*	3	25	75	100
TOTAL			**30**	**23**				**500**
IV	CC12-P22ZY16	Immunology	6	5	3	25	75	100
	CC13-P22ZY17	General and Applied Entomology	6	5	3	25	75	100
	EC5-P22ZY18E	Wildlife Biology	6	4	3	25	75	100
	P22ZYP19	Project Work	12	5		75	25	100
	P22ZY21EC*	Environmental Impact Analysis		4*	3	25	75	100
TOTAL			**30**	**19**				**400**
GRAND TOTAL			**120**	**90**				**1900**

*Extra credit course, not included in the total credits

CC - CORE COURSE, CCE - CORE COURSE ELECTIVE
For the science Programme oral test will be conducted for the practical papers and 5 marks will be allotted and to be included in the external 75 marks i.e., 70 for the practical lab + 5 for the oral test = 75 marks.

PROGRAMME OUTCOMES

PO	**Programme Outcomes (PO)** The Programme Outcomes of the Post Graduates of our College would be the following:
PO 1	Disciplinary knowledge
PO 2	Communication Skills
PO 3	Critical thinking, problem solving and analytical reasoning
PO 4	Reflective thinking and scientific reasoning
PO 5	Moral and ethical awareness, and team work with leadership qualities
PO 6	Multicultural sustainability and self-directed lifelong learning

PROGRAMME SPECIFIC OUTCOMES

PSO	**Programme Specific Outcomes (PSO)** Upon Completion of M.Sc., Zoology Programme, the students would have
PSO 1	**Understood basic concepts,fundamental principles of various branches of zoology**and capability of developing ideas based on them.
PSO 2	**Developedan ease to express scientific thoughts and ideas** in National and International forums with effective communication skills.
PSO 3	**Explored analytical approach, critical thinking,** understanding and interpretation of the data, facts, related to biological sciences as well relevant technologies in zoology in conducting experimental investigation
PSO 4	**Explored scope for research** using various scientific tools and theories. Provide knowledge of a wide range of scientific techniques and application of methods and tools in related fields.
PSO 5	Emerged as **socially responsible individuals with adequate leadership qualities** to work for betterment of society.
PSO 6	Acquired the ability to compete in National level competitive exams such as CSIR-NET, GATE and **life-long learning as academicians, wildlife biologists, scientists** and **entrepreneurs**.

Course Title	Core Course – (CC1) - BIOLOGY OF INVERTEBRATES AND CHORDATES AND PALEONTOLOGY		
Code	P22ZY1		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the basic principles and systematic of animal classification.	PSO 1,2,3,4	K1
CO 2	Demonstrateon the metabolic processes in Invertebrates and Vertebrates.	PSO 1,2,3,4,5,6	K2
CO 3	Utilize the details of adaptive radiation and phylogeny of Invertebrates and Vertebrates	PSO 3,4,5,6	K3
CO 4	Analyze significance of fossils and minor phyla	PSO 1,2,3,4,5,6	K4
CO 5	Justify on the development of brain and skeletal system with reference to pectoral & pelvic griddle.	PSO 1,2,3,4,5,6	K5
CO 6	Build expertise on phylogeny of organisms.	PSO 1,2,3,5,6	K6

Course Title	Core Course – (CC2) - CELL AND MOLECULAR BIOLOGY		
Code	P22ZY2		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall the ultra-structure and functions of cell organelles.	PSO 1,2,3,4	K1
CO 2	Demonstrate about DNA replication, RNA and protein synthesis.	PSO 1,2,3,4,5,6	K2
CO 3	Utilize knowledge on protein synthesis control at the level of transcription and translation.	PSO 3,4,5,6	K3
CO 4	Analyze details of cell membrane structure and cellular communication.	PSO 1,2,3,5,6	K4
CO 5	Elucidate Cancer biology and Apoptosis	PSO 1,2,4,5,6	K5
CO 6	Build comparative understanding on the cytological and molecular techniques	PSO 1,2,3,4,5,6	K6

Course Title	Core Course – (CC3) - GENETICS		
Code	P22ZY3		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall on the fundamental molecular principles of genetics.	PSO 1,2,3,4	K1
CO 2	Demonstrate about the transmission, distribution, arrangement, and alteration of genetic information,and its functions.	PSO 1,3,4,5,6	K2
CO 3	Categorize the mechanism of maintenanceof genetic material in population.	PSO 2,3,4,5,6	K3
CO 4	Analyze the basics of genetic mapping, linkage and crossing over	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate on chromosomal mutations, microbial genetics and extra chromosomal inheritance	PSO 1,2,3,4,5,6	K5
CO 6	Developexpertise on the human genetics and inborn errors of metabolism	PSO 1,2,4,5,6	K6

Course Title	Core Course – (CC4) - Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).		
Code	P22ZY4P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Enumerate the identification and classification of Invertebrates, Vertebrates and Fossil forms	PSO 1,2,3,4	K1
CO 2	Demonstrate about the concept of microscopy	PSO 1,2,3,4,5,6	K2
CO 3	Apply the details of the histochemical and cytochemical techniques	PSO 2,3,4,5,6	K3
CO 4	Explicate on blood group identification and differential cell count in human blood sample	PSO 1,3,4,5,6	K4
CO 5	Elucidate on human karyotyping and calculation of gene frequency	PSO 1,2,4,5,6	K5
CO 6	Develop new techniques of molecular genetics	PSO 1,2,3,4,5,6	K6

Course Title	Elective Course – (EC1) – BIOINSTRUMENTATION AND BIOINFORMATICS		
Code	P22ZY5E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall the Principles and applications of various analytical instruments and different types of microscope used in scientific research.	PSO 1,2,3,4,5	K1
CO 2	Demonstrate the concept of various separation techniques used for biomolecules separation.	PSO 1,2,3,4,6	K2
CO 3	Apply the details of the pharmacological techniques.	PSO 2,3,4,5,6	K3
CO 4	Analyze database and tools related to basic bioinformatics	PSO 1,2,3,4,5,6	K4
CO 5	Deducesteps in sequence alignment and sequence analysis	PSO 1,2,3,5,6	K5
CO 6	Develop expertise in computational biology.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course – (CC5)- ANIMAL PHYSIOLOGY		
Code	P22ZY6		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the concept of thermoregulation and osmoregulation in aquatic and terrestrial animals.	PSO 1,2,3,4	K1
CO 2	Tracethe concept of nervous coordination and excretion	PSO 2,3,5,6	K2
CO 3	Utilize competence on various sensory receptors, muscular and respiratory systems in animals	PSO 1,3,4,5,6	K3
CO 4	Explicate onbioluminescence and animal behaviour with respect to chronobiology	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate the reproductive physiology and disorders associated with reproduction in humans.	PSO 1,2,3,4,5,6	K5
CO 6	Develop understanding on physiological process in organisms.	PSO 1,2,4,5,6	K6

Course Title	Core Course – (CC6)- BIOTECHNOLOGY		
Code	P22ZY7		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall the principles and applications of recombinant DNA technology and genomics.	PSO 1,2,3,4	K1
CO 2	Trace the concept of industrial biotechnology for human welfare	PSO 1,2,3,4,5,6	K2
CO 3	Apply the details of the Pharmaceutical biotechnology with r DNA vaccines	PSO 3,4,5,6	K3
CO 4	Decipher knowledge on animal cell culture and production of transgenic animals.	PSO 1,2,3,5,6	K4
CO 5	Elucidate the principles and applications of Nanobiotechnology	PSO 1,2,3,4,5,6	K5
CO 6	Develop gene therapy for disease treatment	PSO 1,2,3,4,6	K6

Course Title	Core Course – (CC7) - MICROBIOLOGY		
Code	P22ZY8		
	Course Outcomes	PSOs Addressed	Cognitive Level
CO 1	Recall the scope of microbiology, different classifications of microorganisms and different branches of microbiology	PSO 1,2,3,4	K1
CO 2	Demonstrate about the concept of bacterial culture techniques	PSO 2,3,5,6	K2
CO 3	Apply the details of the Food microbiology and various food preservation methods	PSO 1,3,4,5,6	K3
CO 4	Explicate on soil and agricultural microbiology	PSO 1,2,3,4,5,6	K4
CO 5	Elucidatemedical microbiology dealing with pathogenicity, modes of transmission of infections by different microbial species	PSO 1,2,3,4,5,6	K5
CO 6	Develop deep knowledge on microbes and their mode of infection in organisms.	PSO 1,2,4,5,6	K6

Course Title	Core Course – (CC8)- PRACTICAL – II (Pertaining to Animal Physiology, Biotechnology and Microbiology)		
Code	P22ZY9P		
	Course Outcomes	PSOs Addressed	Cognitive Level
CO 1	Recall quantitative estimation of salivary amylase	PSO 1,2,3,4	K1
CO 2	Demonstrate about the quantitative estimation of ammonia and urea	PSO 2,3,4,5,6	K2
CO 3	Apply the details of the physiological mechanism of various receptors	PSO 1,3,4,5,6	K3
CO 4	Explicate on electrophoretic techniques dealing with separation of nucleic acids and proteins	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate on bacterial culture techniques.	PSO 1,2,3,5,6	K5
CO 6	Develop expertise on biotechnological tools and techniques.	PSO 1,2,4,5,6	K6

Course Title	Elective Course– (EC2)- ENTREPRENEURIAL ZOOLOGY		
Code	P22ZY10E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define vermitechnology for sustainable agriculture and understand primary, secondary degradation and vermibed preparation.	PSO 1,2,3,4	K1
CO 2	Trace steps involved in bee keeping and sericulture with different types of Honey Bee and Silkworm	PSO 1,2,3,4,5,6	K2
CO 3	Identify different types of Silkworms, and the methodologies involved in Silkworm rearing with diseases of Silkworms.	PSO 3,4,5,6	K3
CO 4	Explicate on aquaculture techniques and diseases associated with aquaculture.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate on broilers and layers rearing ,Bacterial & Viral diseases associated with poultry farming	PSO 1,2,4,5,6	K5
CO 6	Develop commercialization of by-product of beekeeping and aquaculture.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course – (CC9) - DEVELOPMENTAL BIOLOGY AND EVOLUTION		
Code	P22ZY11		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recalltheories of evolution, concepts of gametogenesis, fertilisation and artificial reproductive technologies	PSO 1,2,3,6	K1
CO 2	Infer on metamorphosis and regeneration	PSO 1,2,3,4,5	K2
CO 3	Make use of knowledge on significance of stem cells and cell differentiation with emphasis on early embryonic development in Drosophila	PSO 2,3,4,5,6	K3
CO 4	Explicate about the evolutionary history of earth and theories of evolution.	PSO 1,3,4,5,6	K4
CO 5	Justify the distribution of animals on earth, its adaptive pattern, evolution and speciation as a causative factor.	PSO 1,2,3,4,5,6	K5
CO 6	Create phylogenetic tree based on ancestral records of organisms.	PSO 1,2,4,5,6	K6

Course Title	Core Course – (CC10)- BIOCHEMISTRY AND BIOPHYSICS		
Code	P22ZY12		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define structure, classification and metabolism of biomolecules along with working mechanism of spectroscope and microscopes	PSO 1,2,3,4	K1
CO 2	Demonstrateon enzymes, hormones and their functions	PSO 2,3,4,5,6	K2
CO 3	Apply significance of thermodynamics with respect to biological science	PSO 1,3,4,5,6	K3
CO 4	Analyze radiation and its impact on the biological system	PSO 1,2,3,5,6	K4
CO 5	Elucidate the principles and applications of various microscopes and spectroscopes.	PSO 1,2,4,5,6	K5
CO 6	Develop expertise on biophysical principles behind scientific instruments.	PSO 1,2,3,4,5,6	K6

Course Title	Core Course – (CC11)-PRACTICAL – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics).		
Code	P22ZY13P		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall Hardy Weinberg law and calculation of gene frequency	PSO 1,2,3,4	K1
CO 2	Inferon analytical chemistry and its use in preparation of solutions.	PSO 2,3,4,5,6	K2
CO 3	Experiment with preparations of various buffer solutions.	PSO 1,3,4,5,6	K3
CO 4	Explicateon the quantitative estimation of proteins, carbohydrates and lipids in animal tissues.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate the principles and applications of Beer and Lambert's law and its usage in spectrophotometer.	PSO 1,2,3,5,6	K5
CO 6	Develop skills in handling research instruments.	PSO 1,2,4,5,6	K6

Course Title	Elective Course – (EC3) - BIOSTATISTICS AND RESEARCH METHODOLOGY		
Code	P22ZY14E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define methods in field biology	PSO 1,2,3,4	K1
CO 2	Demonstrate descriptive statistics and presentation of data	PSO 1,2,3,4,5,6	K2
CO 3	Apply knowledge on hypothesis testing methods	PSO 1,3,4,5,6	K3
CO 4	Analyze methods involved in research from experimental design to report writing	PSO 2,3,4,6	K4
CO 5	Elucidate the concept of writing research publication and online surfing of research articles	PSO 1,2,3,4,5,6	K5
CO 6	Develop expertise on plagiarism and patent filing	PSO 1,2,3,4,5,6	K6

Course Title	Elective Course – (EC4)- ENVIRONMENTAL BIOLOGY AND MANAGEMENT		
Code	P22ZY15E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Defineenvironment, animal associations and community ecology	PSO 2,3,4,5	K1
CO 2	Inferonecosystem ecology	PSO 1,2,3,4,6	K2
CO 3	Apply competence on population ecology	PSO 1,3,4,5,6	K3
CO 4	Analyze the ecological adaptations and zoogeography	PSO 1,2,3,5,6	K4
CO 5	Elucidate ecological resources and legislations to conserve biodiversity	PSO 1,2,3,4,5,6	K5
CO 6	Develop awareness for conserving biodiversity	PSO 1,4,5,6	K6

Course Title	Core Course – (CC12)- IMMUNOLOGY		
Code	P22ZY16		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall innate and adaptive immunity with emphasis on primary and secondary lymphoid organs	PSO 1,2,3,4	K1
CO 2	Infer about antigens, structure and types of immunoglobulin and complement systems	PSO 2,3,5,6	K2
CO 3	Utilizeskills on immune response of body and immune parasitology	PSO 1,3,4,5,6	K3
CO 4	Explicateon MHC complex, immune disorders and transplantation immunology.	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate the immunological techniques and associated diagnostic tests	PSO 1,2,3,4,5,6	K5
CO 6	Develop understanding on transplantation immunology	PSO 1,2,4,5,6	K6

