

**GOVERNMENT ARTS COLLEGE (AUTONOMOUS)
COIMBATORE-641 018**

**Learning outcomes-based Curriculum Framework
(LOCF) for**

M.Sc. ZOOLOGY

(Effective from Academic year 2021-2022 Onwards)



**POSTGRADUATE AND RESEARCH
DEPARTMENT OF ZOOLOGY
MAY-2021**

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PREAMBLE

Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects learning outcome-based curriculum in order to maximize the benefits of the newly designed curriculum. The learning outcome-based curriculum will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.

Tamil Nadu State Council for Higher Education (TANSCH) has formed the State Integrated Boards of Studies, which, with great diligence and expertise has devised the mandatory areas that have to be covered for three-year under graduation and two-year postgraduation courses to realize the facilitation of the mobility of faculty and students from one university to another and to easily solve the problem of equivalence among courses. Great care has been taken so that these areas would take 75% of the course content and the remaining 25% can be decided by the individual institutions. The areas that must be covered by the student that are mandatory for earning the degree to have due value has been worked out so that the student will gain enough depth of knowledge in the subject concerned. 25% percent of the syllabus should be designed by the institutions, and the areas covered under this also must have a weightage of 25%. This gives the autonomous institution seamless liberty on every Board of Studies (BOS) to innovate and experiment, and more importantly, it is here that the institution devises appropriate strategies by which (i) to make creative and critical applications of what has been learnt in the mandatory components, and (ii) to meaningfully connect the learners to the career demands and expectations. It is essential that the theoretical subject knowledge of the students must be translated into practical hands-on experience.

One of the significant reforms in the postgraduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. LOCF also aims at ensuring uniform education standard and content delivery across the country which will help the students to ensure similar quality of education irrespective of the institute and location. With initiatives of University Grants Commission (UGC) for nation-wide adoption and implementation of the LOCF for bachelor's programmes in colleges, universities and HEIs in general. A Core Expert Committee (CEC) was constituted to formulate the modalities for developing the LOCF in various subjects being taught in the undergraduate/postgraduate courses in sciences, humanities, commerce and professional courses. The CEC also constituted the Subject Expert Committees (SEC) in various subjects to prepare detailed guidelines for the LOCF in subjects concerned.

The key components of the planning and development of LOCF are given in terms of clear and unambiguous description of the Graduate Attributes (GA), Qualification Descriptors (QD), Program Learning Outcomes (PLO) and Course Learning Outcomes (CLO) to be achieved at the end of the successful completion of each undergraduate program to be offered by HEIs. Infrastructure of our college is incomparable, adopting different methodologies for teaching and learning process. Thus, different syllabi, teaching methods, hands-on-training, and different learning outcomes are encountered, to negotiate efficiently with the changing

needs, making it essential to graduate from incremental inputs to syllabi revisions, to the use of disruptive approaches to reshape the subject-specific course structures, with measurable learning outcomes. The subject of Zoology has to be understood in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels.

Inner working of living-beings has to be understood by comparing various systems within invertebrates and vertebrates i.e., from a single cell protozoan to multicellular humans, and develop a comprehensive understanding and appreciation of the differences through ICT tools and well-designed hands-on practical exposures along with the field work. Added to this, if the same principle is followed to understand different phyla through the ladder of evolution and compare cardinal features for classification involving both morphological and molecular tools, along with associated field and lab work, the final product would be better trained than routine learning. Diversity in the life forms need to be understood by a Zoologist for its socio-economic capital, in case a student is interested in entrepreneurship, through applied aspects of Zoology; and by a career researcher as a ladder towards multiscale hierarchical systems, where chemical and physical principles would apply from molecules to self-assembled and organized organisms. The vibrancy to synthesize out of the knowledge gained and come out with disruptive outcomes, would define the learning outcomes of the future PG students.

Apart from the above mentioned attributes expected of a PG student, related to the subject area of Zoology to be studied in an integrated and cross-disciplinary manner, with a comprehensive understanding of all living systems, their relationship with the eco-system, and unravelling of their application value; the scale, character and rigour of which may vary from one institution to the other, it would, however, be necessary to bring in uniformity in the learning outcomes with respect to the 'broad-range skill sets' related-to-the-discipline of the study, to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. The student has to imbibe values for cooperative team work, moral and ethical awareness and reasoning, multicultural competence, leadership readiness and qualities and self- directed and lifelong learning attitude.

Students should be equipped to identify the major groups of organisms, discuss the basis of their biodiversity and draw parallels with their phylogenetic relationship, using features of classification on the basis of morphology and molecular information wherever available. This principle of comparative biology can be followed in understanding comparative anatomy, physiology and other functions for all in the hierarchy of animal evolution, instead of dealing with each phylum/order/species and each system as a stand-alone. This allows the student to gain comprehensive knowledge about different animal species in one go, appreciating the differences and similarities, thereby achieving proficiency in handling them experimentally or for research purposes, thus reducing the burden of teaching on mentors, though initially the change in contents of the curriculum is required. Teachers need to be trained for the uniform approach to deliver and communicate. Thus, a comprehensive knowledge of structure-function relationship at the level of gene, genome, cell, tissue, organ, and systems, and thus editing of genes and genomes for industrial application and research purposes. Short dissertations can be designed around these problems to give them hands-on-training and equip them with skill sets for use in future, in the areas of applied aspects of Zoology, including Aquaculture, Nanotechnology and Biomedicine.

1. INTRODUCTION

Zoology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. It covers a fascinating range of topics, and the modern Zoologist needs to have insight into many disciplines. The learning outcomes-based curriculum framework for a M.Sc. degree in Zoology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Zoology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Zoology, or in teaching-learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, assessment of student learning levels.

1.1 Course Structure – Types of Courses.

The following types of courses are offered under CBCS-LOCF:

1. **Core Courses (CC):** A core course is a compulsory course. A student of Post graduate in Zoology has to take 16 such Zoology courses over four semesters.
2. **Elective Courses (EC):** An elective course is a course that is to be chosen from a specified set of courses.
 - I. **Skill Enhancement Course.** A student has to take one such course as an individual project in Semester IV.
 - II. **Discipline Specific Electives (DSE):** These are elective courses that provide advanced post graduate training in specialized areas of Zoology. A set of 4, one each in all the four semesters of the post graduate programme.

2. LEARNING OUTCOME BASED APPROACH TO CURRICULUM PLANNING

The courses should be delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at M.Sc. level. In addition to chalk and board, PowerPoint presentations can be used for teaching the course. The students should do the dissertation/ project work related to practical of different papers, wherever possible. The students are expected to learn the courses with excitements of Zoology along with the universal molecular mechanisms of Zoological designs and their functions. They should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of various offshoots of Zoology. These courses and their practical exercises will help the students to apply their knowledge in future course of their career development in higher education and research. In addition, they may get interested to look for engagements in industry and commercial activities employing Life Sciences, Molecular Biology and Biotechnology. They may also be interested in entrepreneurship and start some small business based on their interest and experience.

2.1 Nature and extent of the M.Sc. degree Programme in Zoology

M.Sc. Zoology course will help to understand the behaviour, structure and evolution of animals. Zoologists use a wide range of approaches to do this, from genetics to molecular and cellular biology, as well as physiological processes and anatomy, whole animals, populations, and their ecology. The scope of Zoology as a subject is very broad. The intention is to understand the subject of Zoology in the evolving biological paradigm in modern times; where, living beings need to be understood at the level of atomic interactions; and comparative systems of organisms need to be studied through the prism of integrated chemical, physical, mathematical and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels. The key areas of study within the subject area of Zoology comprises animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, behaviour, immunology, reproductive biology, and insect, vectors and diseases. M.Sc. degree programme in Zoology also deals with skill enhancement courses such as apiculture, aquarium fish keeping, medical diagnostics, sericulture etc. The depth and breadth of study of individual topics dealt with, would vary with the nature of specific Zoology programmes. As a part of the efforts to enhance the interest and employability of Post graduates of Zoology programmes, the curricula for these programmes are expected to include learning experiences that offer opportunities for higher studies and research at reputed laboratories.

2.2 Aims of Master's degree programme in Zoology

Zoology is the study of all animal life; from primitive microscopic malaria-causing protozoa to large advanced mammals, across all environmental spheres from red deer in mountain forests to dolphins in deep oceans, and from underground burrowing voles to golden eagles in the skies. Some of these animals are useful to us and we nurture them as pets or livestock; some are serious pests or disease-causing; and some are simply splendid and awe-inspiring. No matter what our relation with the animals is, we need to understand their

behaviour, population dynamics, physiology and the way they interact with other species and their environments. It provides students with the knowledge and skill base that would enable them to undertake further studies in Zoology and related areas or in multidisciplinary areas that involve advanced or modern biology and help in developing a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

The modern era requires a classical zoologist with a modern approach to master many subjects of Zoology. The main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research. The students have to become proficient in the identification and study of animals, providing the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc. The curriculum is modified so that a student at M.Sc. level can be a specialist in immunology, ornithology, animal behaviour or entomology. For such specializations, the curriculum needs to focus on special skills to maximise the student's employment probability.

3. GRADUATE ATTRIBUTES IN ZOOLOGY

1. **Disciplinary Knowledge:** Demonstration of a lucid and coherent understanding of the fundamental precepts of Zoology and its diverse subjects such as, Animal Diversity, Biosystematics and Evolution, Cell and Molecular Biology, Animal Physiology, Developmental Biology, Endocrinology, Research Methodology, emerging areas like, Molecular Genetics, Environmental Biology, Fishery Science, Microbiology, Immunology, Entomology, Biotechniques, Biostatistics and Biotechnology.
2. **Communication Skills:** Enhancement of skills in experiments and procedures in classical Zoology, Animal Physiology, Environmental Biology, Biochemistry, Fishery Science, Entomology, Molecular Genetics, Microbiology, Immunology, Biotechnology, and Endocrinology, imbibing expertise for further research, teaching, and placement in various sectors.
3. **Critical Thinking:** Attainment of proficiency in the principles, techniques, and applications of classical zoology, and current thrust areas, such as, Molecular Genetics, Microbiology, Immunology, Biotechnology and Biotechniques, with a critical understanding of recent innovations.
4. **Research-related Skills:** Application of the knowledge, comprehension, skills, and expertise acquired in the subject towards collecting relevant published information, identifying lacunae with potential for research.
5. **Analytical Reasoning:** Manifestation of skills in distinguishing gaps in research by garnering appropriate data, using standard methodologies indicated to obtain experimental results, analysis of the results based on statistical methods and cited literature to formulate viable solutions.
6. **Lifelong Learning:** Acquisition of capability to extrapolate the comprehensive knowledge and skills attained in the classroom, laboratory, and through learning resources, to critically evaluate issues and challenges in Zoology.
7. **Scientific Reasoning:** Ability to convey the outcomes of experiments and projects undertaken in the diverse subjects of Zoology with clarity and precision in various scientific forums, utilising the techniques and basic precepts of Zoology.
8. **Self-directed Learning:** Capacity to apply information gained from scientific resources about recent advances and developments in rapidly growing fields such as, Molecular Genetics, Molecular Biology, Immunology, Microbiology, Biotechniques, and Bioinformatics, to enhance personal knowledge and skills.
9. **Problem Solving:** Competence to use the expertise and skills acquired during the course of study in a novel milieu, to identify and investigate existing problems plaguing modern society and the environment, and devise viable solutions.
10. **Career / Entrepreneurial Skills:** Extrapolation of accrued knowledge and skills in classical zoology in general, and in the fields of Molecular Genetics, Biochemistry, Molecular Biology, Endocrinology, Microbiology, Immunology, Biotechnology, Entomology, and Biotechniques in particular, towards increasing chances of appointment to key positions in the public/private sector, or in launching entrepreneurial ventures, thereby creating job opportunities for others.
11. **Team Work & Leadership Qualities:** Expression of ability to cohesively coordinate with other members in a team to successfully complete a research project, allocating tasks and responsibilities to the members, inspiring individuals to effectively strive together to accomplish the goals of the project.

12. **Digital Literacy:** Resourcefulness to use apt computer software to analyse data obtained by experimentation and research, and proficiency in accessing and evaluating information pertinent to the research or area of interest.

13. **Moral and Ethical Awareness:** Inculcation of strong moral and ethical values, awareness about the role of individuals in shaping society and sustaining the environment, adherence to Intellectual Property Rights, and unbiased actions in all spheres of life.

14. **Multicultural Competence:** Appreciation of beliefs and values of diverse cultures, respecting alternate viewpoints, and capable of interactions with global communities.

