

GOVERNMENT ARTS COLLEGE (AUTONOMOUS)

COIMBATORE-641 018

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

B.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 (TANSCHE) 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 in 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.

Institutional infrastructure of our college is incomparable and functions with an additional variation of adopting different methods for teaching and learning process. The failure to keep pace with the advancing knowledge base, half-hearted engagement and integration with other disciplines, and poor-transfer of skill sets to the students to negotiate efficiently with the changing needs, have made 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 purpose is to understand inner working of living-beings 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. 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.

Apart from the above-mentioned attributes, an integrated and cross-disciplinary manner of comprehensive understanding of all living systems, their relationship with the eco-system, and unravelling of their application value is to be imbibed by the students. Within the broad-range skill sets related to the discipline, what would be required is to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity. These are part of the defined characteristic attributes to be demonstrated by a student along with the social skills like values of cooperative team work, moral and ethical awareness and reasoning, multicultural competence, leadership readiness and qualities related to 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 well thought cardinal features of classification on the basis of morphology and molecular information wherever available. Teachers would need to be trained for the same as well for a uniform approach to deliver and communicate. A comprehensive knowledge of structure-function relationship at the level of gene, genome, cell, tissue, organ, and systems, through development would further add to the knowledge base and the learning outcome in terms of editing of genes and genomes for industrial application and research purposes. Short dissertations could be designed around these problems to give them hands-on-training and equip them with skill sets of use in future, in the areas of applied aspects of Zoology.

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. As it covers a fascinating range of topics, the modern zoologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a B.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 Zoology has to take 14 such Zoology courses over six semesters.

2. **Elective Courses (EC).** An elective course is a course that is to be chosen from a specified set of courses. These courses are of two types.

Discipline Specific Electives (DSE). These are elective courses that provide advanced undergraduate training in specialised areas of Zoology. A set of 4, semester-specific, courses of this kind are offered in the fifth and sixth semesters of the Undergraduate programme.

Generic Electives (GE). These courses, in disciplines other than Zoology, are intended to broaden the training of a student in the Zoology Undergraduate programme. A student of Zoology will take one such course, offered by another department, in each of Semester V to VI.

3. **Ability Enhancement Compulsory Course (AECC).** Two such courses are to be taken, one in Semester I (Environmental Studies) and one in Semester II (Value Education–Gandhian Thoughts).

4. **Skill Enhancement Course (SEC).** A student is to take one such course each in Semester III through Semester VI. Besides, an individual/group project in Semester VI.

2. LEARNING OUTCOMES 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 B.Sc. level. These courses should be studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations can be used for teaching the course. The students should do the dissertation/ project work under practical of different courses, wherever possible.

The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological 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 Zoology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology. 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 B.Sc. degree Programme in Zoology

B.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 disciplinary/subject area of Zoology comprise: 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. B.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 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 Bachelor'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 develop 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. There is a need for the students to compete with the globe, therefore, 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 can choose to focus on a “whole animal” or a “bits of animals” approach. The “whole animal” pathway makes the students proficient in the identification and study of animals while the latter approach provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc. The curriculum can be modified to such extent that a student at B.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 students' employment probability; for example few skills needed by industry may include the species-specific monitoring for key species, handling of dangerous/ poisonous/ wild animals and the use of Geographic Information Systems (GIS) for data collection.

3. GRADUATE ATTRIBUTES IN ZOOLOGY

- a) ***Disciplinary knowledge and skills:*** Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases), and other related fields of study, including broader interdisciplinary subfields such as chemistry, physics and mathematics; (ii) ability to use modern instrumentation for advanced genomic and proteomic technology.
- b) ***Skilled communicator:*** Ability to impart complex technical knowledge relating to Zoology in a clear and concise manner in writing and oral skills.
- c) ***Critical thinker and problem solver:*** Ability to have critical thinking and efficient problem-solving skills in the basic areas of Zoology (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases etc.).
- d) ***Sense of inquiry:*** Capability for asking relevant/appropriate questions relating to issues and problems in the field of Zoology, and planning, executing and reporting the results of an experiment or investigation.
- e) ***Team player/worker:*** Capable of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.
- f) ***Skilled project manager:*** Capable of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.
- g) ***Digitally literate:*** Capable of using computers for Bioinformatics and computation and appropriate software for analysis of genomics and proteomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.

h) ***Ethical awareness/reasoning:*** Capable of conducting their work with honesty and precision thus avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues. Any plan to withhold information from researchers should be properly explained with justification in the application for ethical approval.

i) ***Lifelong learners:*** Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.