Course Title	Core Course – (CC13) - GENERAL AND APPLIED ENTOMOLOGY		
Code	P22ZY17		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Recall taxonomical classification of insects and insect morphology	PSO 1,2,3,4	K1
CO 2	Demonstrate digestive, respiratory and circulatory system of insects.	PSO 1,2,3,5,6	K2
CO 3	Apply skills on excretory, nervous and reproductive system of insects	PSO 2,3,4,5,6	K3
CO 4	Analyze the insect pest varieties of major crop plants	PSO 1,3,4,5,6	K4
CO 5	Justify pest control methods and integrated pest management strategies	PSO 1,2,5,6	K5
CO 6	Develop expertise on the anatomy and physiology of insects.	PSO 1,2,3,4,5,6	K6

Course Title	Elective Course – (EC5) - WILDLIFE BIOLOGY		
Code	P22ZY18E		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define wildlife and its conservation, wildlife protecting legislations	PSO 1,2,3,4	K1
CO 2	Demonstrate knowledge on capture and handling of wild animals.	PSO 2,3,4,5,6	K2
CO 3	Apply knowledge on bio ecology, wildlife health and forensic science.	PSO 1,3,4,5,6	K3
CO 4	Explicateon techniques in taking wildlife census.	PSO 1,2,3,4,5,6	K4
CO 5	Justify the human – wildlife conflicts, legislations and conventions.	PSO 1,2,3,5,6	K5
CO 6	Improvise conservation strategies for endangered species	PSO 1,2,3,4,5,6	K6

Course Title	Project Work		
Code	P22ZYP19		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define research studies	PSO 1,2,3,4	K1
CO 2	Demonstrate innovative ideas for modern science and technology development.	PSO 2,3,4,5,6	K2
CO 3	Applyskills on writing research proposals for funding	PSO 1,3,4,5,6	K3
CO 4	Explicate technically in handling scientific instruments	PSO 1,2,3,5,6	K4
CO 5	Elucidate the concept of writing thesis and research publications.	PSO 1,2,3,4,5,6	K5
CO 6	Elaborate on the process of patent filing and IPR	PSO 1,2,4,5,6	K6

EXTRA COURSES

Course Title	Extra course -1- ORNITHOLOGY		
Code	P22ZY20EC		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define the classification of birds, ecology of birds and their economic value	PSO 1,3,4,5	K1
CO 2	Inferabout the physiology of birds	PSO 1,2,3,4,6	K2
CO 3	Apply skills on ecology of birds	PSO 1,2,3,4,5,6	K3
CO 4	Analyzethe breeding, parental care, feathers and moulting patterns in birds	PSO 2,3,5,6	K4
CO 5	Justify the migration in birds and their economic value	PSO 1,2,3,4,5,6	K5
CO 6	Develop awareness about man-made hazards to birds.	PSO 1,2,3,4,5,6	K6

Course Title	Extra Course -2 - ENVIRONMENTAL IMPACT ANALYSIS		
Code	P22ZY21EC		
Course Outcomes		PSOs Addressed	Cognitive Level
CO 1	Define Environment and sustainability, Environmental impact Assessment (EIA)	PSO 1,2,3,4	K1
CO 2	Infer on origin and development of EIA	PSO 2,3,4,5,6	K2
CO 3	Applytechniques and assessment process of EIA	PSO 1,3,4,5,6	K3
CO 4	Explicateon the role of EIA in developmental activities	PSO 1,2,3,4,5,6	K4
CO 5	Elucidate the main participants in EIA process and environmental audit.	PSO 1,2,3,5,6	K5
CO 6	Create public awareness regarding EIA	PSO 1,3,4,5,6	K6

M.Sc. Zoology Degree Programme
Programme Articulation Matrix (PAM)

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Core course	496	458	632	576	481	502	**3145**
Elective course	161	158	244	243	150	179	**1135**
Extra course	68	53	76	90	74	62	**423**
Total weightage of all courses contributed to Po's	**725**	**669**	**952**	**909**	**705**	**743**	**4703**

CORE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY1	Biology of Invertebrates and Chordates and Paleontology	31	31	38	45	37	31	**213**
P22ZY2	Cell And Molecular Biology	37	31	45	45	37	31	**226**
P22ZY3	Genetics	31	31	45	54	25	45	**231**
P22ZY4P	Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).	45	37	45	37	31	31	**226**
P22ZY6	Animal Physiology	31	31	45	37	45	37	**226**
P22ZY7	Biotechnology	37	31	54	45	22	37	**226**
P22ZY8	Microbiology	37	31	45	45	37	31	**226**
P22ZY9P	Practical – II (Pertaining to Animal Physiology, Biotechnology and Microbiology)	31	37	45	45	31	37	**226**
P22ZY11	Developmental Biology and Evolution	37	37	45	31	37	37	**224**
P22ZY12	Biochemistry and Biophysics	37	31	45	37	37	37	**224**
P22ZY13P	Practical – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics)	37	31	45	37	37	37	**224**
P22ZY16	Immunology	37	31	45	37	37	37	**224**
P22ZY17	General and Applied Entomology	37	37	45	36	31	37	**223**
P22ZYP19	Project Work	31	31	45	45	37	37	**226**
Total Weightage of all Core Courses contributed to PO's		**496**	**458**	**632**	**576**	**481**	**502**	**3145**

ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY5E	Bioinstrumentation and Bioinformatics	31	31	54	45	31	37	**229**
P22ZY10E	Entrepreneurial Zoology	31	37	37	54	31	37	**227**
P22ZY14E	Biostatistics and Research Methodology	31	37	54	54	14	37	**227**
P22ZY15E	Environmental Biology and Management	37	22	45	45	37	37	**223**
P22ZY18E	Wildlife Biology	31	31	54	45	37	31	**229**
Total Weightage of all Elective Courses contributed to PO's		**161**	**158**	**244**	**243**	**150**	**179**	**1135**

EXTRA COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY20EC	Ornithology	31	31	38	45	37	31	**213**
P22ZY21EC	Environmental Impact Analysis	37	22	38	45	37	31	**210**
Total Weightage of all Extra Courses contributed to PO's		**68**	**53**	**76**	**90**	**74**	**62**	**423**

M.Sc. Zoology Degree Programme
Programme Articulation Matrix (PAM) without Extra Credit Courses

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Core course	496	458	632	576	481	502	**3145**
Elective course	161	158	244	243	150	179	**1135**
Total weightage of all courses contributed to Po's without Extra Credit Courses	**657**	**616**	**876**	**819**	**631**	**681**	**4280**

CORE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY1	Biology of Invertebrates and Chordates and Paleontology	31	31	38	45	37	31	**213**
P22ZY2	Cell And Molecular Biology	37	31	45	45	37	31	**226**
P22ZY3	Genetics	31	31	45	54	25	45	**231**
P22ZY4P	Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).	45	37	45	37	31	31	**226**
P22ZY6	Animal Physiology	31	31	45	37	45	37	**226**
P22ZY7	Biotechnology	37	31	54	45	22	37	**226**
P22ZY8	Microbiology	37	31	45	45	37	31	**226**
P22ZY9P	Practical – II (Pertaining to Animal Physiology, Biotechnology and Microbiology)	31	37	45	45	31	37	**226**
P22ZY11	Developmental Biology and Evolution	37	37	45	31	37	37	**224**
P22ZY12	Biochemistry and Biophysics	37	31	45	37	37	37	**224**
P22ZY13P	Practical – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics)	37	31	45	37	37	37	**224**
P22ZY16	Immunology	37	31	45	37	37	37	**224**
P22ZY17	General and Applied Entomology	37	37	45	36	31	37	**223**
P22ZYP19	Project Work	31	31	45	45	37	37	**226**
Total Weightage of all Core Courses contributed to PO's without Extra Credit Courses		**496**	**458**	**632**	**576**	**481**	**502**	**3145**

ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY5E	Bioinstrumentation and Bioinformatics	31	31	54	45	31	37	**229**
P22ZY10E	Entrepreneurial Zoology	31	37	37	54	31	37	**227**
P22ZY14E	Biostatistics and Research Methodology	31	37	54	54	14	37	**227**
P22ZY15E	Environmental Biology and Management	37	22	45	45	37	37	**223**
P22ZY18E	Wildlife Biology	31	31	54	45	37	31	**229**
Total Weightage of all Elective Courses contributed to PO's without Extra Credit Courses		**161**	**158**	**244**	**243**	**150**	**179**	**1135**

M.Sc. Zoology Degree Programme
Weighted Percentage of Course Contribution to PO's
Programme Articulation Matrix (PAM)

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Core course	68.424	68.42	66.375	63.36	68.234	67.568	**66.864**
Elective course	22.223	23.61	25.628	26.73	21.277	24.092	**24.131**
Extra course	9.383	7.92	7.982	9.9	10.5	8.344	**8.994**
Total weighted percentage of all courses contributed to Po's	**100**	**100**	**100**	**100**	**100**	**100**	**100**

CORE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY1	Biology of Invertebrates and Chordates and Paleontology	4.27	4.63	3.991	4.95	5.25	4.172	**4.529**
P22ZY2	Cell And Molecular Biology	5.103	4.63	4.726	4.95	5.25	4.172	**4.805**
P22ZY3	Genetics	4.28	4.63	4.726	5.94	3.55	6.06	**4.911**
P22ZY4P	Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).	6.21	5.53	4.726	4.07	4.39	4.172	**4.805**
P22ZY6	Animal Physiology	4.28	4.63	4.726	4.07	6.38	4.98	**4.805**
P22ZY7	Biotechnology	5.103	4.63	5.672	4.95	3.12	4.98	**4.805**
P22ZY8	Microbiology	5.103	4.63	4.726	4.95	5.25	4.172	**4.805**
P22ZY9P	Practical – II (Pertaining to Animal Physiology, Biotechnology and Microbiology)	4.28	5.53	4.726	4.95	4.397	4.98	**4.805**
P22ZY11	Developmental Biology and Evolution	5.103	5.53	4.726	3.41	5.25	4.98	**4.762**
P22ZY12	Biochemistry and Biophysics	5.103	4.63	4.726	4.07	5.25	4.98	**4.762**
P22ZY13P	Practical – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics)	5.103	4.63	4.726	4.07	5.25	4.98	**4.762**
P22ZY16	Immunology	5.103	4.63	4.726	4.07	5.25	4.98	**4.762**

P22ZY17	General and Applied Entomology	5.103	5.53	4.726	3.96	4.397	4.98	**4.741**
P22ZYP19	Project Work	4.28	4.63	4.726	4.95	5.25	4.98	**4.805**
Total Weighted percentage of all Core Courses contributed to PO's		**68.424**	**68.42**	**66.375**	**63.36**	**68.234**	**67.568**	**66.864**

ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY5E	Bioinstrumentation and Bioinformatics	4.28	4.63	5.672	4.95	4.39	4.98	**4.869**
P22ZY10E	Entrepreneurial Zoology	4.28	5.53	3.886	5.94	4.397	4.98	**4.826**
P22ZY14E	Biostatistics and Research Methodology	4.28	5.53	5.672	5.94	1.99	4.98	**4.826**
P22ZY15E	Environmental Biology and Management	5.103	3.29	4.726	4.95	5.25	4.98	**4.741**
P22ZY18E	Wildlife Biology	4.28	4.63	5.672	4.95	5.25	4.172	**4.869**
Total Weighted percentage all Elective Courses contributed to PO's		**22.223**	**23.61**	**25.628**	**26.73**	**21.277**	**24.092**	**24.131**

EXTRA COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY20EC	Ornithology	4.28	4.63	3.991	4.95	5.25	4.172	**4.529**
P22ZY21EC	Environmental Impact Analysis	5.103	3.29	3.991	4.95	5.25	4.172	**4.465**
Total Weighted percentage of all Extra Courses contributed to PO's		**9.383**	**7.92**	**7.982**	**9.9**	**10.5**	**8.344**	**8.994**

M.Sc. Zoology Degree Programme
Weighted Percentage of Course Contribution to PO's
Programme Articulation Matrix (PAM) without Extra Credit Courses

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
Core course	75.487	74.344	72.133	70.322	76.218	73.712	**73.475**
Elective course	24.503	25.647	27.851	29.668	23.768	26.284	**26.516**
Total weighted percentage of all courses contributed to Po's without Extra Credit Courses	**100**	**100**	**100**	**100**	**100**	**100**	**100**

CORE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY1	Biology of Invertebrates and Chordates and Paleontology	4.718	5.032	4.337	5.494	5.863	4.552	**4.976**
P22ZY2	Cell And Molecular Biology	5.631	5.032	5.136	5.494	5.863	4.552	**5.280**
P22ZY3	Genetics	4.718	5.032	5.136	6.593	3.961	6.607	**5.397**
P22ZY4P	Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).	6.849	6.006	5.136	4.517	4.912	4.552	**5.280**
P22ZY6	Animal Physiology	4.718	5.032	5.136	4.517	7.131	5.433	**5.280**
P22ZY7	Biotechnology	5.631	5.032	6.164	5.494	3.486	5.433	**5.280**
P22ZY8	Microbiology	5.631	5.032	5.136	5.494	5.863	4.552	**5.280**
P22ZY9P	Practical – II (Pertaining to Animal Physiology, Biotechnology and Microbiology)	4.718	6.006	5.136	5.494	4.912	5.433	**5.280**
P22ZY11	Developmental Biology and Evolution	5.631	6.006	5.136	3.785	5.863	5.433	**5.233**
P22ZY12	Biochemistry and Biophysics	5.631	5.032	5.136	4.517	5.863	5.433	**5.233**
P22ZY13P	Practical – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics)	5.631	5.032	5.136	4.517	5.863	5.433	**5.233**

P22ZY16	Immunology	5.631	5.032	5.136	4.517	5.863	5.433	**5.233**
P22ZY17	General and Applied Entomology	5.631	6.006	5.136	4.395	4.912	5.433	**5.210**
P22ZYP19	Project Work	4.718	5.032	5.136	5.494	5.863	5.433	**5.280**
Total Weighted percentage of all Core Courses contributed to PO's without Extra Credit Courses		**75.487**	**74.344**	**72.133**	**70.322**	**76.218**	**73.712**	**73.475**

ELECTIVE COURSES

Course Code	Title of the Course	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	Total
P22ZY5E	Bioinstrumentation and Bioinformatics	4.718	5.032	6.164	5.494	4.912	5.433	**5.350**
P22ZY10E	Entrepreneurial Zoology	4.718	6.006	4.223	6.593	4.912	5.433	**5.303**
P22ZY14E	Biostatistics and Research Methodology	4.718	6.006	6.164	6.593	2.218	5.433	**5.303**
P22ZY15E	Environmental Biology and Management	5.631	3.571	5.136	5.494	5.863	5.433	**5.210**
P22ZY18E	Wildlife Biology	4.718	5.032	6.164	5.494	5.863	4.552	**5.350**
Total Weighted percentage all Elective Courses contributed to PO's without Extra Credit Courses		**24.503**	**25.647**	**27.851**	**29.668**	**23.768**	**26.284**	**26.516**

CLASS	**I – M.Sc., Zoology**	
Semester	**I**	
Course and Code	**Core Course – (CC1)**	**Code: P22ZY1**
Course Title	**BIOLOGY OF INVERTEBRATES AND CHORDATES AND PALEONTOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the principles of systematics and animal classification.
COE2. To understand the respiration, circulation, excretion, and nervous system in Invertebrates
COE3. To understand the integumentary, respiratory, circulatory and excretory systems in Vertebrates.
COE4. To understand the origin, adaptive radiation and phylogeny of Invertebrates and Chordates.
COE5. To understand the study and significance of fossils and Minor phyla.