4. QUALIFICATION DESCRIPTORS FOR A MASTER'S DEGREE PROGRAMME IN ZOOLOGY

1. Demonstration of a lucid and coherent understanding of the fundamental precepts of Zoology and its diverse subjects such as, Animal Diversity, Biosystematics and Evolution, Cell and Molecular Biology, Animal Physiology, Developmental Biology, Endocrinology, Research Methodology, emerging areas like, Molecular Genetics, Environmental Biology, Fishery Science, Microbiology, Immunology, Entomology, Biotechniques, Biostatistics and Biotechnology.
2. Enhancement of skills in experiments and procedures in classical Zoology, Animal Physiology, Environmental Biology, Biochemistry, Fishery Science, Entomology, Molecular Genetics, Microbiology, Immunology, Biotechnology, and Endocrinology, imbibing expertise for further research, teaching, and placement in various sectors.
3. Attainment of proficiency in the principles, techniques, and applications of classical zoology, and current thrust areas, such as, Molecular Genetics, Microbiology, Immunology, Biotechnology and Biotechniques, with a critical understanding of recent innovations.
4. Application of the knowledge, comprehension, skills, and expertise acquired in the subject towards collecting relevant published information, identifying lacunae with potential for research.
5. Manifestation of skills in distinguishing gaps in research by garnering appropriate data, using standard methodologies indicated to obtain experimental results, analysis of the results based on statistical methods and cited literature to formulate viable solutions.
6. Acquisition of capability to extrapolate the comprehensive knowledge and skills attained in the classroom, laboratory, and through learning resources, to critically evaluate issues and challenges in Zoology.
7. Ability to convey the outcomes of experiments and projects undertaken in the diverse subjects of Zoology with clarity and precision in various scientific forums, utilising the techniques and basic precepts of Zoology.
8. Capacity to apply information gained from scientific resources about recent advances and developments in rapidly growing fields such as, Molecular Genetics, Molecular Biology, Immunology, Microbiology, Biotechniques, and Bioinformatics, to enhance personal knowledge and skills.
9. Competence to use the expertise and skills acquired during the course of study in a novel milieu, to identify and investigate existing problems plaguing modern society and the environment, and devise viable solutions.
10. Extrapolation of accrued knowledge and skills in classical zoology in general, and in the fields of Molecular Genetics, Biochemistry, Molecular Biology, Endocrinology, Microbiology, Immunology, Biotechnology, Entomology, and Biotechniques in particular, towards increasing chances of appointment to key positions in the public/private sector, or in launching entrepreneurial ventures, thereby creating job opportunities for others.
11. Expression of ability to cohesively coordinate with other members in a team to successfully complete a research project, allocating tasks and responsibilities to the members, inspiring individuals to effectively strive together to accomplish the goals of the project.
12. Resourcefulness to use apt computer software to analyse data obtained during experimentation and research, and proficiency in accessing and evaluating information pertinent to the research or area of interest.

13. Inculcation of strong moral and ethical values, awareness about the role of individuals in shaping society and sustaining the environment, adherence to Intellectual Property Rights, and unbiased actions in all spheres of life.
14. Appreciation of beliefs and values of diverse cultures, respecting alternate viewpoints, and capable of interactions with global communities.

5. LEARNING OUTCOMES IN MASTER'S DEGREE PROGRAMME IN ZOOLOGY

5.1 Knowledge and Understanding

- Demonstrate
 - (i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields
 - (ii) procedural knowledge that creates different types of professionals in the field of Zoology and related fields such as, apiculture, aquarium fish keeping, medical diagnostics, and sericulture, etc.
 - (iii) skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics, Botany and Mathematics).
- Appreciate the complexity of life processes, their molecular, cellular and physiological processes, their genetics, evolution and behaviour and their interrelationships with the environment.
- Study concepts, principles and theories related with animal behaviour and welfare.
- Understand and interpret data to reach a conclusion.
- Design and conduct experiments to test a hypothesis.
- Understand scientific principles underlying animal health, management and welfare.
- Accept the legal restrictions & ethical considerations placed for animal welfare.
- Understand fundamental aspects of animal science relating to management of animals.
- Assess problems and identify constraints in management of livestock.

5.2 Subject Specific Intellectual and Practical Skills

The students will be able to

- ☐ Understand how organisms are classified and identified.
- ☐ Demonstrate knowledge of basic zoological principles.
- ☐ Use appropriate information with a critical understanding.
- ☐ Learn basic laboratory and analytical skills.
- ☐ Use effective methods for modifying animal behaviour.
- ☐ Participate in animal management programmes in an effective manner.
- ☐ Work safely and effectively in the field, in laboratories and in animal facilities.

- Demonstrate competence in handling and statistical analysis of data gained from practical.
- Learn communication and IT skills, including the collation and statistical analysis of data, citing & referencing work appropriately, communicating using a range of formats.

In course learning outcomes, the student will attain subject knowledge in terms of individual course as well as holistically.

The Core courses would fortify the students with in-depth subject knowledge available currently. Generic electives will bring about integration among various interdisciplinary courses, and skill enhancement courses would further add additional skills related to the subject, as well as, other than subject. In brief, the students graduated with this type of curriculum will be able to disseminate subject knowledge along with necessary skills to suffice their capabilities for academia, entrepreneurship and Industry.

For each syllabus, the course content has been divided into five units with a breakup of the topics to be covered to provide the students better understanding of the main theme represented in the title of each unit. Such type of design indicates the breadth of content to be taught thus ensuring more or less uniform coverage of information on a certain subject.

M.Sc. Zoology Degree Course

PG - SCHEME OF EXAMINATIONS: CBCS PATTERN

(For the students admitted during the academic year 2021-2022 and onwards)

Sub Code	Title of the Paper	Hrs/wk	Internal (CA) Marks	External Marks	Total Marks	Ext – Min.	Total Pass Mark	Credits
Semester – I								
21MZO11C	Core Paper I: Animal Diversity	5	50	50	100	25	50	4
21MZO12C	Core Paper II: Biosystematics & Evolution	5	50	50	100	25	50	4
21MZO13C	Core Paper III: Cell & Molecular Biology	5	50	50	100	25	50	4
21MZO14E	Elective Paper I: Fishery Science	5	50	50	100	25	50	4
	Core Practical I: Including Papers I, II, III, V & Elective I	5						
	Core Practical II: Including Papers IV, VI & Elective II	5						
Semester – II								
21MZO21C	Core Paper IV: Animal Physiology	5	50	50	100	25	50	4
21MZO22C	Core Paper V: Environmental Biology	5	50	50	100	25	50	4
21MZO23C	Core Paper VI: Molecular Genetics	5	50	50	100	25	50	4
21MZO24E	Elective Paper II: Biostatistics, Biotechniques & Research Methodology	5	50	50	100	25	50	4
21MZO25P	Core Practical I: Including Papers I, II, III, V & Elective I	5	50	50	100	25	50	4
21MZO26P	Core Practical II: Including Papers IV, VI & Elective II	5	50	50	100	25	50	4

Sub Code	Title of the Paper	Hrs/wk	Internal (CA) Marks	External Marks	Total Marks	Ext – Min.	Total Pass Mark	Credits
Semester – III								
21MZO31C	Core Paper VII: Biochemistry	5	50	50	100	25	50	4
21MZO32C	Core Paper VIII: Developmental Biology	5	50	50	100	25	50	4
21MZO33C	Core Paper IX: Microbiology	5	50	50	100	25	50	4
21MZO34E	Elective Paper III: General Entomology	5	50	50	100	25	50	4
	Core Practical III: Includes Paper VII, VIII, IX, XI and XII	5						
	Core Practical IV: Includes Paper XI, Elective Papers III and IV	5						
Semester – IV								
21MZO41C	Core Paper X: Biotechnology & Genetic Engineering	5	50	50	100	25	50	4
21MZO42C	Core Paper XI: Immunology	5	50	50	100	25	50	4
21MZO43C	Core Paper XII: Endocrinology	5	50	50	100	25	50	4
21MZO44E	Elective – IV: Applied Entomology	5	50	50	100	25	50	4
21MZO45P	Core Practical III: Includes Paper VII, VIII, IX, XI and XII	5	50	50	100	25	50	4
21MZO46P	Core Practical IV: Includes Paper XI, Elective Papers III and IV	5	50	50	100	25	50	4
21MZO47P	Project Viva Voce		50	50	100	25	50	10
	Total Credits				2100			90

Core - Includes core theory, practical and electives

Includes 50/50 continuous Internal Assessment Marks for Theory and Practical papers respectively

Project evaluation done by both Internal and External examiner for 50 Marks.

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Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	I	21MZO11C	CORE PAPER I: ANIMAL DIVERSITY	5

COURSE LEVEL OUTCOMES

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

1. Compare the functional systems of invertebrates and vertebrates.
2. Compare the functional systems of different vertebrates.
3. Discuss the biology of different animals.
4. Classify invertebrates and chordates based on their morphology.
5. Explain the biology of Indian birds.
6. Describe the aquatic mammals and their adaptations.
7. Elaborate about the flying mammals and their significance.

UNIT I - ELDER INVERTEBRATES

1. Outline classification of invertebrates up to Order level.
2. Unicellular, colonial and multicellular forms.
3. Levels of organization of tissues, organs and systems.
4. Comparative study of morphology and systems of Protozoa (*Amoeba proteus*), Porifera (*Scypha coronata*), Coelenterata (*Aurelia aurita*), Platyhelminthes (*Taenia solium*), Aschelminthes (*Ancylostoma duodenale*).
5. Common nematode pathogens of humans.

UNIT II - ADVANCED INVERTEBRATES

1. Comparative study of systems of - Annelida (*Hirudinaria granulosa*), Arthropoda (*Panaeus indicus*), Mollusca (*Lamellidens marginalis*), Echinodermata (*Cucumaria elongata*).
2. An account on Arachnids - Spiders (*Poecilotheria striata*, *Poecilotheria regalis*) and Scorpions (*Hottentotta tamulus*).
3. Economic importance of Mollusca.
4. Larval forms in Echinodermata - Bipinnaria, Ophiopluteus, Echinopluteus, Auricularia, Doliolaria.

UNIT III - PROCHORDATES AND CYCLOSTOMES

1. Classification and major subdivisions of the Phylum Chordata.
2. Comparative study of Tongue Worm (*Balanoglossus clavigerus*) and Lamprey (*Petromyzon marinus*).
3. Affinities and systematic position of Prochordata.
4. Major characteristics and classification of vertebrates up to order level.

UNIT IV - PISCES, AMPHIBIANS AND REPTILES

1. Comparative account of digestive, respiratory, circulatory, nervous and urinogenital systems of the vertebrates - Pisces (*Scoliodon sorrakowah*), Amphibia (*Hoplobatrachus tigrinas*), Reptilia (*Calotes versicolor*).
2. Migration of fishes (Catadromous - Eel (*Anguilla vulgaris*), Anadromous - Salmon (*Salmo salar*)).

3. Frogs and Toads - Tree frog (*Hyla arborea*), Flying frog (*Rhacophorus malabaricus*), Indian toad (*Bufo melanostictus*), Mid-wife toad (*Alytes obstetricans*).
4. South Indian venomous snakes (Cobras - *Naja naja*, *Ophiophagus Hannah*, Krait- *Bungarus caeruleus*, Viper - *Vipera russelli*, Coral snake - *Calliophis beddomei*, Sea snake - *Hydrophis annandalei*, Mild venomous - Whip snake - *Ahaetulla nasuta*, and non-venomous snakes (Pond snake - *Tropidonotus quincunciatus*, Rat snake - *Ptyas mucosus*, Sand boa - *Eryx johnii*, Indian python - *Python molurus*).

UNIT V - AVES AND MAMMALS

1. Comparative account of digestive, respiratory, circulatory, nervous and urinogenital systems of the vertebrates - Aves (*Columba livia*), Mammals (*Oryctolagus cuniculus*).
2. Common birds in India - Parrot (*Psittacula eupatria*), Sparrow (*Passer domesticus*), Crow (*Corvus splendens*), Weaver (*Ploecious philippinus*), Myna (*Acridotheres tristis*), Koel (*Eudynamis scolopaceus*), Kite (*Haliaster indus*), Flamingo (*Phoenicopterus roseus*), Peacock (*Pavo cristatus*), Owl (*Bubo bubo*).
3. Aquatic mammals and adaptations - Whales (*Balaenoptera musculus*), Dolphins (*Delphinus delphis*, *Platanista gangetica*), Sea cow (*Dugong dugon*).
4. Flying mammals and adaptations - (Gliding flight - Indian giant flying squirrel (*Petaurista philippensis*), True flight - Indian flying fox (*Pteropus medius*).

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

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COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√		√		√
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√		
Scientific Reasoning	√	√	√	√		√	√
Entrepreneurial Skills			√				
Reflective Thinking	√	√		√	√		√
Digital Literacy					√		
Leadership Readiness				√			
Moral and Ethical Awareness		√					
Lifelong Learning	√		√		√		

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	I	21MZO12C	CORE PAPER II: BIOSYSTEMATICS AND EVOLUTION	5

COURSE LEVEL OUTCOMES

On the successful completion of this course, students will be able to

1. Describe the principles of Biosystematics.
2. Classify organisms.
3. Identify organisms based on various aspects of species concept.
4. Discern and differentiate the diversity of primates .
5. Discuss the origin of first cell, new genes and proteins.
6. Analyze the origin and ancestry of humankind.
7. Evaluate the neural mechanisms of behavior.

UNIT I - PRINCIPLES OF BIOSYSTEMATICS

1. Classification, Taxonomy and Biosystematics.
2. Nomenclature - History, Binomial, Trinomial, Homonymy and Synonymy
3. International Code for Zoological Nomenclature (ICZN) and Integrated Taxonomic Information System (ITIS).
4. Domains and kingdoms.
5. Molecular taxonomy - Phylocode, tree of life and bar-coding of life.