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

The qualification descriptors for a Bachelor's Degree programme in Zoology may include the following:

a) Demonstrate (i) a fundamental/systematic or coherent understanding of the academic field of Zoology, its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) procedural knowledge that creates different types of professionals related to Zoology area of study, including research and development, teaching and government and public service; (iii) skills in areas related to specialization area relating the subfields and current developments in the academic field of Zoology.

b) Use knowledge, understanding and skills required for identifying problems and issues relating to Zoology. A keen interest in research and the study of living organisms.

c) Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s);

d) Meet one's own learning needs, drawing on a range of current research and development work and professional materials;

e) Apply one's subject knowledge and transferable skills to new/unfamiliar contexts to identify and analyse problems and issues and solve complex problems with well-defined solutions.

f) Demonstrate subject-related and transferable skills that are relevant to Zoology-related job trades and employment opportunities

g) Good observation skills

i) Able to work precisely

j) A logical approach to problem-solving

- k) Good oral and written communication abilities
- l) Able to work independently or with team members

5. LEARNING OUTCOMES IN BACHELOR'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 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 concurrently; Generic electives will introduce integration among various interdisciplinary courses. The 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 would 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 is to indicate the breadth of content to be taught thus ensuring more or less uniform coverage of information on a certain theme.

B. Sc. Zoology Degree Course
UG - SCHEME OF EXAMINATIONS: CBCS PATTERN
(For the students admitted during the academic year 2021-2022 and onwards)

Part	Sub Code	Title of the Paper	Hrs/ (week)	Internal (CA) Marks	External Marks	Total Marks	Ext – Min.	Total Pass Mark	Credits
Semester - 1									
I	21TAM11L	*Part – I: Language: Tamil I	6	50	50	100	20	40	3
II	21ENG12L	*Part –II: English I	6	50	50	100	20	40	3
III	21BZO13C	Core Paper I: Invertebrata	6	50	50	100	20	40	5
III	21BZO14A	Allied – 1: Allied Botany I	6	30	45	75	18	30	4
		Core Practical I: Includes Core papers I & II	2						
		Allied Practical I: Botany	2						
IV	21ENV1GE	Environmental Studies	2	50	50	100	20	40	2
Semester – II									
I	21TAM21L	*Part – I: Language: Tamil II	6	50	50	100	20	40	3
II	21ENG22L	*Part –II: English II	6	50	50	100	20	40	3
III	21BZO23C	Core Paper II: Chordata	6	50	50	100	20	40	5
III	21BZO24A	Allied – 2: Allied Botany II	6	30	45	75	18	30	4
III	21BZO25P	Core Practical I: Includes Core papers I & II	2	50	50	100	20	40	3
III	21BZO26P	Allied Practical I: Botany	2	25	25	50	10	20	2
IV	21VAL2GE	Value Education – Gandhian Thoughts	2	50	50	100	20	40	2

Part	Sub Code	Title of the Paper	Hrs/ (week)	Internal (CA) Marks	External Marks	Total Marks	Ext – Min.	Total Pass Mark	Credits
Semester – III									
I	21TAM31L	*Part – I: Language: Tamil III	6	50	50	100	20	40	3
I	21ENG32L	*Part –II: English III	6	50	50	100	20	40	3
III	21BZO33C	Core Paper III: Cell Biology & Biotechniques	4	50	50	100	20	40	5
III	21BZO34A	Allied – 3: Chemistry I	6	30	45	75	18	30	4
III		Core Practical II: Includes Core papers III & IV	2						
III		Allied Practical III: Chemistry	2						
IV	21BZO35S	Skill Based Subject – I: Sericulture	4	50	50	100	20	40	3
Semester – IV									
I	21TAM41L	*Part – I: Language: Tamil IV	6	50	50	100	20	40	3
I	21ENG42L	*Part –II: English IV	6	50	50	100	20	40	3
III	21BZO43C	Core Paper IV: Animal Physiology & Biochemistry	4	50	50	100	20	40	5
III	21BZO44A	Allied – 4: Chemistry II	6	30	45	75	18	30	4
III	21BZO45P	Core Practical II: Includes Core papers III & IV	2	50	50	100	20	40	3
III	21BZO46P	Allied Practical III: Chemistry	2	25	25	50	10	20	2
IV	21BZO47S	Skill Based Subject – II: Clinical Lab Technology	4	50	50	100	20	40	3
V	21EXA4GE	@Extension Activities: NCC/NSS/SPORTS/YRC	-	-	100	100	20	40	1