UNIT - I: PRINCIPLES OF SYSTEMATICS AND ANIMAL CLASSIFICATION

Origin and Development of Systematics – Nomenclature (rules and recommendations) – Systematic hierarchy, Taxonomic categories – Major groups in animal classification (Invertebrates) – Classification of Chordate – – Symmetry in animal organization – Coelom: Origin; Types and significance – Metamerism: Types; Evolution of Metamerism – Locomotion in Annelids (Earthworm and Nereis) – Feeding mechanismin Polychaetes – Structure and life history of Amphioxus, Balanoglossus, Ascidian and their evolutionary significance.

UNIT - II: BIOLOGY OF INVERTEBRATES

Life history of *Plasmodium malariae*and *Taenia solium* –Respiration: Gill respiration in prawn; Tracheal respiration in cockroach; Ctenidial and pulmonary respiration in snail (Pila) – Circulation: Earthworm; Prawn; – Excretion: Contractile vacuole in Paramecium; Flame cells in Planaria; Green glands in prawn – Nervous systems: Diffused type in hydra; Nervous system in prawn.

UNIT - III: BIOLOGY OF CHORDATES

Locomotion in fishes – Parental care in fishes – Accessory respiratory organs in fishes– Neoteny in Amphibia – Pulmonary respiration in birds – Flight adaptations in birds – Migration in birds – Structure of skin – Skin derivatives (Glands, Epidermal scales, Horns, Beaks, Feathers, Hair) – Dentition in Mammals – Comparison of brain in Chordates – Comparsion of pectoral girdles, pelvic girdles in Chordates.

UNIT – IV: PHYLOGENY OF INVERTEBRATES AND CHORDATES

Origin and evolution of parasitism; Parasitic adaptations of Trematoda and Cestoda – Origin and Phylogeny of Annelida, Echinodermata – Origin and evolution of fishes – Adaptive radiation in deep sea fishes – Origin of amphibians – Evolutionary significance of crocodiles – Adaptive radiation in birds – Evolution of Vertebrate hearts – Types and evolution of kidneys.

UNIT - V: PALEONTOLOGY AND MINOR PHYLA

The evolutionary time scale: Eras, periods and epoch; Major events – Formation and classification of fossils – Dating of fossils – Fossil records – Invertebrate fossils – Vertebrate

fossils and their importance – Phylogenetic importance of fossils – Minor Phyla: Mesozoa, Rotifera and Phoronida

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define the basic principles and systematic of animal classification.
CO2: Demonstrate on the metabolic processes in Invertebrates and Vertebrates.
CO3: Utilize the details of adaptive radiation and phylogeny of Invertebrates and Vertebrates.
CO4: Analyze significance of fossils and minor phyla.
CO5: Justify on the development of brain and skeletal system with reference to pectoral & pelvic griddle.
CO6: Build expertise on phylogeny of organisms.

Textbooks

1. Barnes, R.D. (1982) – Invertebrate Zoology, IV Ed., Holt Saunders – International Edition.
2. Waterman, A.J. (1971), Chordate Structure and Function, the Macmillan Company.

References

1. Mc Neill Alexander. 1981. The Chordates. CUP.
2. Ayyar, E.K., and Ananthakrishnan, T.N. (1992). A Manual of Zoology. Vol. II (Chordata). Visvanathan Publishers.
3. Barrington, E.J.W.(1979) Invertebrate Structure and Function, II Ed., ELBS and Nelson.
4. Hyman, G.H., The Invertebrates, Vols. I to VII, Mc Graw Hill Book Co Inc., New York.
5. Kent, G.C. (1976), Comparative Anatomy of the Vertebrates, McGraw Hill Book Co Inc., New York.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	0	0	9	9	9	9
CO 4	1	3	9	9	9	9
CO 5	3	9	1	9	9	3
CO 6	9	1	1	0	9	9
Weightage	**31**	**31**	**38**	**45**	**37**	**31**
Weightage percentage of Course contribution to POs	**4.27**	**4.63**	**3.991**	**4.95**	**5.25**	**4.172**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**5.032**	**4.337**	**5.494**	**5.863**	**4.552**

CLASS	**I – M.Sc., Zoology**	
Semester	**I**	
Course and Code	**Core Course – (CC2)**	**Code: P22ZY2**
Course Title	**CELL AND MOLECULAR BIOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand membrane structure of a cell and its communications.
COE2. To understand the structure and function of endoplasmic reticulum, Golgi complex, Lysosome, Mitochondria and Nucleus.
COE3. To understand the structure and function of DNA and RNA
COE4. To understand the cancer biology
COE5. To understand the cytological and molecular techniques

UNIT – I: MEMBRANE STRUCTURE OF CELL AND CELLULAR COMMUNICATION
History and Origin (Prokaryotic and Eukaryotic cell) – Ultra structure, functions and chemical composition of plasma membrane (Lamellar, Micellar & Fluid mosaic model) – General principles of cell communication – Cell adhesion and roles of different adhesion molecules, gap junctions and extracellular matrix.

UNIT – II: STRUCTURAL AND FUNCTIONS OF INTRACELLULAR ORGANELLES
History, ultra structure& functions of Endoplasmic reticulum, Golgi bodies, Lysosomes – Mitochondria (History, ultra structure, biogenesis) – Respiratory chain complex and Electron transport system – Ultra structure and composition of Nucleus, Functions of nuclear pore complex - Chromosome types (Giant, Polytene and Lampbrush) and functions.

UNIT – III: FUNDAMENTAL UNIT OF CELL
DNA: Ultra structure, composition, types & functions – Watson and Crick's structural model, DNA replication – DNA damage and repair mechanisms – DNA recombination (homologous and site-specific) – RNA: (Types, structure & function), Biosynthesis of mRNA, tRNA - Mechanism of protein synthesis.

UNIT – IV: CANCER BIOLOGY
Characteristics of cancer cells – Genetic rearrangements in progenitor cells - Types of tumors – Carcinogens – Cellular oncogenes – Tumor suppressor genes (RB and P53).Metastasis (interaction of cancer cells with normal cells) – Apoptosis. Virus-induced cancer – Cancer and the cell cycle – Therapeutic interventions of molecular biology to uncontrolled cell growth and treatment.

UNIT – V: CYTOLOGICAL AND MOLECULAR TECHNIQUES
Collection & preservation of animal tissue – Fixation, embedding, Sectioning – Cytochemical staining and detection methods of carbohydrates, protein, lipids, DNA and RNA – Cell fractionation – Cell Sorter, Micro plate high through put readers, Animal cell imaging – Autoradiography – Fluorescent *in situ* hybridization (FISH).

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall the ultra-structure and functions of cell organelles.
CO2: Demonstrate about DNA replication, RNA and protein synthesis.
CO3: Utilize knowledge on protein synthesis control at the level of transcription and

translation.

CO4: Analyze details of cell membrane structure and cellular communication.
CO5: Elucidate Cancer biology and Apoptosis.
CO6: Build comparative understanding on the cytological and molecular techniques.

Textbooks

1. De Robertis, E.D..P. and De Robertis, E.M.F. (1987), Cell and Molecular Biology, VIII Ed. Lea and Febiger, Philadelphia.
2. Cooper, J.M., Hausman, R.E. 2009. The Cell. Sinauer Associates, Inc., USA.

References

1. Bruce Alberts and Dennis Brey, (1994), Molecular Biology of the Cell. 3rd Edition. Garland Publishing, Inc. New York and London.
2. Becker and Deamer, (1991), The World of the Cell. 2nd Edition. The Benjamin and Cumming Publishing Company, Inc. California.
3. Alberts, B., Johnson, A., Luwis, J. Raff, M. Robertis, K., Walter, P. 2002. Molecular Biology of Cell. Garland Science (Taylor & Francis Group), New York.
4. Lodish H., Berr, A. and Paul, M. 2003. Molecular Cell Biology, New York: W.H. Freeman.
5. Karp, G. 2008. Cell and Molecular Biology, G. John Wiley & Sons.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	0	0	9	9	9	9
CO 4	9	3	9	0	9	9
CO 5	1	9	0	9	9	9
CO 6	9	1	9	9	9	3
Weightage	**37**	**31**	**45**	**45**	**37**	**31**
Weightage percentage of Course contribution to POs	**5.103**	**4.63**	**4.726**	**4.95**	**5.25**	**4.172**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**5.631**	**5.032**	**5.136**	**5.494**	**5.863**	**4.552**

CLASS	**I – M.Sc., Zoology**	
Semester	**I**	
Course and Code	**Core Course – (CC3)**	**Code: P22ZY3**
Course Title	**GENETICS**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1.To understand linkage and crossing over
COE2.To understand gene concept and gene expression
COE3.To understand various types of chromosomal mutations
COE4.To understand quantitative genetics
COE5.To understand human genetics

UNIT – I: GENETIC INTERACTION, LINKAGE & CROSSING OVER

Allelic gene interactions (complete dominance, Incomplete dominance, Co dominance, Pleiotropism, Penetrance) – Non-allelic gene interactions (complementary genes, supplementary genes, duplicate genes, lethal genes, and epistatsis) – Kinds of linkage (complete and incomplete) – Mechanism of crossing over and its theories (Chiasma, breakage, Contact-first, Strain, and differential contraction theories) - Construction of chromosome map in Drosophila.

UNIT – II: GENE CONCEPT AND REGULATION OF GENE EXPRESSION

Chromatin structure (heterochromatin and euchromatin) –Fine structure of gene – Characteristics of genetic code – Wobble hypothesis – Gene Regulation in Prokaryotes: Lac operon, trp operon and ara operon in bacteria – Gene regulation in eukaryotes: Short term and long term regulation.

UNIT – III: CHROMOSOMAL MUTATIONS

Gene Mutations: Base substitutions; Insertions and deletions; Phenotypic effects of mutations; Suppressor mutations – Chromosome mutations: Chromosome rearrangements (duplications, deletions, inversions, and translocations); Aneuploidy (nullisomy, monosomy, trisomy, and tetrasomy); Polyploidy (autopolyploidy and allopolyploidy) – Causes of mutation: Spontaneous replication errors; Spontaneous chemical changes; Chemicallyinduced mutations; Radiation – Ames Test.

UNIT – IV: MICROBIAL, QUANTITATIVE GENETICS & EXTRA CHROMOSOMAL INHERITANCE

Transposon – Types and mechanism of transposition – Methods of genetic transfers: Transformation; Conjugation; Transduction; Sex-duction – Mapping genes by interrupted conjugation mating – Polygenic inheritance – Types of heritability – Mapping QTLs – Maternal inheritance.

UNIT – V: HUMAN GENETICS

Inborn errors of metabolism: Phenylketonuria; alkaptonuria; albinism; Lesh-Nyhan syndrome andADA deficiency; – Preparation and analysis of human karyotype – Sex determination in man, Drosophilia (Chromosomal theory, quantitative theory, Hormonal theory, Metabolic differentiation theory) – Gynandromorphy (Loss of X chromosomes, binucleated eggs) – Twins and its types – Monogenetic disorders: Sickle cell anemia & cystic fibrosis.– Prenatal diagnosis (Amniocentesis, CVS).

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall on the fundamental molecular principles of genetics.

CO2: Demonstrate about the transmission, distribution, arrangement, and alteration of genetic information, and its functions.

CO3: Categorize the mechanism of maintenance of genetic material in population.

CO4: Analyze the basics of genetic mapping, linkage and crossing over.

CO5: Elucidate on chromosomal mutations, microbial genetics and extra chromosomal inheritance.

CO6: Develop expertise on the human genetics and inborn errors of metabolism.

Textbooks

1. Pierce, B.A. 2012. Genetics A Conceptual Approach. Fourth edition. W. H. Freeman and Company.
2. Griffiths, A.J.F., Susan R. Wessler, Sean B. Carroll, John Doebley. 2015. Introduction to Genetic Analysis. Eleventh edition. W. H. Freeman and Company.

References

1. Daniel L.Hartl (1996) Genetics, III Ed., Jones Barlett Publishers. Boston.
2. David Friefelder (1998) Microbial Genetics, Narosa Publishing House, New Delhi.
3. Jenkins, J.B. (1983) Human genetics, The Benjamin Cummings Publishing Co.
4. Strickberger Monnroe, W. (1996) Genetics, Prentice Hall of India Pvt. Ltd., New Delhi.
5. Watson J D et al (1987) Molecular Biology of gene, IV Ed., The Benjamin Publishing Company Inc., UK.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	0	9	9	1	9
CO 3	0	9	9	9	3	9
CO 4	1	9	9	9	3	9
CO 5	3	1	9	9	9	9
CO 6	9	3	0	9	9	9
Weightage	**31**	**31**	**45**	**54**	**25**	**45**
Weightage percentage of Course contribution to POs	**4.28**	**4.63**	**4.726**	**5.94**	**3.55**	**6.06**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**5.032**	**5.136**	**6.593**	**3.961**	**6.607**

CLASS	**I – M.Sc., Zoology**	
Semester	**I**	
Course and Code	**Core Course – (CC4)**	**Code: P22ZY4P**
Course Title	**Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics)**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To gain knowledge on identification and classification of Invertebrates and Vertebrates
COE2. To understand various fossil forms.
COE3. To understand the concepts of microscopy
COE4. To understand histochemical and cytochemical techniques.
COE5. To understand blood group identification, differential cell counting in blood, human karyotyping, and calculation of gene frequency

BIOLOGY OF INVERTEBRATES AND CHORDATES AND PALAEONTOLOGY

Mounting of Teleost fish scales.
Study of Frog nervous system and brain using virtual laboratory.
Study of Frog circulatory system and heart using virtual laboratory.