UNIT II - SPECIES CONCEPT

1. Taxonomy of hierarchy.
2. Speciation - Species concepts, Mendelian speciation.
3. Kinds of species - Polytypic species, Subspecies, Super species.
4. Modes of speciation – Allopatric and Sympatric.
5. Isolating mechanisms in Speciation

UNIT III – PRIMATES

1. Outline classification of Order Primata.
2. Distribution, diversity and an overview of,
 - a) Prosimians - Lemurs, Lorises and Tarsiers.
 - b) New world monkeys - Capuchins, Howlers, Squirrel monkeys.
 - c) Old world monkeys - Baboons, Macaques and Rhesus monkeys.
 - d) Nilgiri grey Langur and Hoolock gibbon (Small Apes)
 - e) Hominids (Great Apes) - Orangutans, Gorillas, Chimpanzees.
3. Origin and ancestry of human.

UNIT IV - ORIGIN OF LIFE

1. Birth of Universe - Big Bang theory - A brief account.
2. Origin of the first cell.
3. The Evolutionary Time Scale.

4. Origin of new genes and proteins.
5. Biochemical and Physiological evidences.

UNIT V - EVOLUTION AND BEHAVIOUR

1. Natural selection theory of Darwin.
2. Cultural revolution of *Homo neanderthalensis*.
3. Learning behavior of Chimpanzees and Bonobos.
4. Neural basis of learning, memory, cognition, sleep and arousal.
5. Social organization and parental care in human.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Narendran, T.C** (2008), An introduction to Taxonomy, Zoological survey of India.
2. **Roderick D.M, and Edward, C.H.** (2000) Molecular Evolution: A Phylogenetic Approach: Blackwell science.
3. **Stebbins GL** (1966) Process of Organic Evolution, Prentice Hall, New Delhi.
4. **Dobzhansky T, Ayala FA, Stebbins GL and Valentine JW** (1977). Evolution, Surjeet Publishers, New Delhi.
5. **Chattopadhyay.C,** (2012). Life: Evolution, Adaptation, Ethology, Books and Allied (P) Ltd. Third Edition, Kolkatta.

FURTHER READING

1. **Mayr, E** (1969) Principles of Systematic Zoology. McGraw Hill Book Company, Inc., New York
2. **Cain A.J,** (2016), Animal species and their evolution. Princeton University Press.
3. **Chiarelli A.B,** (1973), Evolution of the Primates. Academic Press.
4. **Kapoor, V.C** (1998) Theory and practice of Animal Taxonomy. Oxford & IBH, Publication Co, New Delhi.
5. **David, M. H, Craig Moritz and Barbara K. M.** (1996) Molecular Systematics. Sinauer Associates, Inc.
6. **Motoo Kimura** (1983), The neutral theory of molecular evolution. Cambridge University Press.
7. **Russell, L. Coochon and Fleagle John** (1985). Primate Evolution and Human Origin.
8. **Wood, B.** (2011). Encyclopedia of Human Evolution. Wiley Blackwell.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

PROGRAMME LEVEL OUTCOMES	COURSE LEVEL OUTCOMES						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√
Problem Solving				√			√
Analytical Reasoning	√	√	√	√	√	√	
Research Related Skills	√	√		√	√		√
Scientific Reasoning	√	√		√	√	√	
Entrepreneurial Skills			√				
Reflective Thinking	√	√		√	√	√	√
Digital Literacy					√		
Moral and Ethical Awareness		√				√	√
Lifelong Learning	√			√	√		√

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	I	21MZO13C	CORE PAPER III: CELL AND MOLECULAR BIOLOGY	5

COURSE LEVEL OUTCOMES

At the completion of the semester, students will be able to

1. Compare the structure and functions of cell membrane and cell organelles.
2. Explain the cellular secretion and its importance.
3. Evaluate the bioenergetics and energy production within the cell.
4. Illustrate the different stages of cell division.
5. Analyze the regulation of cell cycle.
6. Elaborate about the structure and functions of genetic material.
7. Describe the significance of DNA and RNA.

UNIT I - CELL STRUCTURE AND CELL MEMBRANE

Structural organization of prokaryotic and eukaryotic cells; cell membrane - structure of membrane models, unit membrane concept, micellar model, lipid bilayer, Fluid mosaic model; chemical composition; functions of Plasma membrane; membrane transport; cell adhesion; electrical properties of membrane; cell wall.

UNIT II - ORGANELLES OF ENDOMEMBRANE

Golgi apparatus: ultrastructure, chemical composition, origin of Golgi complex, process and mechanism of secretion, function; Lysosome - characteristics of lysosomal membrane and enzymes, polymorphism, functions of lysosome; Endoplasmic reticulum - ultrastructure, SER, RER, functions; Ribosomes - Structure and functions.

UNIT III - ORGANELLES OF BIOENERGETICS AND BIOGENESIS

Organelles of bioenergetics: Mitochondria - ultrastructure - respiratory chain complex, chemical composition and enzyme distribution; Oxidative Phosphorylation - mechanism, inhibitors, translocation of ADP and ATP; Organelle of biogenesis: Chloroplast - ultrastructure, photochemical reaction in biogenesis, light reaction and dark reaction, role of CO₂ and H₂O in photosynthesis.

UNIT IV - NUCLEUS AND CELL CYCLE

Nucleus - structure of chromatin and chromosomes, heterochromatin and euchromatin; Cell division - mitosis and meiosis, regulation, steps in cell cycle, regulation and control of cell cycle; structure and functions of microtubules, microfilaments, intermediate filaments and their role in cell division; cancer and cell cycle - therapeutic interventions of uncontrolled cell growth - apoptosis.

UNIT-IV: DNA AND RNA

DNA - structure, chemical composition, properties and importance ; replication in prokaryotic and eukaryotic; RNA - structure and functions of mRNA, tRNA and rRNA; Transcription and processing of RNA; Genetic code, codon anticodon recognition, wobble hypothesis; Prokaryotic and eukaryotic transcription; machinery of protein synthesis; Post translational modifications, protein folding, protein sorting; proteomics and proteomic analysis; Regulation of gene expression in prokaryotes and eukaryotes.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Verma P.S. and V.K. Agarwal.** (2016). Cell Biology. S Chand & Co.
2. **Gerald Karp** (2008). Cell and Molecular Biology; 5th Edition; John Wiley & Sons (Asia) Pvt. Ltd.
3. **Lewin.B** (2000). Gene VII, Oxford University Press, London.
4. **Geoffrey M.Cooper and Robert E. Hausman** (2013).The Cell: A Molecular Approach. Sinauer Associates Inc.
5. **Gupta. P.K.** (2003). Cell and Molecular Biology, Rastogi Publication, Meerut, India.

FURTHER READING

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2. **Lodish.H, Berk.A, Zipursky.SL, Matudaira.P, Baltimore.D and Darnell J.** (2000). Molecular Biology of the cell W.H. Freeman and company, New York.
3. **Arnold Berk, Chris A. Kaiser and Harvey Ledish** (2016). Molecular Cell Biology. W H Freeman.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√
Problem Solving			√				√
Analytical Reasoning	√	√	√	√	√	√	
Research Related Skills		√		√	√	√	√
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills		√	√			√	
Reflective Thinking	√	√		√	√	√	√
Digital Literacy			√		√		
Moral and Ethical Awareness		√				√	√
Lifelong Learning	√				√	√	√

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	I	21MZO14E	ELECTIVE PAPER I: FISHERY SCIENCE	5

COURSE LEVEL OUTCOMESS

On the successful completion of this course, students are able to

1. List out the fundamental concepts of fishery science.
2. Explain the characteristics of fishes and the importance of inland fisheries.
3. Describe the locomotion, migration and respiration of fishes.
4. Discern the sense organs and electric organs as well as poison glands in fishes.
5. Discuss the nutritional requirements of fishes.
6. Illustrate the preservation methods and the byproducts of fishes.
7. Develop entrepreneurship in fishery sector.

UNIT I - FUNDAMENTALS OF FISHERY SCIENCE

Introduction and scope of fishery biology.

Systematics - classification of elasmobranchs, teleosts, crustaceans, and mollusks.

Definition, morphometric and meristic characteristics of fishes.

Inland fisheries - riverine fisheries, estuarine fisheries.

UNIT II - LOCOMOTION, MIGRATION AND RESPIRATION

Locomotion in fishes - types of locomotion.

Migration in fishes - types of migratory fishes and the importance of migration.

Gill respiration - types, structure and mechanism of gill respiration.

Accessory respiratory organs - air bladder.

UNIT III - SENSE ORGANS AND POISON GLANDS

Sense organs - lateral line, Ampullae of Lorenzini, pit organs.

Electric organs - origin, location, structure, mechanism and function.

Poison glands - difference between poisonous and venomous fishes, chemical nature of fish toxin, venom apparatus.

Bioluminescence and its significance.

UNIT IV - FISH FEED, EDIBLE FISHES AND DISEASES

Nutritional requirements of fishes.

Edible fishes - fresh water - *Labeo rohita*, *Cirrhinus mirgala*, *Catla catla*.

Edible fishes - marine - *Sardinalla longiceps*, *Chanos chanos*, *Scoliodon*.

Fish diseases - protozoan diseases - white spot diseases, costiasis; bacterial diseases - gill rot, vertical scale diseases; viral diseases - Epizootic Ulcerative Syndrome (EUS), Infectious Pancreatic Necrosis (IPN); fungal diseases - saprolegniasis, erythroderma.

UNITV- FISHING CRAFTS, NETS, PRESERVATION AND BYPRODUCTS

Fishing crafts - coracle, canoes, kattumaram, vallam, and bean trawlers.

Fishing Nets - cast net, Gill net, Fyke net, Dip net, Hook and line.

Methods of fish preservation - curing, drying, salting, smoking and canning.

Fish byproducts - fish liver oil, fish meal, fish manure, fish hydrolyzed protein, Isinglass, fish glue, fish leather.

Role of ICAR, CMFRI, CIFRI, CIBA in Fisheries Sciences.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Kamleshwar Pandey and Shukla J.P.**(2012). Fish and Fisheries. Rastogi publications, Meerut.
2. **Khanna S.S and Singh H. R.**(2015). A Text book of Fish biology and Fisheries. Narendra publishing house -Delhi.
3. **Jhingran,V.G.**(1987). Fish and Fisheries of Indian, Hindustan Publishing Corporation Delhi– 7.
4. **Karl F Lagler, John E Bardach, Robert R Miller and Dorr RaMary Passiono,** (1970). ‘Ichthyology’, John Willy and son New York.
5. **Khanna S S** (1973). An introduction of Fishes. Central Book Depot, Allahabad.

FURTHER READING

1. **Ribelin W.E.** (ed.) (1975). Pathology of Fishes. Madison–Wisconsin University, Wisconsin Press, U.S.A.
2. **Robart,R.J.**(ed.)(1978). Fish Pathology, Ballaire Tindele, London.
3. **Shunmugam K.** (1922). Fishery Biology and Aquaculture. Leo Pathippagam, Madras 83
4. **Yadav B N** (2006). Fish and Fisheries, Daya Publishing House, Delhi –110 035.
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COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√
Problem Solving			√		√	√	
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√		
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills		√			√	√	
Reflective Thinking	√	√	√	√	√	√	√
Digital Literacy		√		√	√		
Moral and Ethical Awareness		√	√		√	√	√
Lifelong Learning	√		√		√		
Multicultural Competence						√	

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	II	21MZO21C	CORE PAPER IV: ANIMAL PHYSIOLOGY	5

COURSE LEVEL OUTCOMES

At the completion of this course, students will be able to

1. Compare the physiological processes of certain systems across the animal kingdom.
2. Acquire knowledge about the osmoregulatory organs and processing.
3. Describe the method of internal wellbeing and the importance of homeostasis.
4. Explain the functioning of different physiological systems.
5. Analyze the various physiological activities of blood circulation.
6. Demonstrate the working mechanism of brain and neurotransmitters.
7. Discuss the significance of hormones in reproduction.

UNIT I - PHYSIOLOGY AND ENVIRONMENT

1. Homeostasis - Internal environment, body fluids and their significance.
2. Thermoregulation in homeotherms - Comfort zone - heat production, heat loss, lethal temperature, acclimatization.
3. Osmo-ionic regulation in fishes and mammals, extra-renal osmoregulatory organs.
4. Stress and adaptation – Basic concepts, acclimation, avoidance and tolerance - high altitude, diving.

UNIT II - DIGESTION AND RESPIRATION

1. Digestion - Composition of food, balanced diet, digestion of carbohydrates, proteins and lipids, BMR, BMI.
2. Absorption, assimilation, importance of gastrointestinal hormones.
3. Respiration - mechanism of respiration, respiratory pigments, transport and exchange of gases.
4. Neural and chemical regulation of respiration.

UNIT III - BLOOD AND CIRCULATION

1. Blood - Blood corpuscles, hemopoiesis, hemostasis, plasma, blood groups.
2. Circulation - Anatomy of heart, cardiac muscle, myogenic heart, origin and conduction of heart beat, Cardiac cycle,
3. Blood volume, blood pressure, principles and significance of ECG.
4. Neural and chemical regulation of heart beat and circulation.

UNIT IV - EXCRETION, NERVOUS SYSTEM AND SENSE ORGANS

1. Excretion - Excretory products, physiology of excretion, kidney, urine formation, acid - base balance.
2. Muscle - Types and structure, neuromuscular junction, theories, mechanism of muscle contraction.
3. Neuronal physiology - Brain and spinal cord, neurons, action potential, nerve

- impulse propagation, synaptic transmission and neurotransmitters, neuro-degenerative diseases.
4. Sense organs - Vision and hearing.