Part	Sub Code	Title of the Paper	Hrs/ (week)	Internal (CA) Marks	External Marks	Total Marks	Ext – Min.	Total Pass Mark	Credits
Semester – V									
III	21BZO51C	Core Paper V: Embryology	5	50	50	100	20	40	5
III	21BZO52C	Core Paper VI: Genetics	5	50	50	100	20	40	5
III	21BZO53C	Core Paper VII: Evolution	4	50	50	100	20	40	5
III	21BZO54C	Core Paper VIII: Bioinformatics, Biostatistics & Computer Applications	5	50	50	100	20	40	5
		Core Practical III: Includes Core Papers V, VI, VII & VIII	2						
		Core Practical IV: Includes Core Papers IX, X & XI	2						
IV	21BZO55S	Skill Based Subject – III: Applied Zoology	4	50	50	100	20	40	3
IV	21BZO5EL	Non-Major Elective Paper – I: Biofarming I	3	50	50	100	20	40	2
Semester – VI									
III	21BZO61C	Core Paper IX: Immunology & Microbiology	5	50	50	100	20	40	5
III	21BZO62C	Core Paper X: Biotechnology	5	50	50	100	20	40	5
III	21BZO63C	Core Paper XI: Ecology& Ethology	5	50	50	100	20	40	5
III	21BZO64P	Core Practical III: Includes Core Papers V, VI, VII & VIII	2	50	50	100	20	40	3
III	21BZO65P	Core Practical IV: Includes Core Papers IX, X & XI	2	50	50	100	20	40	3
III	21BZO66P	Project & Viva – Voce	4	50	50	100	20	40	8
IV	21BZO67S	Skill Based Subject – IV: Ornamental fish culture	4	50	50	100	20	40	3
IV	21BZO6EL	Non-Major Elective Paper – II: Biofarming II	3	50	50	100	20	40	2
		Total / Credits				3600			140

*Courses offered with four semester Language Papers

@ No External Examinations. Only Continuous Internal Assessment (CIA)

Include 50/50 continuous internal assessment marks for theory and practical papers respectively

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

I B.Sc. ALLIED ZOOLOGY

Year	Sem.	Subject Code	Title of the paper	Hours/Week
2021 -2022 onwards	I	21BBO14A	PAPER I: INVERTEBRATA AND CHORDATA	6

COURSE LEVEL OUTCOME

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

1. Recognize the diversity of the animal kingdom and characteristics of the non-Chordate Phyla and the Chordate classes.
2. Describe the characteristics of Phylum Protozoa with an example as well as the characteristics of Phylum Porifera and Phylum Coelentrata.
3. Describe the characteristics of Phylum Platyhelminthes with an example.
4. Arrange the characteristics of Phylum Nematelminthes and justify the parasitic Nematodes.
5. Explain the characteristics of Phylum Annelida, Phylum Arthropoda (with example), as well as Phylum Mollusca and Phylum Echinodermata.
6. Classify Chordates.
7. Explain the general characters of the classes Pisces, Amphibia, Reptilia, Aves and Mammalia.

UNIT – I

General characters of the Phylum Protozoa and classification up to Class level with an example for each class.

General organization of Paramecium

General characters of the Phylum Porifera and classification up to Class level with an example for each class.

General characters of the Phylum Coelentrata and classification up to Class level with an example for each class.

Coral reefs and coral reef formation.

UNIT – II

General characters of the Phylum Platyhelminthes and classification up to Class level with an example for each class.

General organization and life history of Tapeworm

General characters of the Phylum Nematelminthes and classification up to Class level with an example for each class.

Parasitic adaptations in Helminthes.