Spotters

Radial symmetry (Sea anemone).
Bilateral symmetry (Cockroach).
Acoelomates (Planeria).
Pseudocoelomates (Round worm).
Eucoelomates (Earthworm).
Fossils (Nautiloid, Ammonoid, & Trilobite).

CELL AND MOLECULAR BIOLOGY

Measurements using ocular and stage micrometers.
Histochemical technique (Micrometry).
Differential cell counting in human blood.

Spotters

Ocular micrometer.
Stage micrometer.
Microtome.
Mitosis: Prophase, metaphase, anaphase, and telophase.

GENETICS

Blood group identification and Rh factor in human blood.

Spotters:

Human karyotype: Male andFemale
Maternal inheritance
Gynandromorphy
Mutation: Duplications, deletions, inversions, and translocations.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Enumerate the identification and classification of Invertebrates, Vertebrates and Fossil forms.

CO2: Demonstrate about the concept of microscopy.

CO3: Apply the details of the histochemical and cytochemical techniques.

CO4: Explicate on blood group identification and differential cell count in human blood sample.

CO5: Elucidate on human karyotyping and calculation of gene frequency.

CO6: Develop new techniques of molecular genetics.

Reference Books

1. P.S. Verma and P.C. Srivastava. 2007. Advanced Practical in Zoology. S. Chand & Co.
2. S.S. Lal. 2004. Practical Zoology: Chordates. Rastogi Publications.

Web References

1. https://www.youtube.com/watch?v=HaqgCtA-ioI
2. http://nbtc.naco.gov.in/assets/resources/training/5.pdf
3. https://www.youtube.com/watch?v=YJ7iBvKbXD8
4. https://www.britannica.com/science/ABO-blood-group-system
5. http://courseware.cutm.ac.in/wp-content/uploads/2020/06/ENUMERATION-OF-TOTAL-RED-BLOOD-CORPUSCLES.pdf
6. https://www.youtube.com/watch?v=7AWu4Qb_Emk
7. https://www.leicabiosystems.com/en-in/knowledge-pathway/an-introduction-to-specimen-processing/

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	0	9	9	0	9	9
CO 4	9	0	9	9	3	9
CO 5	9	9	0	1	9	9
CO 6	9	1	9	9	9	3
Weightage	**45**	**37**	**45**	**37**	**31**	**31**
Weightage percentage of Course contribution to POs	**6.21**	**5.53**	**4.726**	**4.07**	**4.39**	**4.172**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**6.849**	**6.006**	**5.136**	**4.517**	**4.912**	**4.552**

CLASS	**I – M.Sc., Zoology**	
Semester	**I**	
Course and Code	**Elective Course – (EC1)**	**Code: P22ZY5E**
Course Title	**BIOINSTRUMENTATION AND BIOINFORMATICS**	
Hours: 6	**Credits : 4**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the principles and applications of various analytical instruments and microscopes used in biological sciences.
COE2. To gain knowledge about various separation techniques, and physiological measuring instruments.
COE3. To understand the pharmacological techniques
COE4. To understand basic concepts of biological databases and its tools
COE5. To understand the sequence alignment and analysis

BIOINSTRUMENTATION

UNIT – I: ANALYTICAL INSTRUMENTS AND MICROSCOPY

Principle, components, working procedure and applications of analytical balance, pH meter, Water bath, Deep freezer, Magnetic stirrer, Geiger-Muller counterand scintillation counter. Microscopy: Principle, components, working procedure and applications of Light, Fluorescence, Phase contrast, Dark field, SEM and TEM microscopes

UNIT – II: SEPARATION TECHNIQUES

Centrifugation: Principle, low speed, high speed and ultracentrifuge – Types of centrifugation (differential, density gradient, rate zonal density gradient, isopycnic). Electrophoresis: Principle and applications of Agarose, SDS-PAGE. Chromatography: Principle and applications of Paper, Thin layer, Column, Ion exchange and HPLC.

UNIT – III: PHARMACOLOGICAL TECHNIQUES

Positron Emission Tomography (PET) – Magnetic Resonance Imaging (MRI) – Functional Magnetic Resonance Imaging (fMRI) – Computed Axial Tomography (CAT) – Electrocardiogram (ECG) – Electroretinogram (ERG) – Electromyography (EMG) – Hemodialyser – Analgesiometer (hot plate & tail flick)

BIOINFORMATICS

UNIT – IV: BIOLOGICAL DATABASES AND TOOLS

Components and applications of Bioinformatics – Introduction of Biological Databases (objectives, properties and classification) –Nucleic acid databases (NCBI, DDBJ, and EMBL) – Protein databases (primary, composite, and secondary) – Specialized Genome databases: (SGD, TIGR, and ACeDB) – Gene Identification databases (CUTG, TRRD, Sputnik) – Structure databases (CATH, SCOP, and PDBsum) – Classification of Bioinformatics tools (BLAST,FASTA, Clustal W) – Protein functional Analysis tool – Sequence Analysis tool.

UNIT – V: SEQUENCE ALIGNMENT AND SEQUENCE ANALYSIS

Introduction to Sequence alignment, Sequence alignment aechnique – Pair-wise sequence alignment (Dot Matrix method, Dynamic Programming) – Multiple sequence alignment (progressive method, iterative method)– Structural alignment – Sequence comparisons – Optimal alignment, Local alignment and Global alignment (algorithm and example).

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall the Principles and applications of various analytical instruments and different types of microscope used in scientific research.

CO2: Demonstrate the concept of various separation techniques used for biomolecules separation.

CO3: Apply the details of the pharmacological techniques.

CO4: Analyze database and tools related to basic bioinformatics.

CO5: Deduce steps in sequence alignment and sequence analysis.

CO6: Develop expertise in computational biology.

Textbooks

1. Webster, J.G. 2004. Bioinstrumentation. Wiley, India.
2. Veerakumari, L. 2015. Bioinstrumentation. MJP Publisher.

References

1. Andrzej Polanski and Marek Kimmel. 2007. Bioinformatics. Springer-Verlag Berlin Heidelberg.
2. N Arumugam and V Kumaresan. 2015. Biophysics and Bioinstrumentation. Saras.
3. Irfan Ali Khan and Atiya Khanum 2003, Fundamentals of Bioinformatics, Ukaaz Publications Hyderabad, India.
4. Murthy, C.S.V. 2003, Bioinformatics, Himalaya Publishing House, Mumbai, Delhi, Nagpur, Bangalore- India.
5. Subramanian, C. 2004, A Text Book of Bioinformatics, Dominant Publishers and Distributors, New Delhi, India.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	0	9	9	9	0
CO 2	9	9	9	9	0	1
CO 3	0	9	9	9	1	9
CO 4	1	9	9	9	3	9
CO 5	9	1	9	0	9	9
CO 6	3	3	9	9	9	9
Weightage	**31**	**31**	**54**	**45**	**31**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**4.63**	**5.672**	**4.95**	**4.39**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit courses	**4.718**	**5.032**	**6.164**	**5.494**	**4.912**	**5.433**

CLASS	**I – M.Sc., Zoology**	
Semester	**II**	
Course and Code	**Core Course – (CC5)**	**Code: P22ZY6**
Course Title	**ANIMAL PHYSIOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand thermoregulation and osmoregulation.
COE2. To understand nervous coordination and excretion.
COE3. To understand muscular system and sense organs.
COE4. To understand bioluminescence and chronobiology.
COE5. To understand the biology of reproduction.

UNIT - I: THERMOREGULATION AND OSMOREGULATION

Thermoregulation in homeotherms, poikilotherms and heterotherms – Classification of animals based on thermoregulation – Temperature compensation in poikilotherms (aquatic and terrestrial animals) – Temperature regulation in homeotherms (Response to cold and heat) – Acclimatization – Osmoregulation in teleost and elasmobranch fishes, aquatic and desert animals.

UNIT – II: NERVOUS COORDINATION AND EXCRETION

Structure and types of nerve cells – Transmission of nerve impulse – Resting membrane potential – Electrical synapses – Chemical synapses – Neurotransmitters. Electric Organs and electro-receptors in fishes & functional significance.Ammonia toxicity – Detoxification pathways – Elimination of excretory products in relation to habitat (Urea cycle, Uric acid).

UNIT - III: SENSE ORGANS, MUSCULAR SYSTEM AND RESPIRATORY SYSTEM

Photoreceptor, Chemoreceptor, Phonoreceptors and Thermoreceptors Tactile receptors – Muscular system: Structure of muscle; Mechanism of muscle contraction – Respiratory system: exchange of gases; transport of gases; control of breathing.

UNIT - IV: BIOLUMINESCENCE AND CHRONOBIOLOGY

Bioluminescence: Occurrence; Structure of bioluminescent organs; Chemistry of light production; Functional significance – Animal behavior: Taxis, kinesis, reflexes, physiological basis of learning and memory – Biological rhythms: Circadian, lunar, circannual rhythms – Biological clock.

UNIT - V: PHYSIOLOGY OF REPRODUCTION

Mammalian reproductive physiology – Reproductive cycles (Menstrual &Estrous cycle) – Hormonal control of reproduction in Man – Significance of Prostaglandins, Reproductive disorders – Birth control methods.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define the concept of thermoregulation and osmoregulation in aquatic and terrestrial animals.
CO2: Trace the concept of nervous coordination and excretion.
CO3: Utilize competence on various sensory receptors, muscular and respiratory systems in animals.
CO4: Explicate on bioluminescence and animal behaviour with respect to chronobiology.

CO5: Elucidate the reproductive physiology and disorders associated with reproduction in humans.
CO6: Develop understanding on physiological process in organisms.

Textbooks

1. Agarwal, R A. 2013. Animal Physiology and Biochemistry. S. Chand and Company, New Delhi.
2. Ian Kay. 1998. Introduction to Animal Physiology. BIOS Publishers.

References

1. Moyes, C.D. and Schulte, P.M. 2007. Principles of Animal Physiology. Pearson Education, Dorling Kindersley Publication. New Delhi.
2. Sherwood, L., Klandorf, H, and Yancey, P.H. 2008. Text Book of Animal Physiology. Cengage Learning, India.
3. Guyton, A.C. 2000. Textbook of Medical Physiology. W.B. Saunders Company, Philadelphia, London, Toronto and Igaku Shoin/Saunders (Tokyo).
4. Hill R.W., Wyse, G.A. and Anderson, M. 2008. Animal Physiology., 2 nd Ed., Sinauer Associates, Inc Publisher, Massachusetts,.
5. Prosser, C.L. 1973. Comparative Animal Physiology. 3 rd Ed., W.B. Saunders & Co. Philadelphia.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	0	9	9	0	9	9
CO 3	9	0	9	9	9	1
CO 4	1	1	9	9	9	9
CO 5	9	3	9	1	9	9
CO 6	3	9	0	9	9	9
Weightage	**31**	**31**	**45**	**37**	**45**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**4.63**	**4.726**	**4.07**	**6.38**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit courses	**4.718**	**5.032**	**5.136**	**4.517**	**7.131**	**5.433**

CLASS	**I – M.Sc., Zoology**	
Semester	**II**	
Course and Code	**Core Course – (CC6)**	**Code: P22ZY7**
Course Title	**BIOTECHNOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the recombinant DNA technology and genomics.
COE2. To understand industrial biotechnology.
COE3.To understands pharmaceutical biotechnology.
COE4. To understand animal biotechnology.
COE5. To understand basics of Nanobiotechnology.

UNIT - I: RECOMBINANT DNA TECHNOLOGY

Outline of recombinant DNA technology – Molecular tools of genetic engineering: Restriction endonucleases, DNA ligases, Alkaline phosphatase, Nucleases & Polymerases; Host cells; vectors (pBR322, phage lambda, cosmids, BAC, YAC & HAC); Methods of gene transfer (Transformation, Transduction, Conjugation, Electroporation); Gene cloning strategies; Isolation and purification of cellular DNA, plasmid DNA, blotting techniques (Southern, Northern & Western), DNA sequencing (Maxim Gilbert & Di-deoxynucleotide method) – RFLP, RAPD, Polymerase Chain Reaction – Construction of cDNA libraries.

UNIT - II: INDUSTRIAL BIOTECHNOLOGY

Bioreactor: Types, common features, operation of conventional bioreactor – Solid substrate fermentation – Sterilization of culture media – Primary and Secondary metabolites – Steps involved in fermentation process – Commercial production of enzymes – Immobilization of enzymes – Types of biosensors – Production of ethanol by fermentation – Production of citric acid –Production of Penicillin – Production of L-glutamic acid.

UNIT - III: PHARMACEUTICAL BIOTECHNOLOGY AND GENE THERAPY

Monoclonal Antibodies Production (Hybridoma Technology) – Pharmaceutical products of DNA Technology – Insulin, Human Growth hormone, Tissue plasminogen activator &interferon. Recombinant vaccines: Subunit (Hepatitis B & Tuberculosis); DNA vaccines; Attenuated vaccines (Cholera) & Recombinant vector vaccines (Vaccinia virus). Gene Therapy: *Exvivo* (Bone marrow transplantation) and *invivo* gene therapy – (Suicide gene therapy).

UNIT - IV: ANIMAL BIOTECHNOLOGY

Animal cell culture: Facilities, contamination, aseptic conditions, Applications – Culture media for animal cells: Types, Physicochemical properties, Complete culture media, Serum-free media. Cell cultures: Characterization of cultured cells, measurement of growth parameters of cultured cells. Primary culture, Subculture and Stem cell cultures. Large scale production – Cytotoxicity (MTT-based) and cell viability (colorimetric based) assays – Transgenic animals (Microinjection method & Embryonic stem cell method) – Transgenesis in mice, cattle, sheep, pigs and fish.