UNIT V - ENDOCRINE SYSTEM

1. Endocrine glands, basic mechanism of hormone action.
2. Hormonal regulation of ovarian, uterine and menstrual cycles.
3. Hormonal interaction in parturition and lactation.
4. Hormones in sleep and circadian rhythm.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Parameswaran R, Ananthasubramanian K.S.** (1989). Outline of Animal Physiology. Viswanathan Pvt.Ltd.
2. **Hoar W S** (1983). General and Comparative Physiology, Prentice Hall of India, New Delhi.
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FURTHER READING

1. **Nielson KS** (1997). Animal Physiology - Adaptation and Environment, Fifth edn, Cambridge University Press, London.
2. **Gordon M S, Bartholomew G a, Grinnel A D, Jorgensen C B, White F N** (1971). Animal Function – Principles and adaptations, Macmillan Co. London.
3. **Richard W Hill** (2016). Animal Physiology, 4th Edition, Sinauer Associates, Inc.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√		√	√	√
Problem Solving						√	
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√		
Scientific Reasoning	√	√	√	√		√	√
Entrepreneurial Skills			√				
Reflective Thinking	√	√		√	√	√	√
Digital Literacy					√		
Leadership Readiness				√			
Moral and Ethical Awareness		√	√				
Lifelong Learning	√		√		√	√	

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	II	21MZO22C	CORE PAPER V: ENVIRONMENTAL BIOLOGY	5

COURSE LEVEL OUTCOMES

At the completion of this course, the students will be able to

1. Integrate the various aspects of ecological components.
2. Differentiate the various ecosystems based on its characteristics.
3. Analyze the concept of ecology of population and community based on its characteristics.
4. Discern about conventional and nonconventional energy resources.
5. Analyze the causes of various types of pollution and modes of management.
6. Distinguish the flora and fauna of various wildlife conservation regions.
7. Apply the concept of remote sensing in pollution evaluation and wildlife census.
8. Analyze EIA in various problematic regions.
9. Undertake steps to avert human wildlife conflict.

UNIT I - CONCEPTS OF ECOLOGY

1. Man and environment.
2. Abiotic components - atmosphere, temperature, light.
3. Law of Limiting factors – Leibig’s law, Sheldford’s law.
4. Species interaction - intraspecific and interspecific.
5. Climates of India and Indian monsoon.

UNIT II - ECOSYSTEM

1. Ecosystem – structure and function, primary production, energy flow, food web, food chain, ecological pyramids.
2. Terrestrial ecosystem - desert and grassland.
3. Aquatic ecosystem - fresh water – lentic and lotic.
4. Marine - stratification, intertidal shores and deep sea.
5. Estuarine ecosystem.

UNIT III - POPULATION ECOLOGY

1. Population ecology - characteristics, natality, mortality, population growth, regulation, demes and dispersal.
2. Community ecology - characteristics, patterns, significance of succession, climax concept.
3. Biographical zones of India.
4. Flora and fauna in India.
5. Conventional and non-conventional energy resources of India.

UNIT IV - POLLUTION ECOLOGY

1. Environmental pollution - air, water, land, radioactive and e-pollution.
2. Global warming and climate change.

3. Earth sustainable development.
4. Principles of remote sensing and its applications.
5. Disaster management - flood, earthquake, forest fire, tsunami.

UNIT V – BIODIVERSITY

1. Wildlife sanctuaries, National parks and Biosphere reserves in India.
2. Red list species and their conservation.
3. Human Wildlife conflict - Elephants - causes, reason and mitigation measures.
4. Environmental Impact Assessment.
5. Western Ghats and its significance.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Sharma P.D.** (2014). Ecology and Environment. Rastogi Publications., Meerut
2. **Verma PS and Agarwal VK** (2000) Environmental Biology- Principles of Ecology, S. Chand & Co Ltd, New Delhi.
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1. **Cox GW** (1997) Conservation Ecology - Concepts and application, Appleton Century Crofts, USA.
2. **Curtis LF and Barrett EC** (1992) Introduction to Environmental Remote Sensing, Springer, Netherlands.
3. **Dhawan, N.G. and Khan, A.S.** (2014). Disaster Management and Preparedness. CBS Publishers. New Delhi.
4. **Asthana, D.K. and Meera, A.** (2001). Environment – Problems and Solution. S. Chand and Company, New Delhi.
5. **Sharma, B.K. and Kaur, H.** (1997). An Introduction to Environmental Pollution. Goel Publishing House, Meerut.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME								
	1	2	3	4	5	6	7	8	9
Disciplinary Knowledge	√	√	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√	√	√
Problem Solving				√	√		√	√	√
Analytical Reasoning	√	√	√	√	√	√	√	√	√
Research Related Skills		√	√		√	√	√		√
Scientific Reasoning	√	√	√	√	√	√	√	√	√
Entrepreneurial Skills			√	√	√		√		
Reflective Thinking	√	√		√	√	√	√	√	√
Digital Literacy			√		√		√	√	
Leadership Readiness				√		√		√	
Moral and Ethical		√	√	√	√	√		√	√
Lifelong Learning	√		√	√	√	√		√	√
Multicultural Competence							√	√	√

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	II	21MZO23C	CORE PAPER VI: MOLECULAR GENETICS	5

COURSE LEVEL OUTCOMES

At the successful completion of this course, students will be able to

1. Discern the basic concept of gene and understand the regulation of gene expression.
2. Explain the organization and functions of genetic material.
3. Describe the transcription and regulation of gene expression in eukaryotes.
4. Apply the knowledge of genetics to reveal the human evolutionary history.
5. Know the population and microbial genetics.
6. Discuss the Hardy-Weinberg law and the factors affecting it.
7. Evaluate genomics and its laboratory applications.

UNIT I - GENE CONCEPT

Fine structure of genes; extra chromosomal inheritance of mitochondrial genes; gene mapping methods - linkage maps, mapping with molecular markers; DNA typing - basis of DNA typing, minisatellite analysis, polymerase chain reaction based analysis, short tandem repeat analysis, mitochondrial DNA analysis, Y chromosome analysis.

UNIT II - REGULATION OF GENE EXPRESSION

Transcription in eukaryotes - initiation, elongation and termination; epigenetic regulation - dosage compensation in mammals and drosophila; genetic imprinting - mechanism and model; catalytic and small RNAs - gene silencing; genetic basis of antibody diversity - germ line and somatic mutation hypotheses, antibody diversity; alternate pathways of transcript splicing.

UNIT III - HUMAN GENETICS

Karyotype and nomenclature of metaphase chromosome bands; chromosome anomalies and diseases - chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor); genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping; brief history of evolutionary genetics; Epistasis and the conversion of genetic variances - human and great ape genetic history.

UNIT IV – POPULATION AND MICROBIAL GENETICS

Populations, gene pool, Hardy-Weinberg law – genetic equilibrium, factors affecting Hardy-Weinberg equilibrium; calculation of gene frequencies for autosomal and sex linked genes; phenotypic and genotypic polymorphisms, transient polymorphism, balanced polymorphisms; methods of genetic transfer- transformation, conjugation, transduction and sex-duction.

UNIT V – GENOMICS

Organization and structure of genome; mapping genomes – physical maps, EST, SNPs as physical markers, FISH, optical mapping, gene maps, integration of physical and genetic maps; sequencing genomes; recognition of coding and noncoding regions and annotation of genes; base calling and sequence accuracy.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Snustad and Simmons.** (2005). Principles of Genetics, (4th Ed.) John Wiley & Sons, USA.
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1. **Benjamin Lewis** (2007). Genes IX, Jones and Bartlett Publishers, U.S.A.
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COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√
Problem Solving				√		√	√
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√	√	√		√
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills			√				
Reflective Thinking	√	√	√	√	√	√	√
Digital Literacy		√		√	√		√
Leadership Readiness				√			
Moral and Ethical Awareness		√		√	√		√
Lifelong Learning	√		√		√		
Multicultural Competence					√	√	

I M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	II	21MZO24E	ELECTIVE PAPER II: BIOSTATISTICS, BIOTECHNIQUES AND RESEARCH METHODOLOGY	5

COURSE LEVEL OUTCOMES

Upon completion of this course, the students will be able to

1. Discern the basic statistical methods.
2. Apply sorting, analytical, critical thinking and problem-solving skills in data handling.
3. Apply the tools and techniques available for the study of the biochemical and biophysical attributes of life.
4. Demonstrate knowledge of research processes (reading, evaluating and developing).
5. Differentiate and select the research process based on necessity.
6. Identify, explain, compare, and prepare the key elements of a research proposal/report.

UNIT I – BIOSTATISTICAL CONCEPTS

Measures of Central tendencies (Mean, Median, Mode), Measures of dispersion- (Standard deviation, Standard error), Probability (Binomial, Poisson and Normal),

Correlation, Regression, Student's 't' test, Chi-square test, Analysis of variance (ANOVA), DMRT

UNIT II – BIOTECHNICAL APPLICATIONS

RIA, PCR, RT-PCR.

Detection of molecules in living cells -FISH, GISH.

Principles and application of electrophoresis- Paper and Gel (PAGE AND SDSPAGE),

Gel Doc, GCMS, HPLC.

UNIT III - PHOTOMETRY

Microscopy- Electron microscope (TEM, SEM, STEM).

Colorimetry.

Spectrophotometry- Ultra violet (UV) spectroscopy, Nuclear magnetic resonance spectroscopy (NMR), Atomic absorption spectroscopy (AAS), Fourier Transform Infrared Spectroscopy (FTIR)

Flame photometry.

Biosensors.

UNIT IV – RESEARCH METHODOLOGY

Meaning of Research, Objectives, Motivation, Types of Research approaches, Significance of research

What is research problem, Selecting the problem, Necessity of defining the problem, Technique involved in defining problem.

Meaning of research design, Need of research design. Futures of good design

UNIT V - INTERPRETATION AND REPORT WRITING

Meaning of interpretation, why interpretation, Technique of interpretation, Precaution of interpretation, Significance of report writing, Different steps of report writing, Layout of research report, Types of report, Mechanics of writing research reports, Precautions of writing research report, Plagiarism, Citation, Citation Index (H-Index, i-10 Index, G-Index), Impact factor.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Gupta S.P.**, (2019). Statistical Methods. Sultan Chand & Sons, Educational Publishers, New Delhi.
2. **Arumugam N., Kumaresan V.**, (2015). Principles and Techniques of Biophysics. Saras Publication, Kanyakumari, Tamil Nadu.
3. **Kothari C.R.** (2008). Research Methodology (Methods and Techniques), New Age International (P) Limited, Publishers, New Delhi.

FURTHER READING

1. **S.M. Shukla and K.L.Gupta** (2017). Statistical Analysis. Sahitya Bhawan Publishers, New Delhi.
2. **Annadurai Pillai** (2007). A text book of biostatistics. New Age International Publishers.
3. **Shanti Bhushan Mishra and Shashi Alok** (2017). Hand book of research methodology. Educreation Publishers.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
Disciplinary Knowledge	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√
Problem Solving		√	√			√
Analytical Reasoning	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√
Scientific Reasoning	√	√	√	√		√
Entrepreneurial Skills			√			
Reflective Thinking	√	√	√	√	√	√
Digital Literacy		√	√		√	
Leadership Readiness			√	√		
Moral and Ethical		√		√		√
Lifelong Learning	√		√		√	
Multicultural		√				

I M.Sc. ZOOLOGY

Year	Sem .	Subject code	Paper Title	Hours / Week
2021-2022 onwards	II	21MZO25P	CORE PRACTICAL I (Includes Paper I: Animal Diversity, Paper II: Biosystematics and Evolution, Paper V: Environmental Biology, Paper III: Cell and Molecular Biology & Elective Paper I: Fishery Science)	5

COURSE LEVEL OUTCOMES

Upon completion of this practical course, students will be able to

1. Identify and discuss about diversity of prevalent specimens.
2. Identify and discuss on the diversity of Primates.
3. Observe and analyse the fauna of regions visited.
4. Analyze and determine the organic content of various water samples.
5. Discern and differentiate adaptive features of various categories of organisms.
6. Identify fishes from various habitats and analyse their characteristics.
7. Discern the various Biotechnical equipments and their function.

ANIMAL DIVERSITY

SPOTTERS limited to animal diversity-

Aurelia aurita, Ancylostoma duodenale, Hirudinaria granulosa, Panaeus indicus, Lamellidens marginalis, Cucumaria elongata, Poecilotheria striata, Hottentotta tumulus, Balanoglossus clavigerus, Petromyzon marinus, Anguilla vulgaris, Hyla arborea, Rhacophorus malabaricus, Naja naja, Bungarus caeruleus, Vipera russelli, Hydrophis annandalei, Tropidonotus quincunciatus, Eryx johnii, Psittacula eupatria, Passer domesticus, Ploecious philippinus, Eudynamis scolopaceus, Haliaster indus, Phoenicopiterus roseus, Bubo bubo, Platanista gangetica, Dugong dugon, Petaurista philippensis, Pteropus medius.

Field visit to shores of water bodies for observation and collection of samples.