General characters of the Phylum Annelida and classification up to Class level with an example for each class.

UNIT – III

General characters of the Phylum Arthropoda and classification up to Class level with an example for each class.

General organization and reproduction in Cockroach.

Social life in insects.

General characters of the Phylum Mollusca and classification up to Class level with an example for each class.

General characters of the Phylum Echinodermata and classification up to Class level with an example for each class.

UNIT – IV

General characters of the Phylum Chordata and outline classification up to class level.

General characters of the Class: Pisces.

General organization of all systems of Shark (except endoskeletal system).

Migration in Fishes.

General characters of the Class: Amphibia.

Parental care in Amphibia.

UNIT – V

General characters of the Class: Reptilia.

An account of Dinosaurs.

General characters of the Class: Aves.

Flight adaptations in birds.

General characters of the Class: Mammalia.

General organization of all systems of Rabbit (except endoskeleton).

Dentition in Mammals.

PEDAGOGY STRATEGIES

- Board and Chalk lecture
- Powerpoint slide presentations
- Seminar
- Assignments
- Online and Offline Class Practicals

- Quizzes
- Group discussion

REFERENCES:

1. **R. L. Kotpal** (2019). Modern Textbook of Zoology: Invertebrates 12th Edition. Rastogi Publications, New Delhi.
2. **Rajesh Kumar Shah and Santoshkumar Abujam** (2019). Invertebrate Zoology – I. Mahaveer Publications, New Delhi.
3. **R.L. Kotpal** (2007). Modern Textbook of Zoology, Vertebrates.
4. **Jordan E.L. and P.S Verma** (2015). Chordata Zoology (11th Edition). S. Chand and Company Ltd., New Delhi-110 055.
5. **Agarwal, V** (2003). Chordate Zoology, S. Chand & Co., New Delhi.
6. **Renganathan, T.K.** (1996). Chordate Zoology. Jayalakshmi Printers, Tuticorin.

FURTHER READING:

1. **E.L. Jordan & P.S. Verma** (2009). Invertebrate Zoology. S. Chand & Co. New Delhi.
2. **J.Z. Young** (2006). The Life of Vertebrates. The Oxford University Press, New Delhi.
3. **E.L. Jordan & P.S. Verma** (2010). Chordate Zoology. S. Chand & Co. New Delhi.

WEBSITE(S)

- <https://biodifferences.com/difference-between-chordates-and-non-chordates.html>
- <http://tolweb.org>
- <https://animaldiversity.org>
- <https://www.digitalatlasofancientlife.org>

MAPPING OF PROGRAM LEVEL OUTCOME WITH COURSE LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME						
	1	2	3	4	5	6	7
Disciplinary Knowledge	✓	✓	✓	✓	✓	✓	✓
Communication Skills	✓	✓	✓				✓
Critical Thinking		✓		✓	✓	✓	✓
Analytical Reasoning	✓	✓		✓	✓	✓	
Research Related Skills	✓		✓			✓	✓
Scientific Reasoning			✓	✓	✓	✓	
Reflective Thinking				✓			✓
Digital Literacy	✓						
Lifelong Learning	✓			✓			

I B.Sc. ALLIED ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	II	21BBO24A	PAPER II – GENERAL PRINCIPLES OF ZOOLOGY	6

COURSE LEVEL OUTCOME

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

1. Cite the scope and branches in Zoology.
2. Discuss the organization of an animal cell biology and the basic concepts in Genetics.
3. Justify stages in the development of an organism.
4. Recognize the functioning of the various organ systems.
5. Infer the commercial and industrial value of animals.

UNIT – I CELL BIOLOGY AND GENETICS

Structure of an animal cell.

An account of cancer.

Genetic disorders in man-Haemophilia, Phenylketonuria and Down's syndrome.

Blood group systems- ABO system and Rh system.

UNIT – II DEVELOPMENTAL BIOLOGY

Structure of egg and sperm of rabbit.

Fertilization, cleavage, blastulation and gastrulation in rabbit.

Foetal membranes (Yolk sac, amnion, chorion and allantois) and Placenta in rabbit.

Human Infertility and *in vitro* fertilization.

UNIT – III PHYSIOLOGY

Respiration-Transport of gases O₂ and CO₂.