UNIT - V: NANOBIOTECHNOLOGY

Introduction to Nanobiotechnology – Nano biotechnological devices – Bottom-up and Top-down approaches – Types and applications of Nano biosensors –Fabrication, structure and therapeutic applications of Carbon nanotubes, Liposome based drug delivery technologies –

Cancer diagnosis and therapy – Preparation and uses of DNA microarrays.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall the principles and applications of recombinant DNA technology and genomics.
CO2: Trace the concept of industrial biotechnology for human welfare.
CO3: Apply the details of the Pharmaceutical biotechnology with r DNA vaccines.
CO4: Explicate on animal cell culture and production of transgenic animals.
CO5: Elucidate the principles and applications of Nano biotechnology.
CO6: Develop gene therapy for disease treatment.

Textbooks

1. Satyanarayana, U. 2007. Biotechnology. Books and Allied (P) Ltd.
2. Shanmugam, S. 2011. Nanobiotechnology. MJP Publishers, Chennai.

References

1. Brown, C.M., Campbell, I and Priest, F.G. (1988) Introduction to Biotechnology, Blackwell Scientific Publications, U.K.
2. Higgins, I.J., Best, D.J. and Jones, J. (1988) Biotechnology-Principles and Applications. Blackwell Scientific Publications, Oxford, London, Edinburgh.
3. Keshav Trehan (1996), Biotechnology, New Age International Pvt. Ltd. Publishers, New Delhi.
4. Primrose, S.B.(1989) Modern Biotechnology. Blackwell Scientific Publications, Oxford, London, Edinburgh.
5. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. 1992. Recombinant DNA. 2 nd Ed., W. H. Freeman, New York.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	0	0	9	9	9	9
CO 4	1	9	9	0	9	9
CO 5	9	1	9	9	3	9
CO 6	9	3	9	9	0	9
Weightage	**37**	**31**	**54**	**45**	**22**	**37**
Weightage percentage of Course contribution to POs	**5.103**	**4.63**	**5.672**	**4.95**	**3.12**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**5.631**	**5.032**	**6.164**	**5.494**	**3.486**	**5.433**

CLASS	**I – M.Sc., Zoology**	
Semester	**II**	
Course and Code	**Core Course – (CC7)**	**Code: P22ZY8**
Course Title	**MICROBIOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand classification of microorganisms
COE2. To understand the culture techniques
COE3. To understand food microbiology
COE4. To understand soil and agricultural microbiology
COE5. To understand medical microbiology

UNIT - I: CHARACTERISTICS OF MICROORGANISMS

Introduction, history and scope of Microbiology - General characteristics and composition of Prokaryotes and Eukaryotes - Classification of microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woes, classification and salient features of bacteria according to Berger's Manual of Determinative Bacteriology - Nomenclature and modern methods of Bacterial taxonomy.

UNIT - II: CULTURE TECHNIQUES

Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth - Bacteriological media: types (complex, synthetic, differential, enrichment and selective media) and their uses, culture characteristics of bacteria on different media - Cultivation of bacteria: aerobic and anaerobic culture, pure culture techniques, shaker and still culture, maintenance and preservation of microbial culture - Bacterial growth: growth kinetics, growth curve. Batch, continuous and synchronous culture.Measurement of growth and influence of environmental factors affecting growth.

UNIT - III: FOOD MICROBIOLOGY

Food spoilage and food borne infections - general principles underlying food spoilage and contamination, canned food spoilage, spoilages of vegetables, fruits, meat and meat products, milk and milk products, fish, and poultry– Food Poisoning (Botulism, Staphylococcal poisoning, and Mycotoxicosis) – Food preservation –Radiations - UV, Gamma and microwave Temperature, Chemical and naturally occurring antimicrobials -Biosensors in food industry – Food preservation techniques.

UNIT - IV: SOIL AND AGRICULTURAL MICROBIOLOGY

Role of microorganisms in soil formation and soil fertility – Biogeochemical cycles (Nitrogen, Carbon, Phosphorus cycle) – Nitrogen fixation, Mechanism of biological nitrogen fixation – Microorganisms as Biofertilizers (Rhizobium, Azotobacter, Azospirillum, VAM) – Biopesticides (Bacterial, Fungal, Viral).

UNIT - V: MEDICINAL MICROBIOLOGY

Pathogenicity, Infection, Virulence, Causative agents, Modes of transmission, control measures: Bacterial diseases (Diphtheria, Tuberculosis, Leptospirosis, Pneumonia, & Cholera); Viral diseases (Measles, Chickenpox & Chikungunya virus infection); Sexually transmitted diseases (AIDS, Gonorrhea, Bacterial Vaginosis (BV) & Human Papillomavirus (HPV); Protozoan diseases (Malaria, Leishmaniasis, Trypanosomiasis).

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall the scope of microbiology, different classifications of microorganisms and different branches of microbiology.

CO2: Demonstrate about the concept of bacterial culture techniques.

CO3: Apply the details of the Food microbiology and various food preservation methods.

CO4: Explicate onsoil and agricultural microbiology.

CO5: Elucidate medical microbiology dealing with pathogenicity, modes of transmission of infections by different microbial species

CO6: Develop new methodsfor treating microbial infections in organisms.

Textbooks

1. Pelczar, Chan and Kreig, 1993. Microbiology, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
2. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. 2017. Prescott's Microbiology. Tenth edition. McGraw-Hill.

References

1. Thomas, C.G.A, 1998, Medical Microbiology, ELBS Publications.
2. Ananthanarayanan, R. and Jayaram Panikar, C.K. 2000. Text Book of Microbiology, Orient Longman, Chennai and Hyderabad.
3. Powar, C.B. and Diginawala, H.F. 1987, General Microbiology-Vol.I & II. Himalaya Publishing House, Bombay.
4. Sharma, P.D. 1993, Microbiology – Rastogi Publications, Meerut.
5. Ananthanarayanan, R. and Jayaram Panikar, C.K. 2013. Text Book of Microbiology. University Press, Hyderabad.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	0	9	9	0	9	9
CO 3	9	0	9	9	1	9
CO 4	1	9	9	9	9	1
CO 5	9	1	9	9	9	3
CO 6	9	3	0	9	9	9
Weightage	**37**	**31**	**45**	**45**	**37**	**31**
Weightage percentage of Course contribution to POs	**5.103**	**4.63**	**4.726**	**4.95**	**5.25**	**4.172**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**5.631**	**5.032**	**5.136**	**5.494**	**5.863**	**4.552**

CLASS	**I – M.Sc., Zoology**	
Semester	**II**	
Course and Code	**Core Course – (CC8)**	**Code: P22ZY9P**
Course Title	**PRACTICAL – II (Pertaining to Animal Physiology, Biotechnology and Microbiology).**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives
COE1. To obtain knowledge about the quantitative estimation of salivary amylase activity.
COE2. To obtain knowledge on quantitative estimation of ammonia and urea.
COE3. To understand physiological mechanism of various receptors.
COE4. To gain knowledge on electrophoretic techniques.
COE5.To obtains knowledge on bacterial culture techniques.

ANIMAL PHISIOLOGY
Quantitative estimation of amylase activity.
Quantitative estimation of ammonia.
Quantitative estimation of urea.
Estimation of salinity in aquarium water samples.
Spotters
Photoreceptor
Chemoreceptor
Phonoreceptor
Bioluminescent organ (bait in deep sea fishes)

BIOTECHNOLOGY
Demonstration of DNA isolation
Demonstration of Agarose gel electrophoresis
Demonstration of SDS-PAGE
Spotters
Cosmid
BAC (Bacterial Artificial Chromosome)
Polymerase Chain Reaction
DNA Microarray

MICROBIOLOGY
Culturing of bacterial broth – Bacterial growth curve.
Preparation of culture media (Agar medium – slant, plating, streaking)
Serial Dilution technique
Antibiotic sensitivity for standard antibiotics
Gram staining
Spotters
Inoculation loop
Autoclave
Incubator
Hot air oven
Laminar flow hood

“Industrial-/Forest-/Zoo-visit (Educational Tour) report should be included in the practical record”

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall quantitative estimation of salivary amylase.

CO2: Demonstrate about the quantitative estimation of ammonia and urea.

CO3: Apply the details of the physiological mechanism of various receptors.

CO4: Explicate on electrophoretic techniques dealing with separation of nucleic acids and proteins

CO5: Elucidate on bacterial culture techniques.

CO6: Develop expertise on biotechnological tools and techniques.

Reference Books

1. Rajan, S and Selvi Christy. 2010. Experimental Procedures in Life Sciences. CBS Publishers, New Delhi.
2. P.S. Verma and P.C. Srivastava 2007. Advanced Practical in Zoology. S. Chand & Co.

Web References

1. https://innovareacademics.in/journals/index.php/ijpps/article/download/24447/14317
2. https://slideplayer.com/slide/11374559/
3. https://core.ac.uk/download/pdf/33367638.pdf
4. https://www.ideals.illinois.edu/bitstream/handle/2142/53459/quantitativedete00mojo.pdf?sequence=2
5. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/agarose-gel-electrophoresis
6. https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/dna-isolation-gel-electrophoresis-and-pcr/

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	9	0	9	9	1	9
CO 4	1	1	9	9	9	9
CO 5	9	9	9	0	3	9
CO 6	3	9	0	9	9	9
Weightage	**31**	**37**	**45**	**45**	**31**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**5.53**	**4.726**	**4.95**	**4.397**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**6.006**	**5.136**	**5.494**	**4.912**	**5.433**

CLASS	**I – M.Sc., Zoology**	
Semester	**II**	
Course and Code	**Elective Course– (EC2)**	**Code: P22ZY10E**
Course Title	**ENTREPRENEURIAL ZOOLOGY**	
Hours: 6	**Credits : 4**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand Vermiculture techniques.
COE2. To understand Apiculture techniques.
COE3. To understand Sericulture techniques.
COE4. To understand Aquaculture techniques.
COE5. To understand Poultry farming techniques.

UNIT – I: VERMICULTURE

Ecological classification of earthworms (Epigeic, Endogeic and Anecic species) – Common species for culture – Life cycle of *Eudrilus eugenia*; Methods of vermiculture : Pit method; Windrow method – Predator and pathogen control in wormeries – Economic importance of vermiculture – Quality control, packing, transport and marketing.

UNIT – II: APICULTURE

Species of honey bees – Castes of Honey Bees – Life cycle of Honey Bee – Methods of Beekeeping, Apiculture appliances – Seasonal management of honeybee colonies – Diseases, pests, and predator management – Extraction, storage, bottling and packaging of honey – Products of Apiculture – Indian beekeepers strategies for honey marketing.

UNIT – III: SERICULTURE

Types of silkworms: Mulberry, Tasar, Muga, Eri – Life cycle of *Bombyx mori* – Disinfection of rearing houses and appliances – Tray and shelf rearing methods – Rearing environmental conditions – Post Cocoon processing and production of raw silk – Disease and pest Management – Harvesting of cocoon – Transportation and Marketing of Cocoons.

UNIT – IV: AQUACULTURE

Scope of Aquaculture – Present state of aquaculture – Types of cultivable fishes – Indian major carps, Methods of fish farming – Types of fish ponds – Construction of fish pond – Maintenance of fish pond – Induced breeding and Seed production in carps – Types of fish feed – Common fish diseases and its control measures – Fish farm implements – Byproducts of fishing industries.

UNIT – V: POULTRY FARMING

Common Breeds of Poultry – Fowl house construction – Deep litter system – Cage system – Selection and incubation of eggs – Brooding of chick – Rearing of growers – Rearing of broilers – Culling – Sexing – Poultry diseases: Infectious Coryza, Avian influenza, Ranikhet, Coccidiosis, Fowl Pox – Economic importance of poultry.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define vermitechnology for sustainable agriculture and understand primary, secondary degradation and vermibed preparation.
CO2: Trace steps involved in bee keeping and sericulture with different types of Honey Bee and Silkworm.

CO3: Identify different types of Silkworms, and the methodologies involved in Silkworm rearing with diseases of Silkworms.
CO4: Explicate on aquaculture techniques and diseases associated with aquaculture.
CO5: Elucidate on broilers and layers rearing , Bacterial & Viral diseases associated with poultry farming.
CO6: Develop commercialization of by-product of beekeeping and aquaculture.

Textbooks

1. Shukla, G.S. and V.B. Upadhyay 2003 Economic Zoology, Rastogi publications.
2. Ahsan, J. and S.P. Shiha 2005 A hand book of Economic Zoology, S. Chand & Co.

References

1. Sultan Ahmed Ismail, 2005. The Earthworm Book. Second Revised Edition. Other India Press, Goa, India.
2. Sardar Singh, 1962. Beekeeping in India. Indian Council of Agricultural Research.
3. Johnson, M. 2015. Sericulture. Nesamony Memorial Christian College, Kanyakumari.
4. Ganga, G. 1992. Introduction to Sericulture. Oxford & IBH, New Delhi.
5. Arumugam, N. 2008. Aquaculture. Saras Publications.
6. Ram P. Singh. 2012. Modern Livestock and Poultry Production. Biotech Publisher.
7. Rama Rao, V. 2004. Poultry Science. Mangal Deep Publications.
8. Arumugam, N., A. Thangamani, S. Prasanna kumar, L.M. Narayanan, N.C Nair, S. Leelavathy, N. Soundara Pandian, T. Murugan, J. Johnson Rajeswar, R. Ram Prabhu, Jayasurya. 2015. Economic Zoology. Saras Publication.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	0	0	9	9	9	9
CO 4	1	9	9	9	3	9
CO 5	9	1	0	9	9	9
CO 6	3	9	1	9	9	9
Weightage	**31**	**37**	**37**	**54**	**31**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**5.53**	**3.886**	**5.94**	**4.397**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**6.006**	**4.223**	**6.593**	**4.912**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**III**	
Course and Code	**Core Course – (CC9)**	**Code: P22ZY11**
Course Title	**DEVELOPMENTAL BIOLOGY AND EVOLUTION**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand reproduction and assisted reproductive technologies.
COE2. To understand the metamorphosis and regeneration.
COE3. To understand cell differentiation.
COE4. To understand the concepts of evolution.
COE5. To understand the adaptive pattern and speciation concepts.

UNIT – I: REPRODUCTION AND ASSISTED REPRODUCTIVE TECHNOLOGIES

Gametogenesis (Spermatogenesis & Oogenesis) – cell surface molecules in sperm-egg recognition in animals – Ultra structure of human sperm and egg – Mechanism and physiology of fertilization – Activation of egg cytoplasm – Infertility (Male and Female) – Super ovulation – Artificial Insemination – Intracytoplasmic Sperm Injection – Gamete IntraFallopian tube Transfer –*invitro* Fertilization.