Field Visit for observation and recording of birds.

BIOSYSTEMATICS AND EVOLUTION

Identification and collection of Indian fossils.

SPOTTERS

Lemur, Loris, Tarsier, Capuchin, Baboon, Macaque, Rhesus monkey, Nilgiri grey langur, Hoolock gibbon, Orangutan, Gorilla, Chimpanzee.

Visit to Ariyalur region.

Visit to museums.

ENVIRONMENTAL BIOLOGY

a. Determination of

i) Phosphate,

ii) Nitrite,

iii) Calcium,

- iv) Iron in water samples
- v) Total Dissolved Solids (TDS)
- vi) Total Alkalinity of Water Samples.
- b. Study of Soil Fauna.
- c. Study of adaptive features in Amphibia, Reptiles, Aves and Mammalia.
- d. Animal association – i) Parasitism, ii) Mutualism.

FISHERY SCIENCE

Identification of marine, brackish and inland fishes.
 Morphometric and meristic characters of fish.
 Analysis of gut contents.
 Length - weight relationship in freshwater fish and marine fish- calculation 'K' (Condition Factor).
 Study of fish blood (RBC, WBC, Hb).
 Study of scales by temporary mounting.
 Dissection of digestive system in relation to feeding habit.
 Induced breeding techniques- Demonstration only.

CELL & MOLECULAR BIOLOGY - SPOTTERS

- a. Dounce homogenizer
- b. Chromatography – HPLC
- c. Autoradiography
- d. Electrophoresis – SDS PAGE
- e. ELISA
- f. X-Ray Crystallography
- g. NMR
- h. Surface Plasmon Resonance (SPR).

REFERENCE BOOKS

1. **Pillay TVR.** 1990. Aquaculture- Principles and Practices. Fishing News Books Ltd., London.
2. **Conklin, A.R. Jr.,** (2004). Field Sampling: Principles and Practices in Environmental Analysis, CRC Press.
3. **Indian Council of Agricultural Research, ICAR** (2006). Handbook of Fisheries and Aquaculture, DIPA, New Delhi, INDIA

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Communication Skills							
Critical Thinking	√	√	√		√	√	√
Problem Solving							√
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√		√
Scientific Reasoning	√	√	√	√		√	√
Entrepreneurial Skills			√			√	√
Reflective Thinking	√	√		√	√	√	√
Digital Literacy					√		√
Leadership Readiness				√			
Moral and Ethical Awareness		√					
Lifelong Learning	√		√		√		√
Multicultural Competence							

I M.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	II	21MZO26P	CORE PRACTICAL II (Includes Paper IV: Animal Physiology, Paper VI: Molecular Genetics, & Elective Paper II: Biostatistics, Biotechniques and Research Methodology)	5

COURSE LEVEL OUTCOMES

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

1. Demonstrate a clear understanding of the fundamental concepts of Animal Physiology, Genetics, Biostatistics, Biotechniques and Research Methodology.
2. Explain techniques and applications of Animal Physiology, Genetics, and Biotechniques.
3. Distinguish gaps in research and try to remedy them.
4. Collect data using standard research methodologies, conduct experiments employing current techniques, and analyse the results obtained using Biostatistics, to propose feasible solutions.
5. Compile and meticulously convey the results obtained through experimentation and research in scientific forums.
6. Analyse current scientific problems, and resolve them.
7. Apply the expertise obtained in the principles and practice of Biotechniques, Genetics, Biostatistics and Animal Physiology towards employability in public and private sectors, entrepreneurial ventures or further research.

ANIMAL PHYSIOLOGY

Osmoregulation by weight change in crab.

Counting of blood cells – RBC, WBC, TC and DLC.

Determination of bleeding time and clotting time.

Influence of temperature on oxygen consumption of fish.

Identification of nitrogenous excretory products.

Determination of ammonia excreted by fish.

Determination of Na⁺ and Cl⁻ ions loss and gain in a freshwater fish.

SPOTTERS

Incubator

Centrifuge

Ultracentrifuge

pH meter

Microtome

Colorimeter

Spectrophotometer

Polymerase Chain Reaction

Gel Documentation System

GENETICS

Culture of *Drosophila*, sex identification, identification of mutants.

Mounting of salivary glands of *Chironomus* larva.

Isolation of DNA from squamous epithelial cells.

Pedigree analysis.

Human karyotyping and chromosomal abnormalities.

Identification of sex chromatin – Barr body.

BIostatISTICS

Collection of data and construction of frequency distribution.

Diagrammatic representation

Arithmetic mean

Mean deviation

Standard deviation and variance

Co-efficient of variation

Student's 't' test

Chi-square test

BIOTECHNIQUES (Demonstration Only)

Electrophoretic separation of serum proteins.

Chromatography – Two-dimensional chromatography

Paper chromatography

Photomicrography

RESEARCH METHODOLOGY

Steps in Thesis writing.

REFERENCES

1. **Keller G.** (2001). Applied Statistics with Microsoft Excel. Duxbury
2. **Shanti Bhushan Mishra and Shashi Alok** (2017). Hand book of research methodology. Educreation Publishers.
3. **Arumugam N., Kumaresan V.,** (2015). Principles and Techniques of Biophysics. Saras Publication, Kanyakumari, Tamil Nadu.
4. **Parameswaran R, Ananthasubramanian K.S,** (1989). Outlines of Animal Physiology. Viswanathan Pvt.Ltd.
5. **Monroe W Strickberger** (2012). Genetics 3rd Edition, Prentice Hall of India Pvt. Ltd.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Communication Skills	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√
Research-related Skills	√	√	√	√	√	√	√
Analytical Reasoning	√	√	√	√	√	√	√
Lifelong Learning	√			√			√
Scientific Reasoning	√	√	√	√	√	√	√
Self-directed Learning	√	√	√				√
Problem Solving	√	√	√	√	√	√	√
Career/Entrepreneurial Skills	√	√	√	√	√	√	√
Leadership Qualities			√	√	√	√	√
Digital Literacy	√	√	√	√	√	√	√
Moral and Ethical Awareness			√	√			
Multicultural Competence	√				√		√

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	III	21MZO31C	CORE PAPER VII: BIOCHEMISTRY	5

COURSE LEVEL OUTCOMES

Upon completion of this course, students will be able to

1. Elaborate on the structure, classification and biological importance of carbohydrates, proteins and lipids.
2. Relate the regulation of various metabolic pathways and metabolic disorders.
3. Collaborate the fundamental knowledge of enzymes, coenzymes with their role in biological reactions.
4. Elucidate the biological importance of vitamins, minerals and antioxidants.
5. Explain the metabolism of carbohydrates.
6. Describe the mechanism of protein and nucleic acids.
7. Contrast the synthesis and metabolism of lipids.
8. Undertake a career in biochemistry in the form of teaching and research.

UNIT I – CARBOHYDRATES

1. Classification- structure and functions of Glucose, Ribose, Sucrose and Starch.
2. Glycolysis, TCA cycle and HMP pathway.
3. Glycogenesis, glycogenolysis and gluconeogenesis.
4. Biological oxidation, electron transport system and oxidative phosphorylation.
5. Diabetes mellitus and glycogen storage diseases.

UNIT II - PROTEINS AND NUCLEOTIDES

1. Amino acids – classification and properties.
2. Proteins: structure and biological significance.
3. Transamination, Deamination and Urea cycle.
4. Structure, biosynthesis and degradation of purines and pyrimidines.
5. Phenylketonuria, Hyperuricemia and Gout.

UNIT III - LIPIDS

1. Classification and biological significance.
2. Fatty acids: structure – classification.
3. Biosynthesis and oxidation of fatty acids.
4. Biosynthesis and degradation of cholesterol.
5. Fatty liver, Hypercholesterolemia.

UNIT IV - ENZYMES

1. Nomenclature and classification.
2. Enzyme specificity and mechanism of enzyme action.
3. Factors influencing enzyme activity and enzyme kinetics.
4. Enzyme inhibition.
5. Co-enzymes and Isoenzymes.

UNIT V - VITAMINS AND MINERALS

1. Fat soluble vitamins.
2. Water soluble vitamins.
3. Biological functions of macro-minerals.
4. Biological functions of micro-minerals.
5. Free radicals and Antioxidants.

REFERENCES

1. **Satyanarayana, U. and Chakrapani, U.** (2013). Text book of Biochemistry. Elsevier India Pvt. Ltd.
2. **Lehninger, A.L.** (2004). Principles of Biochemistry. CBS Publishers, New Delhi.
3. **Agarwal, R.A. and Anil K. Srivastava and Kaushal Kumar.** (2002). Text book of Animal Physiology and Biochemistry. S. Chand & Company Ltd. New Delhi.
4. **Robert Harper's** Biochemistry, (1996). 24th Edition.
5. **Veerakumari K** (2002). Biochemistry, MJP Publishers, Chennai

FURTHER READING

1. **Thomas M Devlin** (1982). Textbook of Biochemistry – with clinical correlations. John Wiley & Sons.
2. **Pankaja Naik** (2017). Essentials of Biochemistry. Jaypee Brothers Medical Publishers, Meerut.
3. **Ambika Shanmugam** (2016). Fundamentals of Biochemistry for Medical students. 8th Ed. Wolters Kluwer India Pvt. Ltd.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME							
	1	2	3	4	5	6	7	8
Disciplinary Knowledge	√	√	√	√	√	√	√	
Critical Thinking	√	√	√		√	√	√	√
Problem Solving		√		√				√
Analytical Reasoning	√	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√		√
Scientific Reasoning	√	√	√	√	√	√	√	√
Entrepreneurial Skills			√					√
Reflective Thinking	√	√	√	√	√	√	√	√
Digital Literacy		√			√			√
Leadership Readiness				√				
Moral and Ethical Awareness		√		√				√
Lifelong Learning	√		√		√	√		

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	III	21MZO32C	CORE PAPER VIII: DEVELOPMENTAL BIOLOGY	5

COURSE LEVEL OUTCOMES

Upon completion of this course, the students will be able to

1. Elucidate the basic concepts of Developmental Biology in animals.
2. Analyze the experimental aspects of Developmental Biology.
3. Elucidate the different types of fertilization in Invertebrates and Vertebrates.
4. Discuss the concept of cell commitment in determination and differentiation of development.
5. Describe the differentiation of organ systems as well as various reproductive techniques
6. Summarize the achievements of reproductive technology for Human welfare.

UNIT I - GAMETOGENESIS AND FERTILIZATION

Primordial Germ Cell (PGC) - determination and migration in insects (*Drosophila*) and mammals.

Spermatogenesis in mammals.

Oogenesis in mammals.

External fertilization in Sea urchin.

Internal fertilization in mammals.

UNIT II - CLEAVAGE AND GASTRULATION

Patterns of embryonic cleavage.

Cleavage and blastula formation in *Caenorhabditis elegans*, amphibia and birds.

Gastrulation and specification of germ layers in *Caenorhabditis elegans*, amphibia and birds.

Morphogenetic movements.

Pattern of development in *Drosophila*.

UNIT III - TISSUE DIFFERENTIATION AND ORGANOGENESIS

Neurulation and the formation of neurula.

The primary differentiation of mesoderm and endoderm.

The ectodermal derivation in vertebrates - development of the brain and differentiation of neurons.

The mesodermal derivatives in vertebrates - development of limbs.

The endodermal derivatives in vertebrates - development of the alimentary canal and its accessory organs.

UNIT IV - INDUCTION, COMMITMENT AND FATE MAP

Genomic equivalence - concept and evidence (cloning of sheep).

Genomic imprinting and DNA methylation.

Induction and Competence - induction of lens in amphibians, Induction of vulva in *C. elegans*.

Levels of cell commitment - specification (autonomous conditional - morphogenetic gradients, syncytial).

Determination and Differentiation.

Fate map (amphibia) and cell lineage.

UNIT V - DEVELOPMENTAL BIOLOGY AND HUMAN WELFARE

Ecological regulation of development - life cycle of *Dictyostelium discoideum*. Teratogenesis in human development - environmental and genetic.

Twins and chimeras.

Assisted reproductive technology (ART) in man - Artificial Insemination (AI), *In vitro* Fertilization (IVF), Embryo Transfer (ET), Gamete Intra-Fallopian Transfer (GIFT) and Zygote Intra-Fallopian Transfer (ZIFT).

Cryopreservation of gametes and embryos.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. Verma P.S and Agarwal V.K (2014). Chordate Embryology. S. Chand & Co.
2. Balinsky B.I. (2012). An Introduction to Embryology. Centage Learning, India.
3. Richard M. Twyman (2001). Instant Notes - Developmental Biology. BIOS Scientific.
4. Berrill N.J. (1971). Developmental Biology. McGraw Hill Inc., USA.

FURTHER READING

1. Scott F. Gilbert (2020). Developmental Biology, Tenth Edition, Sinauer Associates, Inc.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
Disciplinary Knowledge	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√
Problem Solving		√		√		
Analytical Reasoning	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√
Scientific Reasoning	√	√	√	√	√	√
Entrepreneurial Skills			√			√
Reflective Thinking	√	√		√	√	√
Digital Literacy					√	√
Leadership Readiness				√		
Moral and Ethical Awareness		√	√		√	√
Lifelong Learning	√		√		√	
Multicultural Competence						√

II M.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	III	21MZO33C	CORE PAPER IX - MICROBIOLOGY	5

COURSE LEVEL OUTCOMES

On the successful completion of the course, students will be able to:

1. Summarize the vast scope of microbiology and the diversity of the microbial world.
2. Explain the processes of bacterial culture and growth, and the mechanisms to control microbes.
3. Discuss the importance of microorganisms in maintaining soil fertility, their crucial role in the biogeochemical cycles, their role as indicators of aquatic and air pollution.
4. Infer the significance of microbes as causative organisms of food and dairy spoilage, consequent diseases, methods to preserve food, and regulations to maintain quality.
5. Elucidate the types and mode of action of probiotics.
6. Illustrate and differentiate the pathogenesis and virulence of medically important microbes.
7. Describe the vital contribution of microbes to industry and agriculture.
8. Develop insight to review the crucial role of microbes in environmental sustainability through bioremediation, and the contribution of GMOs.
9. Detail the importance of Intellectual Property Rights in patenting microbial gene sequences / microbial products, and extrapolate this knowledge for further research, entrepreneurship, and career prospects.

UNIT I - SCOPE, CLASSIFICATION, FUNGI, VIRUSES AND EXTREMOPHILES

1. Scope of microbiology - Classification of microbes – Five kingdom concept.
2. Yeasts and Fungi – Characteristics - Diseases caused - Economic importance - *Ganoderma*.
3. Pathogenesis of viruses - Host and virus factors involved - Host cell transformation by viruses and oncogenesis of DNA and RNA viruses - Structure, genomic organization, pathogenesis and control of Human Immunodeficiency Virus - Emerging viruses (Nipah, SARS-CoV-2)
4. Extremophiles - distribution, abundance, ecological niche – Types (Bacterial, Archaeal and Eucaryal) – Thermophiles, commercial aspects of thermophiles, applications of thermozymes – Methanogens - Alkalophiles and Acidophiles, applications - Halophiles and Barophiles, Applications of halophiles and their extremozymes.

UNIT II – BACTERIA, BACTERIAL GROWTH AND CONTROL OF MICROBES

1. Bacteria – Classification – Structure – Reproduction – Economic importance.
2. Bacterial Growth: Mathematical expression of growth - Generation time – Growth curve - Growth as affected by environmental factors (temperature, pH, oxygen, carbon and nitrogen sources).
3. Control of microbes – Sterilization – Disinfection – Chemotherapy – Antisepsis – Mode of action of antimicrobial agents.

4. Antibiotics - Classification - Biological action of antibiotics - Bacterial resistance to antibiotics.

UNIT III – SOIL, AQUATIC AND AEROMICROBIOLOGY

1. Soil microbiology – Soil microbes – Nitrogen fixation – *nif* genes – CO₂ fixation and regeneration – degradation of cellulose and lignin (Role of *Phanerochaete chrysosporium*) – Syntrophism. Microorganisms in sulfur, phosphorus and iron cycles.
2. Biohydrometallurgy - Microbiology of leaching of sulfide minerals - Applications of bioleaching techniques.
3. Aquatic microbiology – Aquatic pollution and sources – Aquatic microbes – Importance – Microbiology of domestic and waste water – Purification methods – Waste water treatment – Water quality testing.
4. Microbiology of Air - Distribution of microorganisms in air – Aeroallergens.

UNIT IV – FOOD, DAIRY AND MEDICAL MICROBIOLOGY

1. Food microbiology – Food microbes and sources – Examination – Food spoilage – Food poisoning – Prevention of food poisoning – Food preservation – Mechanism of action and uses of probiotics (*Lactobacillus*, *Bifidobacterium*, *Saccharomyces*).
2. Dairy microbiology – Microorganisms – Bacteriological examination – Milk borne diseases – Milk preservation – Pasteurization – Sterilization – Dehydration.
3. Microbiological quality standards of food - Government regulatory practices and policies - FDA, EPA, HACCP, ISI.
4. Medical microbiology – Microbial Diseases & Disease reservoirs – Pathogenesis, virulence, infection and epidemiology of Diphtheria, Tuberculosis, Cholera, Typhoid, Syphilis and Leprosy - Diseases transmitted by animals (Rabies, Plague).

UNIT V – INDUSTRIAL AND AGRICULTURAL MICROBIOLOGY, BIOREMEDIATION, GMO's AND IPR

1. Industrial microbiology – Fermentation technology – Vinegar – Production of Lactic acid – Amino acids – Hormones – Antibiotics.
2. Agricultural microbiology – Biofertilizers – Rhizobium – Azotobacter – BGA – VAM fungi – Azolla – Biopesticides – Silage.
3. Bioremediation of Xenobiotics - Microbiology of degradation of xenobiotics - decay behaviour - Biomagnification and degradative plasmids – Petroleum hydrocarbons (*Pseudomonas fluorescens*), oil pollution, surfactants and pesticides.
4. Genetically Modified Organisms released - Environmental impact assessment - Ethics.
5. Intellectual Property Rights (IPR) - Patents, Trademarks, Copyrights, Secrets, implication of patenting - Patenting of genes and DNA sequences.

Visit to laboratories and industries.

REFERENCES:

1. **Arumugam N, Mani A, Selvaraj AM, Narayanan LM** (2014). Microbiology. Saras Publications.
2. **Ananthanarayanan K & Panickar CKJ** (1988). Textbook of Microbiology, 3rd Edition.
3. **Dubey RC & Maheswari DK** (2004). Textbook of Microbiology. S. Chand & Co. Ltd., New Delhi.
4. **Pelczar MJ, Chan ECS & Krieg NR** (2001). Microbiology. McGraw-Hill, New York.

FURTHER READING

1. **Burrows W & Freeman B** (1985). Burrow's Textbook of Microbiology, 22nd Edition. Igaku-Sholin-Saunders International Edition.
2. **Dimmock NJ & Primrose SB** (1994). Introduction to Modern Virology. 4th Edition. Blackwell Scientific Publications, Oxford.
3. **Johri BN** (2000). Extremophiles. Springer Verlag, New York
4. **Baker KH & Herson DS** (1994). Bioremediation. MacGraw Hill Inc., NY.
5. **Wacekett LP & Hershberger CD** (2000). Biocatalysis and Biodegradation: Microbial Transformation of Organic Compounds. ASM Publications.
6. **Yadav M, Meenu M, Sehrawat N & Sharma AK** (2019). Intellectual Property Rights in Microbiology. In: Singh H, Keswani C, Singh S (eds) Intellectual Property Issues in Microbiology. Springer, Singapore. https://doi.org/10.1007/978-981-13-7466-1_4

USEFUL LINKS

1. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/ganoderma>
2. <https://www.who.int/news-room/fact-sheets/detail/nipah-virus>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7165108/>
4. <https://academic.oup.com/femsre/article/20/3-4/591/517205>
5. <https://www.researchgate.net/profile/Steven-Ripp/publication/12467700>

PEDAGOGY STRATEGIES

- Board and chalk lecture
- Powerpoint slide presentations
- Visit to laboratories and industries
- Online and offline class practical
- Assignment
- Seminar
- Group discussion
- Quizzes

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME								
	1	2	3	4	5	6	7	8	9
Disciplinary Knowledge	√	√	√	√	√	√	√	√	√
Communication Skills	√	√	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√	√	√
Research-related Skills		√	√	√	√	√	√	√	√
Analytical Reasoning		√	√	√	√	√	√	√	√
Lifelong Learning	√	√	√	√	√	√	√	√	√
Scientific Reasoning		√	√	√	√	√	√	√	√
Self-directed Learning		√	√	√	√	√	√	√	√
Problem Solving		√	√	√	√	√	√	√	√
Entrepreneurial Skills	√	√	√	√	√	√	√	√	√
Leadership Qualities		√	√	√	√	√	√	√	√
Digital Literacy	√	√	√	√	√	√	√	√	√
Moral and Ethical Awareness			√	√				√	√
Multicultural Competence	√				√		√	√	√

II M. Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	III	21MZO34E	ELECTIVE PAPER III - GENERAL ENTOMOLOGY	5

COURSE LEVEL OUTCOMES

At the completion of this course, students will be able to

1. Describe the diversity of insects.
2. Identify the different orders of insects with taxonomy.
3. Undertake collection, identification and preservation of insects.
4. Distinguish the winged and wingless insects.
5. Describe the structure and functions of different systems of insects.
6. Elucidate the process and role of metamorphosis of insects.
7. Elaborate on the nervous coordination and light emitting properties of insects.
8. Discern the application of knowledge of endocrine physiology of insects.

UNIT I - INSECT TAXONOMY

1. Origin and evolution of Insects.
2. Scope and branches of entomology.
3. Collection, mounting and preservation of insects.
4. Outline classification of Class Insecta upto order level.
5. Salient features with examples of the insect Orders - Thysanura, Odonata, Orthoptera, Coleoptera, Diptera, Hymenoptera, Lepidoptera, Hemiptera.

UNIT II - INSECT MORPHOLOGY

1. Integument -Epidermis, basement membrane, cuticle, moulting mechanism.
2. Head - Orientation, sutures, eyes, antennae, mouth parts and types.
3. Thorax - Segmentation, tergum, sternum, pleuron, legs and modifications.
4. Wings - Structure and modification, venation, coupling apparatus, mechanism of flight.
5. Abdomen - Segmentation, modification and genital structures.

UNIT III - INSECT PHYSIOLOGY

1. Digestive system - Alimentary canal, digestive glands, physiology of digestion, types of feeding.
2. Respiratory system - tracheal system, mechanism of gaseous exchange and ventilation, respiration in aquatic insects,
3. Circulatory System - Pumping organs, Circulation, Chemical composition of haemolymph, Structure and functions of haemocytes.
4. Excretory System - organs, excretory products, mechanism of excretion, salt and water balance.

UNIT IV - MUSCULAR, NERVOUS AND ENDOCRINE SYSTEMS

1. Muscular System - skeletal muscles, visceral muscles, energetics of muscle contraction.
2. Reproductive system - male and female reproductive organs, insemination and fertilization, Oviposition.

3. Exocrine glands - glands secreting useful products, defense glands, pheromone glands, salivary glands, accessory reproductive glands.
4. Endocrine glands - neurosecretory cells, corpus cardiacum, corpus allatum, ecdysial glands, ring glands, structure and functions of hormones,

UNIT V - NERVOUS COORDINATION

1. Nervous System - structure of neurons, Central, Visceral and Peripheral nervous systems, Physiology of nervous system.
2. Sense organs - Mechanoreceptors, Chemoreceptors, Photoreceptors, Auditory receptors and Thermoreceptors.
3. Metamorphosis - division, hormonal control of metamorphosis, ecdysis,
4. Bioluminescence - distribution and structure of bioluminescence organs, mechanism of light production, significance.
5. Sound production - mechanisms and significance.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

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1. **Rajendra Singh** (2010). Elements of Entomology, Rastogi Publishing, Meerut.
2. **M. S. Mani** (1982). General Entomology. Oxford & IBH Publishing Co, Delhi.
3. **Ambrose DP** (2004). The Insect Structure, Function and Biodiversity, Kalyani Publications, New Delhi.
4. **Chapman RF, Simpson SJ and Douglas AE** (2012). The Insects: Structure and Function, Fifth edn., Cambridge University Press, London.
5. **O.W. Richards and R.G. Davies** (2014). Imm's General Textbook of Entomology. Springer.

FURTHER READING

1. **Nayar K. K, T.N. Ananthakrishnan and B.V. David.** (1983). General and Applied Entomology, Tata McGraw Hill publishing Co. Ltd., New Delhi.
2. **Imms, A.D** (1972). Text Book of Entomology. Volume. I & II Ed. by Richard & Owen. ELBS
3. **Robert E. Snodgrass** (1935). Principles of Insect Morphology. McGraw Hill Book Co. Inc. New York.
4. **Vincent B. Wigglesworth** (1972). The Principles of Insect Physiology. Springer, London.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME							
	1	2	3	4	5	6	7	8
Disciplinary Knowledge	√	√	√	√	√	√	√	√
Critical Thinking	√	√	√	√	√	√	√	√
Problem Solving		√	√			√		√
Analytical Reasoning	√	√	√	√	√	√	√	
Research Related Skills	√	√	√		√			√
Scientific Reasoning	√	√	√	√	√	√	√	√
Entrepreneurial Skills			√					√
Reflective Thinking	√	√	√	√	√	√	√	√
Digital Literacy				√	√	√		
Moral and Ethical Awareness	√	√	√		√			√
Lifelong Learning	√		√		√	√		√

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	IV	21MZO41C	CORE PAPER X: BIOTECHNOLOGY AND GENETIC ENGINEERING	5

COURSE LEVEL OUTCOMES

After completion of the course, students will be able to

1. List the specific applications of the plethora of enzymes and vectors employed in the genetic engineering process.
2. Compare of the prokaryotic and eukaryotic cells as hosts (advantages and limitations).
3. Describe the various techniques employed in the isolation and purification of DNA (genomic and plasmid), gene transfer, gene synthesis, gene amplification, gene sequencing and in the construction of genomic and cDNA libraries.
4. Critically analyze the current advanced techniques in protein engineering, detection of DNA-protein interaction, detection of protein-protein interaction and genome editing.
5. Interpret the concepts of genomics, genome mapping (genetic and physical mapping) and genome sequencing.
6. Discuss proteomics, protein separation technique, protein characterization technique, protein identification technique and protein sequencing technique,
7. Evaluate the applications of biotechnology in diagnostics, therapeutics and forensics.
8. Explain the various aspects of animal reproductive biotechnology.
9. Infer the role of biotechnology in the production of transgenic animals.