UNIT – II: METAMORPHOSIS AND REGENERATION

Hormonal control on growth and metamorphosis of insects and amphibians – Formation of limb bud in amphibian – – Mechanism of cell death and ageing – Regeneration in various Invertebrates and Vertebrates – Mechanism and factors influencing regeneration.

UNIT – III: CELL DIFFERENTIATION

Differentiation, Potency, commitment, specification, and determination – Stem cells, Embryonic and Adult stem cells – Significance of stem cells – Drosophila: Early embryonic development (Cleavage, Gastrulation) – Early anterior-posterior axis specification (Maternal effect genes) – Segmentation genes – Homeotic selector genes – Organizer and its function – Induction – Spemann and Man gold experiments.

UNIT – IV: ORIGIN OF LIFE AND MECHANISM OF EVOLUTION

Origin of Life: Theories of origin of life (Special creation, Spontaneous generation & cosmozoic theories), Theory of chemical evolution at molecular level – Populations, Gene pool, Gene frequency – Hardy-Weinberg Law – Factors affecting Hardy-Weinberg equilibrium.

UNIT – V: ADAPTIVE PATTERNS AND SPECIATION

Races to species – Adaptive radiation in mammals – Simson's Adaptive grid and Macroevolution. Behavioral adaptations and strategies – Sexual competition and selection – Types of isolating mechanisms – Mode of speciation: Allopatricity and Sympatricity – Stages in primate evolution including Homo.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall theories of evolution, concepts of gametogenesis, fertilisation and artificial reproductive technologies.
CO2: Infer on metamorphosis and regeneration.
CO3: Make use of knowledge on significance of stem cells and cell differentiation with

emphasis on early embryonic development in Drosophila.
CO4: Explicate about the evolutionary history of earth and theories of evolution.
CO5: Justify the distribution of animals on earth, its adaptive pattern, evolution and speciation as a causative factor.
CO6: Create phylogenetic tree based on ancestral records of organisms.

Textbooks

1. Gilbert, S.F. 2010. Developmental Biology, 9th Edn. Sinamer Associates Inc. Publishers. Massachusetts, USA.
2. Strickberger, M.W. 1996. Evolution: Jones and Barlett Pub.Inc., London.

References

1. Balinsky, B.L. 1981. An introduction to Embryology V Ed. Saunders Co. Philadelphia.
2. Berrill, N.J. 1986. Developmental Biology, Tata McGraw Hill, New Delhi.
3. Gurubachan. S. Miglani, 2006. Developmental Genetics. I.K. International Publishing House Pvt.Ltd.
4. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Nalentine, J.W. 1975. Evolution. Surjeet Pub. And Co., New York.
5. Chattopathyay, S. 2008. LIFE: Evolution, Adaptation & Ethology. Arunabha Sen Books and Allieded, Pvt., LTD., Kolkata.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	0	0	9
CO 2	9	9	9	9	1	0
CO 3	0	9	9	9	9	1
CO 4	9	0	9	1	9	9
CO 5	1	1	9	9	9	9
CO 6	9	9	0	3	9	9
Weightage	**37**	**37**	**45**	**31**	**37**	**37**
Weightage percentage of Course contribution to POs	**5.103**	**5.53**	**4.726**	**3.41**	**5.25**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit courses	**5.631**	**6.006**	**5.136**	**3.785**	**5.863**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**III**	
Course and Code	**Core Course – (CC10)**	**Code: P22ZY12**
Course Title	**BIOCHEMISTRY AND BIOPHYSICS**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To acquire knowledge about the structure, classification, and metabolism of biomolecules.
COE2. To gain knowledge about enzymes, hormones and their functions.
COE3. To understand the thermodynamics.
COE4. To gain knowledge about radiation and its impacts on biological system.
COE5. To study the principles and applications of various microscopes and spectroscopies.

UNIT – I: PROTEINS AND LIPIDS

Proteins: Structure, classification and biological functions, Physicochemical properties of amino acids, Classification of amino acids based on structure, Glycogenic and Ketogenic amino acids – Catabolic phase of amino acids (Oxidative deamination, Transamination, Decarboxylation).

Lipids : Classification and functions of lipids – Structure of glycerol and fatty acids – Physical properties of lipids Phospholipids, Sphingolipids, Glycolipids – classification of Steroids – Metabolism of glycerol – β-Oxidation of fatty acids and Ketosis.

UNIT – II: CARBOHYDRATES

Classification – Structure and properties of monosaccharide, disaccharides (Maltose, Lactose, Sucrose), and polysaccharides (Starch, Glycogen, Chitin, Proteoglycan, Glycoprotein) – Biosynthesis of gycogen (Glycogenesis) – Glycolysis – Krebs's cycle – HMP pathway – Gluconeogenesis of lactic acid (Cori cycle).

UNIT – III: ENZYMES AND HORMONES

Enzymes: Classification of enzymes – Properties of enzymes – Enzyme activation energy – Enzyme action (Lock &key and Induced fit hypothesis) – Mechanism of enzyme action (Michael and Mendon hypothesis) – Enzyme kinetics – Enzyme Inhibition (Competitive, Non-competitive, Allosteric inhibition).

Hormones: Hypothalamic releasing hormones and function, Mechanism of action of group I & II hormones, Anterior and Posterior Pituitary hormones and functions, Biosynthesis of Thyroid hormones – Biosynthesis and functions of adrenocorticosteroids.

UNIT – IV: THERMODYNAMICS AND RADIATION BIOLOGY

Concept of free energy: First and Second Laws of Thermodynamics, Biological energy transducers (Enthalpy and Entropy).

Radiation Biology: Scope of Radiation Biology – Sources of natural radiation (Terrestrial and cosmic) – Types of radiation (Alpha, Beta & Gamma) – Properties of Radiation (external emitters and internal emitters) – Man made radiation: Medical (occupational, diagnostic) – Nuclear fuel cycle – Radiation Units: Becquerel, RAD, Gray & Curie.

UNIT – V: ELECTRON MICROSCOPY AND SPECTROSCOPY

Electron Microscopy: Principle & applications of SEM, TEM, AFM & STM.

Spectroscopy: Principle and applications of UV-VIS Spectrophotometer – Flame Photometry – Circular dichroism (CD) and Optical Rotatory Dispersion (ORD).Principle and application

of X-ray diffraction, FTIR, Atomic absorption, NMR and ESR Spectroscopes.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define structure, classification and metabolism of biomolecules along with working mechanism of spectroscope and microscopes.
CO2: Demonstrate on enzymes, hormones and their functions.
CO3: Apply significance of thermodynamics with respect to biological science.
CO4: Analyze radiation and its impact on the biological system.
CO5: Elucidate the principles and applications of various microscopes and spectroscopes.
CO6: Develop expertise on biophysical principles behind scientific instruments.

Textbooks

1. Veerakumari, L. 2005. Biochemistry. MJP Publishers.
2. Daniel, M. 1992. Basic Biophysics for Biologists, Wiley International, New Delhi.

References

1. Lehninger, A. L., Nelson D.K and Cox, M.M., 1993. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
2. Stryer, L., 1988. Biochemistry, W.H. Freeman and Company, New York.
3. Narayanan, P. 2007. Essentials of Biophysics. II Edn. New Age International Pub.
4. Shan, V.C. (1985) Elements of Radiation Biology, Todays & Tomorrows Printers & Publishers, New Delhi.
5. Grosh, D.S. (1965) Biological Effects of Radiation, Blaisdell Publishing Co. Sharma, A.K. (1998) Guest Editor Preservation of Food by Ionising Radiation, IANCAS Bulletin, 14(1).

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	9	0	9	9	1	9
CO 4	9	1	9	0	9	9
CO 5	9	9	0	1	9	9
CO 6	1	3	9	9	9	9
Weightage	37	31	45	37	37	37
Weightage percentage of Course contribution to POs	5.103	4.63	4.726	4.07	5.25	4.98
Weightage percentage of Course contribution to Pos without Extra Credit Courses	5.631	5.032	5.136	4.517	5.863	5.433

CLASS	**II – M.Sc., Zoology**	
Semester	**III**	
Course and Code	**Core Course – (CC11)**	**Code: P22ZY13P**
Course Title	**PRACTICAL – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics).**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand Hardy Weinberg law and calculation of gene frequency
COE2. To understand solution preparation methods
COE3. To understand buffer preparation methods
COE4. To understand quantitative estimation of total sugar in animal tissues
COE5. To understand Beer and Lambert's law

DEVELOPMENTAL BIOLOGY AND EVOLUTION

Study of fertilization through a model diagram
Hardy – Weinberg Law and calculation of gene frequency.

Spotters

Female infertility: PCOS, Endometriosis.
Intracytoplasmic Sperm Injection Technique.
Gamete Intrafallopian tube Transfer Technique.
In vitro Fertilization Technique.

BIOCHEMISTRY AND BIOPHYSICS

Calculation of normality, molarity, and percentage.
Determination of pH of water samples.
Quantitative estimation of protein.
Quantitative estimation of total carbohydrate.
Quantitative estimation of lipids.
Beer and Lambert's law verification.

Spotters

Mortar & Pestle.
Centrifuge.
Spectrophotometer.
Flame Photometer
X-Ray Diffractometer

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall Hardy Weinberg law and calculation of gene frequency.
CO2: Infer on analytical chemistry and its use in preparation of solutions.
CO3: Experiment with preparations of various buffer solutions.
CO4: Explicate on the quantitative estimation of proteins, carbohydrates and lipids in animal tissues.
CO5: Elucidate the principles and applications of Beer and Lambert's law and its usage in spectrophotometer.
CO6: Develop skills in handling research instruments.

Reference Books

1. Rajan, S and Selvi Christy. 2010. Experimental Procedures in Life Sciences. CBS Publishers, New Delhi.
2. P.S. Verma and P.C. Srivastava 2007. Advanced Practical in Zoology. S. Chand & Co.

Web References

1. https://www.khanacademy.org/science/ap-biology/natural-selection/hardy-weinberg-equilibrium/v/applying-hardy-weinberg
2. https://www.ssi.shimadzu.com/literature/AD0087-determination-protein-total-fat-carbohydrates-milk-ft-nir.html
3. https://people.umass.edu/~mcclemen/581Carbohydrates.html
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5789268/

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	1	0	9	9	9	9
CO 4	9	1	9	9	1	9
CO 5	9	3	9	0	9	9
CO 6	9	9	0	1	9	9
Weightage	**37**	**31**	**45**	**37**	**37**	**37**
Weightage percentage of Course contribution to POs	**5.103**	**4.63**	**4.726**	**4.07**	**5.25**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**5.631**	**5.032**	**5.136**	**4.517**	**5.863**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**III**	
Course and Code	**Elective Course – (EC3)**	**Code: P22ZY14E**
Course Title	**BIOSTATISTICS AND RESEARCH METHODOLOGY**	
Hours: 6	**Credits : 4**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the methods in field biology.
COE2. To understand the descriptive statistics and presentation of data.
COE3. To understand hypothesis testing methods.
COE4. To understand methods involved in research.
COE5. To understand various resources of journals.

BIOSTATISTICS

UNIT – I: COLLECTION OF DATA IN FIELD BIOLOGY

Planning of statistical investigation – Types of statistical units, Types of investigation & Degree of Accuracy – Collection of Data: Primary Data (Direct, Indirect, Information through &Questionnaire method) and Secondary Data (Published sources in International, Semi-Official & Private publications) – Methods of Sampling: Random sampling (Simple, Stratified & Cluster random sampling) – Non-random sampling (Judgment, Quota sampling & Convenience sampling).

UNIT – II: DESCRIPTIVE STATISTICS AND PRESENTATION OF DATA

Measures of central tendency: Mean, median, and mode – Measures of dispersion: Range, variance, standard deviation, standard error – Probability distributions (Binomial, Poisson and normal).

Diagrammatic presentation of Data: Line diagram, Simple Bar diagram, Multiple Bar diagram, Component Bar Diagram, Percentage Bar diagram, Pictogram & Cartogram). Graphic presentation of Data: One variable line graph, two or more variable line graph, Range chart, Band graph, Histogram, Frequency curve and Ogive curve.

UNIT – III: TESTING HYPOTHESIS

Test of hypothesis (Null hypothesis and Alternative hypothesis) – Confidence Interval – Levels of significance – Student t test (paired and unpaired tests) – Chi square test – One way and two way analyses of variance (F-values) – Regression Analysis - Use of SPSS in Data Analysis.

RESEARCH METHODOLOGY

UNIT – IV: RESEARCH METHODOLOGY

Research: Definition, Sources for collection of research articles, Sources for Literature collection, Selection of research theories, Experimental Design, Types and layout of research report (Introduction, Materials and Methods, Results and Discussion, Conclusion Summary &References), Precautions in preparing the research report. Bibliography and annexure in the report.Presentation of results (in the form of Tables, Figures), Evaluation of data (Statistical Analysis).

UNIT – V: JOURNALS AND ONLINE BROWSING OF RESEARCH ARTICLES

Popular Magazines Short communications, Review articles, News bulletin and periodicals

(monthly, quarterly and half-yearly journals and reviews). Online browsing of research articles: infonet, inflibnet and Pubmed.Peer-reviewed journals, indexed and non-indexed journals.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Define methods in field biology.
CO2: Demonstrate descriptive statistics and presentation of data.
CO3: Apply knowledge on hypothesis testing methods.
CO4: Analyze methods involved in research from experimental design to report writing.
CO5: Elucidate the concept of writing research publication and online surfing of research articles.
CO6: Develop expertise on plagiarism and patent filing.

Text Books

1. Gurumani, N. 2010. An Introduction to Biostatistics. MJP Publishers, Chennai.
2. Gurumani, N. 2006. Research Methodology for Biological Sciences. MJP Publishers.