UNIT I: MOLECULAR TOOLS IN GENETIC ENGINEERING

Cutting and Joining Enzymes – Restriction endonucleases, DNA ligase; Homopolymer tailing, Linkers, Adaptors; Modifying Enzymes – DNA Polymerase, Klenow enzyme, Reverse transcriptase, Alkaline phosphatase, Terminal transferase, Polynucleotide kinase, Methylase; Vectors for Prokaryotic cells – Plasmid vector, Bacteriophage vector, Cosmid vector, Bacterial artificial chromosome vector (BAC); Vectors for Eukaryotic cells – Yeast artificial chromosome vector (YAC), Animal viral vector, Shuttle vector; Host Cells – Advantages and Limitations of Prokaryotic cells and Eukaryotic cells.

UNIT II: TECHNIQUES IN GENETIC ENGINEERING

Methods in the isolation and purification of DNA (genomic and plasmid); Methods of Gene Transfer – Transformation, Transduction, Electroporation, Liposome mediated gene transfer, Microinjection,

Particle bombardment; Gene Synthesis – Chemical synthesis (Phosphoramidite method); Gene Amplification – PCR technique, variants and applications; DNA Sequencing – Basic sequencing methods - Sanger Coulson method, Next generation sequencing (NGS) methods- Pyrosequencing; Gene Libraries – genomic library, cDNA library.

UNIT III: ADVANCED TECHNIQUES IN GENETIC ENGINEERING

Protein Engineering–Site-directed mutagenesis; Techniques to detect DNA-Protein Interaction – Electrophoretic mobility shift assay (EMSA), DNA Footprinting; Techniques to detect Protein-Protein Interaction – Coimmunoprecipitation, Yeast Two hybrid system; Genome Editing Techniques – Zinc finger nucleases (ZFNs), Transcription activator-like effector nucleases (TALENs), Clustered regularly interspaced short palindromic repeats (CRISPRs).

UNIT IV: GENOMICS AND PROTEOMICS

Genomics- Basic Concept; Genome mapping - Genetic mapping and Physical mapping, Markers for genetic mapping, Techniques in Physical mapping - Restriction mapping, Radiation hybrid mapping, Sequence tagged site mapping; Genome sequencing - clone-by-clone genome sequencing method, whole genome shotgun method. Proteomics – Basic Concept; Protein separation technique - 2D-PAGE; Protein characterization technique - MALDI-TOF Mass spectrometry; Protein identification technique - Peptide mass fingerprinting (PMF); Protein sequencing technique - Edman degradation, Tandem mass spectrometry.

UNIT V: MEDICAL BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Diagnostics – Molecular Probes, Enzyme linked immunosorbent assay (ELISA), RT-PCR, DNA microarray, DNA Hybridization- Fluorescent *in situ* hybridization technique; Therapeutics – Monoclonal antibodies (mABs), Recombinant vaccines-COVID 19 vaccine; Gene Therapy – *ex vivo*, *in vivo*, Anti gene therapy, Antisense therapy; Forensics – DNA fingerprinting.

Animal reproductive biotechnology –super ovulation, artificial insemination, *in vitro* fertilization, embryo recovery, culture of embryos, cryopreservation of embryos, embryo transfer technology; Transgenic Animals – Transgenic fish, Transgenic mouse - Knockout mice, Applications.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion

- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Sathyanarayana, U.** (2018) Biotechnology, 1st Edition. *Books & Allied (P) Ltd.*
2. **Ignacimuthu, S.J.** (2008). Biotechnology: An Introduction. Alpha Science International Ltd.
3. **Dubey, R.C.** (2014). A Text book of Biotechnology. S. Chand & Co., New Delhi.
4. **Primrose, S.B. and Twyman, R.M.** (2006). Principles of Gene Manipulation, 7th Edition. Blackwell Scientific Publishers, Oxford.
5. **Pepplerand, H.J. and Perlman, D.** (2004). Microbial Technology. Academic Press.
6. **Benjamin Lewin** (1990). Genes-VII. Oxford University Press.
7. **Liebler, D. C.** (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.

FURTHER READING

1. **Campbell, A. M., & Heyer, L. J.** (2003). Discovering Genomics, Proteomics, and Bioinformatics. Cold Spring Harbor Laboratory Press and Benjamin Cummings.
2. **Green, M. R. and Sambrook, J.** (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. **Brown, T. A.** (2006). Genomes (3rd ed.). New York: Garland Science Pub.
4. **Gordon, I.** (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
5. **Levine, M. M.** (2004). New Generation Vaccines. New York: M. Dekker.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME								
	1	2	3	4	5	6	7	8	9
Disciplinary Knowledge	√	√	√	√	√	√	√	√	√
Communication Skills		√							
Critical Thinking	√	√	√	√	√	√	√	√	√
Problem Solving		√		√				√	
Analytical Reasoning	√	√	√	√	√	√	√	√	√
Research Related Skills		√	√	√	√		√		√
Scientific Reasoning	√	√	√	√		√	√	√	√
Entrepreneurial Skills			√	√	√		√	√	√
Reflective Thinking	√	√		√	√	√	√		√
Digital Literacy			√		√		√	√	
Moral and Ethical		√		√					√
Lifelong Learning	√		√		√	√		√	√

II M. Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	IV	21MZO42C	CORE PAPER XI: IMMUNOLOGY	5

COURSE LEVEL OUTCOMES

Upon completion of this course, students will be able to

1. Explain the basic mechanisms of innate and adaptive immunity.
2. Describe the molecular basis behind cellular processes involved in inflammation and immunity.
3. Employ immune system for successful treatment and explore the strategies of monoclonal antibodies and vaccines.
4. Apply the immunological concepts to design experiments and interpret results.
5. Detail the Immunological methods to treat immunodeficiency diseases.
6. Discern the mechanisms for undertaking compatible tissue transplantation.
7. Elaborate on how immune system fights infections and cancer.

UNIT I - IMMUNITY, ORGANS AND CELLS OF THE IMMUNE SYSTEM

Types of immunity: Innate and Acquired – Humoral immunity and Cell mediated Immunity: Central and Peripheral Lymphoid Organs. Thymus, Bone marrow, Spleen, Lymph nodes and other Peripheral lymphoid tissue - GALT. Cells of the immune system – Detailed aspects of T-cell and B-cell, Macrophages, Phagocytes, NK cells, T cell and B cell receptor and function. Complement system – mode of activation- Classical, Alternate and Lectin pathways, biological functions.

UNIT II - ANTIGEN, ANTIBODY AND ITS REACTIONS

Antigens: Types, Properties, Haptens, Epitopes, Adjuvants, Auto antigens, Blood group antigens. Immunoglobulin structure, Types, Properties and Function. Theories of antibody production - Clonal selection theory, Antibody diversity. Factors governing Antigen – Antibody interactions - Affinity, Avidity, Valency, Cross reactivity. Agglutination, precipitation, complement fixation. Immunofluorescence, ELISA and RIA.

UNIT III - T & B CELLS MATURATION, ACTIVATION AND DIFFERENTIATION AND MHC MOLECULES

T & B cells - maturation, activation and differentiation - T & B cell cooperation - superantigens - T independent B cell activation - cytokines and cytokine receptors. Hybridoma Technology and Monoclonal Antibodies. Interferons (IFN), Interleukins and its types. General organization, genes, inheritance, molecules, immune responsiveness and Types of MHC molecules and disease susceptibility.

UNIT IV - HYPERSENSITIVITY REACTIONS, AUTOIMMUNITY AND IMMUNODEFICIENCY DISEASES

Gell and Coombs classification - Hypersensitivity reactions – Ig E mediated (Type I), Antibody mediated (Type II), immune complex mediated (Type III), Cell mediated (Type IV). Organ specific and systemic autoimmune diseases - mechanisms - treatment of autoimmune diseases. Primary immunodeficiencies - defects in lymphoid lineage, 35 myeloid lineage and complement systems - treatment of immunodeficiency - AIDS and other acquired or secondary immunodeficiencies.

UNIT V - TRANSPLANTATION AND TUMOUR IMMUNOLOGY

Transplantation -Types, immunological mechanisms of graft rejection- immunological strategies to prevent graft rejection-role of immunosuppressive drugs. General and specific immunosuppressive therapy -Tumour antigens, Tumours of the immune system -oncogenic viruses, Immune response to tumours, tumour evasion of the immune system - cancer immunotherapy.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- -content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Goldsby. R.A, Kindt.T.J, Kuby J and Osborne BA** (2013). Immunology, 7 th Eds. W.H. Freeman Publication.
2. **Rastogi.S.C.** (2010). Elements of Immunology. CBS Publishers and Distributors.
3. **Roitt I.M., Brostoff. J, Male. D.K., Roth** (2012). Immunology, Student consult. International 8th Edition., Elsevier Ltd.
4. **Janeway Travers** (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York. 3rd ed.

FURTHER READING

1. **Peter J. Delves and Ivan M. Roitt** (1998). Encyclopaedia of Immunology; Academic Press. 2nd Ed.
2. **Chapel H and Halbey M** (1986). Essentials of Clinical Immunology. ELBS.
3. **Noel R. Rose, Herman Friedman, John L. Fahey** (1986). Manual of Clinical Laboratory Immunology. ASM. 3rd ed.
4. **Pravash Sen. Gupta** (2003). Clinical Immunology. Oxford University Press.
5. **Darla J. Wise and Gordon Carter** (2010). Immunology. Wiley–Blackwell.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking	√	√	√		√		√
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√		
Scientific Reasoning	√	√	√	√		√	√
Entrepreneurial Skills			√				
Reflective Thinking	√	√		√	√		√
Digital Literacy					√		
Leadership Readiness				√			
Moral and Ethical Awareness		√					
Lifelong Learning	√		√		√		

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the paper	Hours/Week
2021 – 2022 Onwards	IV	21MZ043C	CORE PAPER – XII ENDOCRINOLOGY	5

COURSE LEVEL OUTCOMES

On the successful completion of the course, students will be able to:

1. Discern the structure and function of endocrine glands as well as understand endocrine disorders, metabolic regulations, and metabolic abnormalities, and their management.
2. Describe the synthesis and modes of secretion of hormones.
3. Differentiate among endocrine, paracrine and autocrine systems.
4. Apply endocrinological principles to determine the pathophysiological basis and consequences of specific endocrine disorders.
5. Relate the roles of the endocrine system in maintaining homeostasis.
6. Integrate growth and development, response to environmental insults and promote successful reproduction.
7. Analyse the integrative workings of the human body through the signalling system.

UNIT – I INVERTEBRATE & VERTEBRATE ENDOCRINOLOGY

Introduction to Endocrinology – Scope, Objectives and Modern Concept of neurosecretion – Endocrine control of growth and reproduction in Annelids - Endocrine mechanism in Mollusca – Moulting, Metamorphosis in Crustaceans and Insects – Hormonal role of insect diapause. Animal Hormones – Exocrine, Endocrine, Heterocrine glands and their secretion – Kinds of Hormones, Properties of Hormones and Mode of Action - Summary of Endocrine Glands and Biological functions.

UNIT – II MICROBIAL ENDOCRINOLOGY

Common Cold - Cold induced Endocrine Hormones – Hormones and Breathing – Respiratory Stimulants - SARS -CoV-2 - Endocrine disturbance of Coronavirus – Adrenal insufficiency – Types, Adrenal crisis -Psycho – neuroendocrine interaction - Catecholamine stress hormone – Adrenaline, Cortisol, Norepinephrine - Hormonal changes during Stress – Effect of Stress and Stress Management - Endocrine Tumour Syndromes – Vaccines against endogenous hormones.

UNIT – III HUMAN ENDOCRINOLOGY

Structure and Biological Significance of Pituitary, Thyroid, Parathyroid, Adrenal, Thymus and Islets of Langerhans -Neuroendocrinology – Role of Auto receptors, oxytocin receptors, vasopressin receptors and ‘population signal’. Pituitary disorders – Hormonal Risk in Cardiovascular system - Complementary or Antagonistic actions. (Renin-angiotensin-aldosterone and estrogen alone or combined with progesterone, testosterone) - Thyroid disorders – Hypocalcaemia tetany and Diabetes Mellitus.

UNIT –IV GASTRO ENDOCRINOLOGY

Enteroendocrine Cells – Gastrin, Secretin, Cholecystokinin, Leptin and GIP – Biological functions of Prostaglandins and Cytokines - Steroids and Hormone Abuse - Synthesis of Steroid Hormones - Adrenal corticosteroids and Sex steroids - Gonads - Progestin’s, Androgens, Oestrogen’s. Anti – ageing Hormone - melatonin, growth hormone, testosterone, and dehydroepiandrosterone (DHEA) –

Obesity and Overweight – Hormonal regulations of Obesity -Anorexia and Nutrition – Hormone Replacement Therapy (HRT).