References

1. Sokal, R.R. and F.J. Rohlf 1981, Introduction to Biostatistics, WH Freeman & Co. USA.
2. Zar, J.H. 1984, Biostatistical analysis, Prentice Hall, New Jersey, USA.
3. Anderson, T.W. 1983, An Introduction to Multivariate Analysis, John Wiley.
4. Kothari, C.R. 2004. Research Methodology: Methods and Techniques. Second edition, New Age International Publishers, New Delhi.
5. Louis Cohen, Lawrence Manion, and Keith Morrison. 2007. Research Methods in Education. Sixth edition. Routledge, Taylor & Francis Group.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	9	9	9	9	1	1
CO 3	9	0	9	9	3	9
CO 4	0	9	9	9	0	9
CO 5	1	9	9	9	1	9
CO 6	3	1	9	9	9	9
Weightage	**31**	**37**	**54**	**54**	**14**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**5.53**	**5.672**	**5.94**	**1.99**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**6.006**	**6.164**	**6.593**	**2.218**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**III**	
Course and Code	**Elective Course – (EC4)**	**Code: P22ZY15E**
Course Title	**ENVIRONMENTAL BIOLOGY AND MANAGEMENT**	
Hours: 6	**Credits : 4**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand ourenvironment and community.
COE2. To understand the concepts of ecosystem.
COE3. To understand the population ecology.
COE4. To understand the concepts of ecological adaptations and Zoogeography.
COE5. To understand the ecological resources and biodiversity.

UNIT – I: ENVIRONMENT AND COMMUNITY ECOLOGY

Abiotic factors (Air, Water, Light, Temperature and Soil) – Biotic environment: Interspecific relationship (Symbiosis, Commensalism, and Mutualism) Antagonistic relationships (Parasitism, Predation, and Competition) – Characteristics of community – Types of succession – Edges and ecotones Concept of climax – Freshwater, Marine and Terrestrial habitat.

UNIT - II: ECOSYSTEM ECOLOGY

Ecosystem: Concept, components – Food chain, Food web, Trophic levels in a food pyramid, Dynamics of ecosystem – Ecological pyramids – Structure, function and Energy flow of Freshwater, Marine, Estuarine, Grassland, Forest and Desert ecosystems.

UNIT – III: POPULATION ECOLOGY

Characteristics of a population – Population density (Natality, Mortality) – Age distribution – Population growth curves – Population regulation and Equilibrium – Life history strategies (r and K selection) – Biotic potential – Concept of metapopulation – Demes and dispersal – Interdemic extinctions.

UNIT – IV: ECOLOGICAL ADAPTATIONS AND ZOOGEOGRAPHY

Introduction to adaptations – Causes of adaptive radiations – Types of adaptations (Aquatic, Cursorial, Desert, Fossorial, Arboreal, and Flight Adaptations) - Zoogeography importance in evolution – Types (Oriental, Australian, Neotropical, Ethiopian, Nearctic, Palaearctic region) – Oceanic and Continental islands.

UNIT – V: APPLIED ECOLOGY

Renewable and Non-Renewable natural resources – Bioremediation &Biomagnifications – Environmental pollution: Air, Water and Soil pollutions – Biological indicators of pollution – Environmental Protection Act – Global environmental change – Major drivers of biodiversity change – Genetic and species diversity – Hot spots of biodiversity in India – Threats – Biodiversity management approaches.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define environment, animal associations and community ecology.
CO2: Infer on ecosystem ecology.
CO3: Apply competence on population ecology.
CO4: Analyze the ecological adaptations and zoogeography.

CO5: Elucidate ecological resources and legislations to conserve biodiversity.
CO6: Develop awareness for conserving biodiversity.

Textbooks

1. Peter Stiling. 2001. Ecology: Theories and Applications. 4th edition. Pearson.
2. Odum, E.P and Barrett, G.W. 2005. Fundamentals of Ecology. Thompson Brooks Cole (EWP) 5th Ed.

References

1. Clarke, G.L. 1954, Elements of Ecology. John Wiley & Sons. NY.
2. Dash, M C. 1998. Fundamentals of Ecology. 5th edition. Mcgraw-Hill, New Delhi.
3. Kormondy, E.J. 1996. Concepts of Ecology, 4th edition. Pearson Education, Inc., USA.
4. Smith T.M. and SmithR.L. 2008. Elements of Ecology. Sixth edition, Pearson Education, New Delhi.
5. Turk A. and Turk J. 1993. Environmental Science. Fourth edition, Saunders.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	0	9	9	9	9	0
CO 2	9	9	9	9	0	1
CO 3	9	0	9	9	1	9
CO 4	9	1	9	0	9	9
CO 5	1	3	9	9	9	9
CO 6	9	0	0	9	9	9
Weightage	**37**	**22**	**45**	**45**	**37**	**37**
Weightage percentage of Course contribution to POs	**5.103**	**3.29**	**4.726**	**4.95**	**5.25**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit courses	**5.631**	**3.571**	**5.136**	**5.494**	**5.863**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**IV**	
Course and Code	**Core Course – (CC12)**	**Code: P22ZY16**
Course Title	**IMMUNOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the lymphoid organs.
COE2. To understand the antigens, immunoglobulin and complement.
COE3. To understand immune response.
COE4. To understand immune disorders and immune parsitology.
COE5. To understand immune techniques.

UNIT – I: LYMPHOID ORGANS

Immunity: Innate and adaptive immunity. Lymphoid organs: Primary and secondary – structure and functions. Cells of the immune system: Origin and fate of stem cells (lymphoid, myeloid & erythroid lineage), T & B Lymphocytes, Null cells, Natural Killer cells, Macrophages, Polymorphonuclear cells, Dentritic cells, Antigen presenting cells, Mast cells, Lymphokines and Cytokines.

UNIT – II: ANTIGENS, IMMUNOGLOBULIN AND COMPLEMENT

Antigen: Chemical composition and heterogeneity – Origin of antigens Exogenous, Endogenous, Autologus, Allogenic &Autoantigens) – Immunogenicity & Antigenicity – Classification of antigens (T cell dependent and T cell independent) – haptens &adjuvant . Antibody: Monoclonal and polyclonal antibodies, Ultra structure, properties & types of immunoglobulin; Epitopes (Isotype, Allotype & Idiotype) – Complement: Nomenclature, complement receptors, Classical pathway, Alternate pathway, Regulation of complement activity and functions.

UNIT – III: IMMUNE RESPONSE AND IMMUNOPARSITOLOGY

Antigen processing and presentation – Activation and differentiation of B and T cells – B and T cell receptors – Immune response: Primary and secondary immune response – Mechanism of humoral and cell mediated immune response – Immunity to infections: Immune evasion mechanisms of Protozoa – Immunological tolerance to Bacteria – Viruses (Non-specific and Specific) mechanisms Immunoprophylaxis: Vaccines (antigen, subunit, recombinant, anti idiotypic antibodies & toxoids as vaccines)

UNIT – IV: IMMUNE DISORDERS

Major Histocompatibility Complex: Functions; Structure and Pathway of class I and class II MHC Molecules – Hypersensitivity: Types – I, II, III, IV and V – Autoimmune disorders (Pernicious anemia, Thyrotoxicosis & Rheumatoid disease) – Immunodeficiency diseases – Tumor immunity: Tumor antigens; Immune response to tumors – Transplantation immunity: Host versus Graft reaction; Graft versus host reaction.

UNIT – V: IMMUNOLOGICAL TECHNIQUES

Salient features of Antigen-Antibody reactions: Specificity, Binding site, Strength & Properties (Affinity, Avidity, Cross reactivity, Neutralization of toxins) – Types of Ag-Abs reactions: Agglutination, Precipitation and Flocculation reactions – Diagnostic tests (Enzyme Linked Immunosorbant Assay (ELISA), Radioimmunoassay (RIA), blood typing – Brucella agglutination test – Widal test – Immunofluorescence – Binder – Ligand assays.

Course Outcomes

Upon Completion of the course student would be able to:

CO1: Recall innate and adaptive immunity with emphasis on primary and secondary lymphoid organs.
CO2: Infer about antigens, structure and types of immunoglobulin and complement systems.
CO3: Utilize skills on immune response of body and immune parasitology.
CO4: Explicate on MHC complex, immune disorders and transplantation immunology.
CO5: Elucidate the immunological techniques and associated diagnostic tests.
CO6: Develop understanding on transplantation immunology.

Textbooks

1. Kindt, T.J., Goldsby, R.A., Osborne, B.A. 2007. Kuby Immunology. W.H. Freeman & Co., New York.
2. Roitt, (3rd Edition) 2002. Immunology Crover Medical Publishing Company, London.

References

1. Barret, J. T., 1983, A text book of Immunology. (5th Edition) The C.V. Mosly Company.
2. Weinn, D.M. and Steward, L. 1993. Immunology. Singapore Publishers Private Ltd.
3. Kannan, R. 2011. Immunology. Oxford University Press, New Delhi.
4. Lal, S.S., Kumar, S. 2012. Immunology. Rastogi Publication, Meerut.
5. Male, D., Brostoff, J., Roth, D.B., Roit, I. 2006. Immunology. Elsevier, Philadelphia.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	0	9	9	0	9	9
CO 3	9	0	9	9	9	1
CO 4	9	1	9	1	9	9
CO 5	1	3	9	9	9	9
CO 6	9	9	0	9	1	9
Weightage	37	31	45	37	37	37
Weightage percentage of Course contribution to POs	5.103	4.63	4.726	4.07	5.25	4.98
Weightage percentage of Course contribution to Pos without Extra Credit Courses	5.631	5.032	5.136	4.517	5.863	5.433

CLASS	**II – M.Sc., Zoology**	
Semester	**IV**	
Course and Code	**Core Course – (CC13)**	**Code: P22ZY17**
Course Title	**GENERAL AND APPLIED ENTOMOLOGY**	
Hours: 6	**Credits : 5**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the classification of insects.
COE2. To understand the digestive, respiratory and circulatory system of Insects.
COE3. To understand the excretory, nervous and reproductive system of insects.
COE4. To understand the insect pests and their management.
COE5. To understand the pest control methods.

UNIT – I: TAXONOMY AND MORPHOLOGY OF INSECTS

Basis of insect classification – Key characteristics with common South Indian Insects – Morphology of the insect –Types of head, head sutures and Sclerites – Types of mouth parts (Biting & chewing, piercing & sucking, rasping & sucking, chewing & lapping, sponging, siphoning) – Thorax segments and appendages of Diptera and hymenoptera). Wings: structure and modifications; venation – Typical leg structure and its modifications.

UNIT – II: PHYSIOLOGY OF INSECTS

Structure & functions of Body wall: Different layers & chemical composition – Structure and physiology of digestive system – Respiratory system: Aerial and Aquatic – Circulatory system: Structure of heart; Mechanism of haemolymph circulation; Haemolymph and its composition & Haemocytes and their functions.

UNIT – III: PHYSIOLOGY OF INSECTS

Excretory system: Structure of Malpighian tubules and their functions – Nervous system: Structure; Neurotransmitters; Structure and function of compound eye – Male and female reproductive systems – Neuroendocrine system of insects; Endocrine control of moulting and metamorphosis; Role of hormones in male and female reproduction.

UNIT – IV: INSECT PESTS

Biology, damage caused and control methods: Paddy (*Orseolia oryzae, Leptocorisa acuta*); Rice (*Tribolium castaneum, Sitophilus oryzae*) Sugarcane (*Chilo infuscatellus, Tryporyza nivella*); Cotton (*Earias insulana, Aphis gossypii*); Coconut (*Rhyncophorus ferrugineus*); Brinjal (*Leucinodes orbanalis*); Tomato (*Spodoptera litura*); Lady's finger (*Earias fabia*).

UNIT – V: PEST CONTROL METHODS

Principles of Insect control: Prophylactic measures, Cultural, Mechanical, Physical and Biological methods – Parasites and predators – Chemical methods: Pesticides, Classification, Mode of action, Toxicity, Insecticide resistance to environmental safety – Non conventional methods, Use of Insect Growth Regulators (IGR), Repellents, Antifeedants, Pheromones and Chemosterilants. Integrated Pest Management.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Recall taxonomical classification of insects and insect morphology.
CO2: Demonstrate digestive, respiratory and circulatory system of insects.
CO3: Apply skills on excretory, nervous and reproductive system of insects.

CO4: Analyze the insect pest varieties of major crop plants.
CO5: Justify pest control methods and integrated pest management strategies
CO6: Develop expertise on the anatomy and physiology of insects.

Textbooks

1. R. F. Chapman. 2013. The Insects: Structure and Function. Stephen J. Simpson, Angela E. Douglas. Cambridge University Press.
2. Nalina Sundari, M.S. 2011. Entomology. MJP Publishers, Chennai.

References

1. Wigglesworth, V.B. 1992, Physiology of Insects. IX Ed. Chapman and Hall London.
2. Nayar, K.K., Ananthakrishnan, T.N. and David, M., 1995. General and Applied Entomology. Tata McGraw Hill Pub. Co., Ltd., New York.
3. Arumugam, N., A. Thangamani, S. Prasanna kumar, L.M. Narayanan, N.C Nair, S. Leelavathy, N. Soundara Pandian, T. Murugan, J. Johnson Rajeswar, R. Ram Prabhu, Jayasurya. 2015. Economic Zoology. Saras Publication.
4. Rathinaswamy, T.K., 1986. Medical Entomology, S. Viswanathan and Co., Madras.
5. Mani, M.S. 1982. General Entomology, Oxford and IBH Publishing Co. New Delhi.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	9	9	9	0	1	9
CO 3	0	9	9	9	3	9
CO 4	9	0	9	9	9	1
CO 5	9	9	0	0	9	9
CO 6	1	1	9	9	9	9
Weightage	**37**	**37**	**45**	**36**	**31**	**37**
Weightage percentage of Course contribution to POs	**5.103**	**5.53**	**4.726**	**3.96**	**4.397**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**5.631**	**6.006**	**5.136**	**4.395**	**4.912**	**5.433**

CLASS	**II – M.Sc., Zoology**	
Semester	**IV**	
Course and Code	**Elective Course – (EC5)**	**Code: P22ZY18E**
Course Title	**WILDLIFE BIOLOGY**	
Hours: 6	**Credits : 4**	**Max Marks : 75**

Course Educational Objectives

COE1. To understand the Indian wildlife and its conservation.
COE2. To understand capture and handling of wild animals.
COE3. To understand the Bio-ecology, Wildlife health and Forensic science.
COE4. To learn the wildlife census techniques.
COE5. To understand human-animal conflicts.

UNIT – I: WILDLIFE OF INDIA

Wildlife Management: Interface between forest and wildlife management in India, Legal instruments for managing wildlife in India, Principles and practices of wildlife management, Course and fine filter approaches for wildlife management, Management plan for Protected Areas, Need for wildlife management planning – Read Data Book and IUCN Red List of threatened animals – Aims and objectives of wildlife conservation – History of wildlife conservation in India – Necessity for wildlife conservation.