UNIT – V REPRODUCTIVE ENDOCRINOLOGY

Structure and Biological functions of Hormones; estrogen and progesterone in women and testosterone in men – Disorders due to Hypo and Hyper secretion of Sex Hormones – Violent and Criminal behaviour of Male Sex Hormones - Primary reproductive glands - ovaries in women and testes in men - Hormonal signals from the pituitary gland; luteinizing hormone (LH) and follicle stimulating hormone (FSH) - Hormonal Contraception - Placental Hormones – Prolactin in Pregnancy - Gender identity and TGNB Hormones.

PEDAGOGY STRATEGIES

1. Board and Chalk Lecture
2. PowerPoint Slide Presentation
3. Seminar
4. Assignments
5. Online and Offline Class Practicals
6. E-content

REFERENCES

1. **William's** Textbook of Endocrinology (2015). 13th Edition.
2. **Greenspan's** Basic and Clinical Endocrinology, 10th Edition by David Gardner; Dolores Shoback.
3. **Bentley, P. J** (1966). Comparative Vertebrate Endocrinology., Cambridge University Press, UK
4. **Norris D. O.** (1978). Vertebrate Endocrinology. Elsevier Academic Press.

FURTHER READING

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2. **Ian Orchard, Angela B. Lange & A S M Saleuddin (Eds.)** (2018). Advances in Invertebrate (Neuro) Endocrinology: A collection of Reviews in Post Genomic Era, Vol. 2. Apple Academic Press
3. **Madhu Thapliyal & Ashish Thapliyal** (2020). Endocrinology - Introduction to Endocrinology. Dymocks online bookstore.
4. **Brown R.,** (1994). An Introduction to Neuroendocrinology, Cambridge University Press, Cambridge, UK.

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2. <https://www.labster.com/simulations/endocrinology/>
3. http://www.freebookcentre.net/medical_text_books_journals/endocrinology_ebooks_online_texts_download.html
4. <https://www.qldscienceteachers.com/junior-science/biology/experiments/endocrine-system>

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Communication Skills				√		√	
Critical Thinking	√	√	√	√	√	√	√
Problem Solving		√		√		√	
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√	√	√	√	√
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills						√	
Reflective Thinking	√	√	√	√	√	√	√
Digital Literacy				√	√	√	
Moral and Ethical		√	√		√	√	
Lifelong Learning	√		√		√		
Multicultural Competence						√	

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	IV	21MZO44E	ELECTIVE PAPER IV - APPLIED ENTOMOLOGY	5

COURSE LEVEL OUTCOMES

At the successful completion of this course, students will be able to

1. Identify the productive and destructive insects.
2. Describe the role of beneficial as well as the harmful insects.
3. Detail the life cycle, damage and control measures of agricultural pests.
4. Distinguish the different kinds of pests.
5. Forecast and monitor the pest outbreak.
6. Evaluate the different types of agricultural pests.
7. Explain the pest control methods.
8. Apply the natural pesticides to control the pest population.
9. Appraise the recent developments in pest control.

UNIT I - PRODUCTIVE INSECTS

1. Insects as most successful group of organisms.
Biology, life cycle and economic Importance of,
2. Silk worm (*Bombyx mori*)
3. Lac insect (*Tachardia lacca*)
4. Helpful Insects - Pollinators, Scavengers, Medicinal value,
5. Insects as human food.

UNIT II - DESTRUCTIVE INSECTS

1. Insect Pests - definition, kinds of pests, pest outbreak, pest surveillance, forecasting and monitoring.
2. Destructive insects - Locust, Termites.
3. Disease transmitters to plants - Aphids, Whiteflies.
4. Insect vectors to man - *Anopheles culicifacies*, *Aedes aegypti*, *Culex pipiens*.
5. Insect pests of domestic animals - Black Flies (*Simulium aureohirtum*), Warble Flies (*Hypoderma lineate*), Louse Flies (*Hippobosca maculate*).

UNIT III - AGRICULTURAL PESTS

- Identification, life cycle, symptoms of damage and management of Pests of,
1. Food crops: Paddy - *Scirpophaga incertulas*, *Nilaparvata lugens*.
 2. Stored grains: Rice - (*Sitophilus orizae*), Wheat - (*Sitotroga cerealla*).
 3. Vegetables: Brinjal - (*Leucinodes orbonalis*), Potato - (*Agrotis ipsilon*).
 4. Oil Seeds: Coconut - (*Oryctes rhinoceros*), Groundnut - (*Amsacta albistriga*).
 5. Mango - (*Idioscopus niveosparus*), Pulses - (*Helicoverba armigera*).
 6. Sugarcane - (*Scirpophagus novella*), Cotton - (*Earias insulna*).
 7. Spices: Cardamom- (*Sciothrips cardamomi*), Pepper - (*Longitarsus nigripennis*).
 8. Money plants: Coffee - (*Xylotrechus quadripes*), Tea - (*Heliopeltis theivora*).

UNIT IV - PEST MANAGEMENT

1. Pest Control Methods - natural, topographic, climatic, legal, physical, mechanical and cultural methods.
2. Chemical control - Organic, Inorganic, Synthetic insecticides and mode of their action.
3. Fumigants in pest control.
4. Principles of Integrated Pest Management.
5. Pesticides and environment.

UNIT V - RECENT TRENDS

1. Biological Pest Control- parasites, parasitoids, pathogens, predators.
2. Biotechnological approach in pest management
3. Insect attractants, repellants, chemo-sterilants, antifeedants.
4. Botanical insecticides - Neem, Pyrethrum, Nicotine.
5. Nano pesticides and nano fertilizer.

PEDAGOGY STRATEGIES

- Lecture by chalk and talk
- power point presentation
- e-content
- group discussion
- assignment
- quiz
- peer learning
- seminar

REFERENCES

1. **Rajendra Singh** (2010), Elements of Entomology, First Edition, Rastogi Publications, Meerut.
2. **Vasantharaj David. B and Ramamurthy, T** (2011). Elements of Economic Entomology, Popular Book Depot, Chennai -15.
3. **K.K. Nayar, T.N. Anantha krishnan and B. Vasantharaj David** (1976). General and Applied Entomology. Tata McGraw-Hill, New Delhi.
4. **Peter G. Fenemore and Alka Prakash**, (1992). Applied Entomology, Wiley Eastern Limited.
5. **Tembhare, D.B** (2009) Modern Entomology, Himalaya publishing house, Mumbai.

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1. **Krishnan, N.T.** (1993). Economic Entomology. JJ Publications, Madurai.
2. **Shyamsunderlal Pradhan** (1969). Insect Pests of Crops. National Book Trust, India.
3. **Fletcher T. Bainbrigge** (1914). Some South Indian Insects, Madras: Govt. Press.
4. **Haldhar and Deshwal** (2017). Fundamentals of Agriculture Entomology. New Vishal Publication.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME								
	1	2	3	4	5	6	7	8	9
Disciplinary Knowledge	√	√	√	√	√	√	√	√	√
Communication Skills		√							
Critical Thinking	√	√	√		√		√	√	√
Problem Solving			√			√		√	
Analytical Reasoning	√	√	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√			
Scientific Reasoning	√	√	√	√		√	√	√	
Entrepreneurial Skills			√				√	√	
Reflective Thinking	√	√		√	√		√		√
Digital Literacy			√		√			√	
Leadership Readiness				√					
Moral and Ethical		√							√
Lifelong Learning	√		√		√				√

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours /Week
2021 - 2022 onwards	IV	21MZO45P	CORE PRACTIAL – III (Includes Paper VII: Biochemistry, Paper VIII: Developmental Biology, Paper IX: Microbiology, Paper XI: Immunology& Paper XII: Endocrinology)	5

COURSE LEVEL OUTCOMES

Upon completion of this practical course, students will be able to,

1. Prepare haemin crystals.
2. Undertake quantitative determination of biochemical parameters in blood, urine and tissue.
3. Comment on regeneration in Amphibians.
4. Undertake analysis of development of chick.
5. Analyse characteristics of microbial organisms by various methods.
6. Determine the effect of hormones on physiological processes.
7. Summarise structural characteristics of glands.

BIOCHEMISTRY

Preparation of haemin crystals.

Quantitative estimation of the following in blood samples.

Glucose, Cholesterol, Haemoglobin

Quantitative estimation of glucose in urine.

Quantitative estimation of tissue protein.

Quantitative estimation of tissue carbohydrate.

Quantitative estimation of tissue lipids.

DEVELOPMENTAL BIOLOGY

Regeneration of tail in amphibian tadpoles.

Vital staining and mounting of chick embryo at various stages.

A study of early stages of chick embryo development (96 hours).

IMMUNOLOGY AND MICROBIOLOGY

Study of mammalian primary and secondary lymphoid organs - slides.

Micro – measurement of yeast, RBC and WBC.

Gram's staining of bacteria.

Hanging drop method to observe live microorganisms.

Study of the structural characteristics and economic importance of bacteria, algae and fungi.

Collection and identification of microorganism - Finger Pad method, Otomycosis – Oral Bacteria

ENDOCRINOLOGY

Dissection of endocrine system in cockroach and fish.

Study of histological slides pertaining to mammalian endocrine glands- Pituitary, pineal, thyroid, pancreas, adrenal, testis, ovary.

Effect of thyroxine and thiourea (anti-thyroid agent) on oxygen consumption in fish.

SPOTTERS

Gram's stain
Autoclave
Laminar Air Flow chamber
Inoculation Loop
Inoculation Needle
Western Blot
ELISA
WIDAL kit
VDRL kit

REFERENCE BOOKS

1. **Leslie Hudson and Frank C. Hay** (1989). Practical Immunology. Blackwell Scientific Publication. 3rd ed.
2. **Wilson K & Walker J.** (2002). Practical Biochemistry: Principles and Techniques. Cambridge University Press, Oxford.
3. **Rajasekara Pandian M and Senthil Kumar B.** (2007). Immunology and Immunotechnology. Panima Publishing Corporation, New Delhi, India.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Critical Thinking		√	√	√	√	√	
Problem Solving		√		√	√		
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√	
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills		√	√	√		√	
Reflective Thinking	√	√	√	√	√	√	√
Digital Literacy				√	√	√	
Leadership Readiness				√			
Lifelong Learning			√		√		

II M Sc ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	IV	21MZO46P	CORE PRACTIAL – IV (Includes Paper X - Biotechnology and Genetic Engineering, Elective Paper III - General Entomology, and Elective Paper IV – Applied Entomology)	5

COURSE LEVEL OUTCOMES

Upon completion of this practical course, students will be able to

1. Isolate the DNA from rat liver.
2. Undertake collection, identification and preservation of various insect species.
3. Dissect and display the insects.
4. Differentiate beneficial and harmful insects.
5. List out the most important agricultural pests.
6. Report suitable pest control measures.
7. Analyze the digestive enzymes in insect gut.

BIOTECHNOLOGY AND GENETIC ENGINEERING

1. Isolation of DNA from rat liver by phenol extraction method.
2. Transgenic animals – photographs.

SPOTTERS

1. PCR
2. Gel Documentation Unit
3. Spectrophotometer
4. Centrifuge – ultra centrifuge

ENTOMOLOGY

Identification of the following insect orders and their families using dichotomous keys:

1. Apterygota
2. Orthoptera
3. Lepidoptera
4. Coleoptera
5. Hemiptera
6. Diptera
7. Hymenoptera
8. Odonata

DISSECTIONS

Digestive system, Nervous system and Reproductive system of Cockroach, Nepa and Cybister.

MOUNTINGS

Mouth parts: Honey bee, Bed bug, Mosquito, House fly and Cockroach.

PHYSIOLOGY

Qualitative analysis of the digestive enzymes of an insect.

Study of haemocytes in the haemolymph of cockroach.

Qualitative analysis of Protein, Carbohydrate and Lipid in the haemolymph of an insect.

SUBMISSIONS

Insect box - Minimum two insect per Order.

Insect pests - 5, Infested Crops - 5.

Slides -Whole mounting of small insects - 5.

ACTIVITIES

Periodic field collection, preservation and identification of insects.

Studies of different types of damage caused by insect pests.

Field study of insects in the college campus.

Field visit to collect insects of different orders.

Study on the life history of vectors – Mosquitoes and housefly.

Visit to a Sericulture Unit.

Visit to TNAU.

Preparing Insect Photographic Album.

Study tour related to Entomology.

REFERENCES

1. **Regupathy, A., Palanisamy, S., Chandramohan, N. and Gunathilagaraj, K.** (1997).
A guide on Crop Pests. Sooriya Desktop Publishers, Coimbatore, India.
2. **Snodgrass, R. E.** (1935). Principles of Insect Morphology, Cornell Univ. Press, USA.

FURTHER READING

1. **Hill, D. S.** (1983). Agricultural insect pests of the tropics and their control, Cambridge University Press, UK.
2. **Old, R. W., Primrose, S. B., and Twyman, R. M.** (2001). Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	√	√	√	√	√	√	√
Communication Skills				√			
Critical Thinking		√	√	√	√	√	
Problem Solving		√		√	√		
Analytical Reasoning	√	√	√	√	√	√	√
Research Related Skills	√	√	√		√	√	
Scientific Reasoning	√	√	√	√	√	√	√
Entrepreneurial Skills		√		√		√	
Reflective Thinking	√	√	√	√	√	√	√
Digital Literacy				√	√	√	
Leadership Readiness				√			
Moral and Ethical Awareness		√	√	√	√	√	
Lifelong Learning	√		√		√		
Multicultural Competence						√	