UNIT - II: CAPTURE AND HANDLING OF WILD ANIMALS

Capture and handling of animals - purpose, restraint techniques, different capture methods and animal barriers. Drug immobilization - drug delivery equipment and accessories. Immobilization drugs - action, dosage, response and side effects, safety measures, complications. Handling and transport of wild animals, designing sledge, crate and holding enclosures. Management and identification of animals in conflict, identification by natural marking, individual damage; behavioral idiosyncrasies, etc. Managing problem animals using passive marking collars, tags, branding, rings.

UNIT – III: BIO-ECOLOGY, WILDLIFE HEALTH AND FORENSIC

Introduction to disease and causes: Major viral, bacterial, protozoan, fungal and parasitic diseases of Indian wild mammals, birds and reptiles. Non-infectious diseases: nutritional diseases, poisoning, stress, shock, capture myopathy, physical trauma. Disease control operations. Wildlife forensic: Use of different techniques in wildlife forensics with special emphasis on identification of species from different parts of reptiles, birds, mammals and plants. Use of forensic tools and wildlife crimes – a few case studies. Threats to survival: – Great Indian Bustard – White- Rumped vulture – Gray Slender Loris – Blackbuck – Greater One-Horned Rhinoceros – Asian Elephant – Fishing Cat – Indian Tiger – Asiatic Lion.

UNIT – IV: WILDLIFE CENSUS TECHNIQUES

Objective of census – Estimation of abundance in wildlife studies – Direct count: Line transects, Point counts, Mark-recapture – Indirect count: pellet count, calls, sent mark, pug mark, camera trap, radio telemetry, remote sensing – Working principle, advantage, limitations and applications of GIS and GPS in wildlife sciences.

UNIT – V: HUMAN WILDLIFE CONFLICTS & ACTS AND CONVENTION

Human wildlife conflicts in India – Causes, consequences, and mitigation – Scenario, Mitigation strategies, and challenges: Human-Elephant conflict; Human-Tiger conflict; Human-Leopard conflict.An overview of different acts related to Wildlife protection and

conservation. Wildlife Protection Act (1972) and its detailed structure, recent amendments in WPA 1972 and their role in Wildlife protection and Conservation.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define wildlife and its conservation, wildlife protecting legislations.
CO2: Demonstrate knowledge on capture and handling of wild animals.
CO3: Apply knowledge on bio ecology, wildlife health and forensic science.
CO4: Explicate on techniques in taking wildlife census.
CO5: Justify the human – wildlife conflicts, legislations and conventions.
CO6 : Improvise conservation strategies for endangered species.

Textbooks

1. Varadharajan Gokula. 2013. Elementary Wildlife Biology. Lap Lambert Academic Publishing.
2. Goutam Kumar Saha and Subhendu Mazumdar. 2017. Wildlife Biology: An Indian Perspective. PHI Learning Private Limited.

References

1. Sutherland W.J.2000. The conservation hand book: research, management and policy Blackwell Science Ltd
2. Andrawartha, H.C. and L.C. Birch. 1974. The distribution and abundance of animals. The University of Chicago press, London.
3. Agarwal, V.P. 1980. Forests in India. Oxford and IBH Publishing Co. New Delhi.
4. Giles, R.H. 1984. Wild life management techniques. The wild life society, Washington and Natraj Publishers, Dehra Dun.
5. Saharia, V.B. 1982. Wild life in India. Nataraj Publishers, Dehra Dun.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	9	0	9	9	1	9
CO 4	9	1	9	9	9	3
CO 5	1	9	9	0	9	9
CO 6	3	3	9	9	9	9
Weightage	**31**	**31**	**54**	**45**	**37**	**31**
Weightage percentage of Course contribution to POs	**4.28**	**4.63**	**5.672**	**4.95**	**5.25**	**4.172**
Weightage percentage of Course contribution to Pos Without Extra Credit Courses	**4.718**	**5.032**	**6.164**	**5.494**	**5.863**	**4.552**

CLASS	**II – M.Sc., Zoology**		
Semester	**IV**		
Course	**Project Work**		**Code: P22ZYP19**
Title			
Hours: 12	**Credits : 5**	**Max Marks : 100**	

COURSE EDUCATIONAL OBJECTIVES

CEO1. To impart insight into further research studies.
CEO2. To learn about innovative ideas for modern science and technology development.
CEO3. To get an idea on writing research proposals for funding.
CEO4. To make students technically skilled in handling scientific instruments.
CEO5. To understand the concept of writing thesis and research publications**.**

A dissertation should be submitted.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Define research studies.
CO2: Demonstrate innovative ideas for modern science and technology development.
CO3: Apply skills on writing research proposals for funding.
CO4: Explicate technically in handling scientific instruments.
CO5: Elucidate the concept of writing thesis and research publications.
CO6: Elaborate on the process of patent filing and IPR.

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	9	0	9	9	1	9
CO 4	9	1	9	0	9	9
CO 5	1	3	9	9	9	9
CO 6	3	9	0	9	9	9
Weightage	**31**	**31**	**45**	**45**	**37**	**37**
Weightage percentage of Course contribution to POs	**4.28**	**4.63**	**4.726**	**4.95**	**5.25**	**4.98**
Weightage percentage of Course contribution to Pos without Extra Credit Courses	**4.718**	**5.032**	**5.136**	**5.494**	**5.863**	**5.433**

EXTRA CREDIT COURSES (Self-study)

CLASS	**M.Sc., Zoology**	
Semester	**III**	
Course & Code	**Extra Credit Course -1**	**P22ZY20ECC1**
Title	**ORNITHOLOGY**	
Self Study	**Credits : 4**	**Max Marks : 100**

Course Educational Objectives

CEO1. To understand the classification of birds.
CEO2. To understand physiology of birds.
CEO3. To understand the ecology of birds.
CEO4. To understand the breeding of birds.
CEO5. To understand the migration of birds.

UNIT - I

Classification of Birds up to orders with examples – fossil birds – origin and evolution of birds.
Habitat ecology of Indian birds: Coastal birds – Inland water birds – Birds of high altitudes and deserts.
Status and Distribution: Distribution of birds in India – Endangered birds of India and their conservation.

UNIT - II

Methods: Morphometric measurements – methods used in food habit studies.
Feeding ecology: Insectivores – Frugivores –Nectarivores – Graminivores – Carnivores and Scavengers – Perch related variables and time activity budget studies with suitable example.
General Organization – digestive system – circulatory system – excretory system - respiratory system – sense organ, nervous system and coordination.

UNIT - III

Territory: Functions of Territory – Types of Territory – Sizes and shapes of Territory – Defense of Territory – Site Fidelity.
Songs and Calls: Functions of Voice (Reproductive, Social and Individual) – Birds Vocabularies – Nature of song – Non – Vocal sounds.
Nests: Functions of nests – Choice of nest sites – Colonial nesting – Forms of nest – Multiple nests – Nest materials – Nest building.

UNIT - IV

Reproduction: Breeding seasons – Factors influencing breeding seasons – Seasonal reproductive cycle – Photo periodism – Courtship and display – Sexual selection – Pair bond – Sexual dimorphism – Mating systems - Polyandry, Polygyny – Promiscuity – Co-operative breeding – Brood parasites.
Egg Laying: Timing of egg laying – Clutch size – Incubation patterns – Hatching.
Parental Care: Feeding – Nest sanitation – Brooding the young – Defense of young.
Feathers and Moulting: Types – Functions – Growth – Moulting.

UNIT - V

Migration: Theories of migration – Timing of migration – Physiology of migration– Orientation and navigation.

Population Regulation: Population densities – Predation – Competition – Climate and weather – Accidents – Parasites and diseases – Population fluctuations.

Economic values of birds: Food and other products from birds – Birds of agricultural Importance – Bird hazard in airports – Recreation – Esthetics – Hunting– Bird watching.

Course Outcomes

Upon Completion of the course student would be able to:
CO1: Define the classification of birds, ecology of birds and their economic value.
CO2: Infer about the physiology of birds.
CO3: Apply skills on ecology of birds.
CO4: Analyze the breeding, parental care, feathers and moulting patterns in birds.
CO5: Justify the migration in birds and their economic value.
CO6: Develop awareness about man-made hazards to birds.

Textbooks

1. Welty, J. 1982. The Life of Birds. Saunders College Publishing, New York.

Reference Books

1. Ali, S., and S.D. Ripley. 1969. The Handbook of Birds of India and Pakistan. Oxford University Press – Delhi.
2. Farner D.S. and J.K. King. 1971-75. Avian Biology. 1-5 vols. Academy Press, Delhi.

MAPPING OF PO AND CO

Course Outcomes (CO)	Programme Outcomes (PO)					
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	9	0	9	9	9	0
CO 2	9	9	9	9	0	1
CO 3	9	1	9	9	1	9
CO 4	0	9	9	0	9	9
CO 5	1	9	1	9	9	3
CO 6	3	3	1	9	9	9
Weightage	31	31	38	45	37	31
Weightage percentage of Course contribution to POs	4.28	4.63	3.991	4.95	5.25	4.172

CLASS	**M.Sc., Zoology**	
Semester	**IV**	
Course & Code	**Extra Credit Course -2**	**P22ZY21ECC2**
Title	**ENVIRONMENTAL IMPACT ANALYSIS**	
Self-Study	**Credits : 4**	**Max Marks : 100**

Course educational objectives
CEO1. To understand our environment.
CEO2. To understand the origin and development of EIA.
CEO3. To understand the process of EIA.
CEO4. To understand the role of EIA in developmental activities.
CEO5. To know the environmental audit.

UNIT I: CONCEPT AND APPROACHES FOR ENVIRONMENT
Environmental science, global concerns about environment, Environmental protection and sustainability: principles of sustainability, structure of natural systems, causes of land degradation and environmental pollution, population growth and environment Monitoring, Legal and institutional status of environment.

UNIT II: ORIGIN AND DEVELOPMENT
Purpose and aim, core values and principles, History of EIA development, Environmental Management plan, Environmental Impact Statement, Scope of EIA in planning a project and its implementation.

UNIT III: EIA PROCESS
Assessment process of Environmental Impact: Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application, Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, EIA Document.

UNIT IV: MAIN PARTICIPANTS IN EIA PROCESS
Roles of Project proponents and environmental consultants, Roles of the State Pollution Control Boards (PCBs) /Pollution Control Committee (PCCs), Impact Assessment Act (IAA).Public participation.

UNIT V: ENVIRONMENTAL APPRAISAL AND PROCEDURES IN INDIA AND EIA
Environmental Audit of different environmental resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation. Impact on Environmental component: air, noise, water, land, biological, social and environmental factors.

Course Outcomes
Upon Completion of the course student would be able to:
CO1: Define Environment and sustainability, Environmental impact Assessment (EIA).
CO2: Infer on origin and development of EIA.
CO3: Apply techniques and assessment process of EIA.
CO4: Explicate on the role of EIA in developmental activities.
CO5: Elucidate the main participants in EIA process and environmental audit.
CO6: Create public awareness regarding EIA.

Recommended Readings

1. Kulkarni V and Ramachandra TV, (2006). Environmental Management, Capital Pub. Co. New Delhi.
2. Petts, J. (2005) Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK.
3. Glasson, J. Therivel, R. and Chadwick, (2006) A. Introduction to Environmental Impact Assessment. Routledge, London.
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York;
5. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
6. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford;
7. Therivel, R. and Partidario, M.R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
8. Vanclay, F. and Bronstein, D.A. (1995)

MAPPING OF PO AND CO

Course Outcomes (CO)	**Programme Outcomes (PO)**					
	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	9	9	9	9	0	0
CO 2	0	9	9	9	9	1
CO 3	9	0	9	9	1	9
CO 4	9	1	9	9	9	3
CO 5	9	3	1	0	9	9
CO 6	1	0	1	9	9	9
Weightage	**37**	**22**	**38**	**45**	**37**	**31**
Weightage percentage of Course contribution to POs	**5.103**	**3.29**	**3.991**	**4.95**	**5.25**	**4.172**

Changes made - M.Sc Zoology

Theory Papers

S.No.	Course Code	Course Title	Percentage of change made in the course content (%)
1.	P22ZY1	Biology of Invertebrates and Chordates and Paleontology	43
2.	P22ZY2	Cell and Molecular Biology	42
3.	P22ZY3	Genetics	22
4.	P22ZY5E	Bioinstrumentation and Bioinformatics	58
5.	P22ZY6	Animal Physiology	8
6.	P22ZY7	Biotechnology	76
7.	P22ZY8	Microbiology	79
8.	P22ZY10E	Entrepreneurial Zoology	20
9.	P22ZY11	Developmental Biology and Evolution	5
10.	P22ZY12	Biochemistry & Biophysics	9
11.	P22ZY14E	Biostatistics and Research Methodology	66
12.	P22ZY15E	Environmental Biology and Management	61
13.	P22ZY16	Immunology	27
14.	P22ZY17	General and Applied Entomology	18
15.	P22ZY18E	Wildlife Biology	68

Practical Papers

S.No.	Course Code	Course Title	Percentage of change made in the course content (%)
1	P22ZY4P	Practical – I - Pertaining to CC1, CC2 & CC3	5
2	P22ZY9P	Practical – II - Pertaining to CC6, CC7 & CC8	5
3	P22ZY13P	Practical – III - Pertaining to CC11 and CC12	2
	P22ZYP19	Project Work	-

In Total, 34.11 % of the course content of the M.Sc., Programmehas been revised and approved for the academic year 2022 to 2025 by the Board of Studies.

Some online courses suggested for students on MOOC platform

NPTEL courses under Biotechnology discipline

1. NOC: Cell Culture Technologies
2. NOC: Experimental Biotechnology
3. NOC: Introduction to dynamic models in Biology
4. NOC: Wildlife Ecology
5. NOC: Data analysis for Biologists.

Coursera – Animal Science discipline

1. Dairy production and management
2. Animals and Society
3. Ecology: Ecosystem Dynamics and Conservation
4. Bugs 101: Insect – Human interaction
5. Paleontology: Ancient Marine Reptiles

Edx Courses–Biology & Life Science discipline

1. Introduction to Biology – The Secret of Life
2. Molecular Biology – Part 1: DNA Replication & Repair
3. Cellular mechanism of Brain Function
4. Introduction to Animal Behavior.