Excretion-Nephron-Structure and Urine formation.

Structure of Neuron-nerve impulse conduction-synaptic transmission.

UNIT – IV ECONOMIC ZOOLOGY

Vermiculture

Sericulture.

Lac culture.

Apiculture.

UNIT – V ECONOMIC ZOOLOGY

Prawn culture.

Carp culture.

Ornamental fish culture

Introduction to Aquaponics.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Field/Institution visit

REFERENCES

1. **N. Arumugam** (2016). A Text Book of Embryology. Saras Publications, Sivakasi.
2. **P.S. Verma & Agarwal** (2009). Animal Physiology. S. Chand & Co., New Delhi.
3. **P.S. Verma & Agarwal** (2001). Concepts of Cell Biology. S. Chand & Co., New Delhi.

FURTHER READING

1. **Shukla, G.S. and Upadhyaya, V.B.** (1999-2000). Economic Zoology. Rastogi Publications, New Delhi.
2. **Mani, M.S.** (2006). Insects, NBT, India.
3. **Jabde, P.V.** (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture. Discovery Publishing House, Meerut.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME.

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME				
	1	2	3	4	5
Disciplinary Knowledge	✓	✓		✓	✓
Communication Skills	✓	✓	✓	✓	✓
Critical Thinking	✓	✓	✓		
Problem Solving	✓	✓		✓	✓
Research Related Skills	✓	✓	✓	✓	✓
Scientific Reasoning				✓	✓
Entrepreneurial Skills				✓	✓
Reflective Thinking				✓	✓
Moral and Ethical Awareness				✓	✓
Lifelong Learning	✓	✓		✓	✓

I B.Sc. ALLIED ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	I &II	21BBO25P	ALLIED ZOOLOGY PRACTICAL (Based on Allied Papers I & II)	2

COURSE LEVEL OUTCOME

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

1. Identify Invertebrate and Vertebrate specimens
2. Ascertain the structure of Alimentary canal of Fish and Cockroach.
3. Assimilate the structure function relation of mouthparts, scales and setae.
4. Analyze the development of frog.
5. Justify the adaptations of desert and volant organisms as well as Parental care.
6. Enumerate the economic importance of Honey Bee, Silkworm and edible fishes.

DISSECTIONS

1. Fish – Alimentary canal.
2. Cockroach – Alimentary canal.

MOUNTINGS

1. Earthworm – Body setae
2. Cockroach – Mouth parts.
3. Honey bee - Mouth parts.
4. Types of scales in Fish.

SPOTTERS – IDENTIFICATION

Identify, draw and write notes on:

1. *Paramecium*: Entire.
2. Ascon: Entire.
3. *Obelia*: Colony, Medusa.
4. *Fasciola hepatica* (Liverfluke): Entire.
5. *Ascaris*: Entire.
6. Prawn: Entire.
7. Pila: Entire.
8. Starfish: Entire – Oral and Aboral view.
9. Shark: Entire.
10. *Calotes*: Entire.

EMBRYOLOGY

1. Structure of egg and sperm of frog.
2. Blastula of Frog.
3. Gastrula of Frog.

ADAPTATIONAL SIGNIFICANCE

1. Desert – Scorpion.
2. Volant – Draco and Bat.

ANIMAL BEHAVIOUR

1. Parental care – Arius, Hippocampus.

ECONOMIC ZOOLOGY

1. Honey bee – Queen, worker, drone.
2. Silkworm – Adult, egg, Caterpillar, Pupa and Cocoon.
3. Edible fishes – Catla, Sardine.

REFERENCES

1. **P S Verma** (2010) A Manual of Practical Zoology – Invertebrates. S Chand & Co., New Delhi.
2. **P S Verma** (2011). A Manual of Practical Zoology – Chordates, S. Chand & Co., New Delhi.
3. **S. S. Lal** (2018). Practical Zoology - Invertebrate Vol. 1. Rastogi Publications, Meerut.
4. **S. S. Lal** (2019). Practical Zoology - Vertebrate Vol. 2. Rastogi Publications, Meerut.
5. **P. S. Verma and P.C. Srivastava.** (2012). Advanced Practical Zoology. S. Chand & Co., Meerut.

MAPPING OF PROGRAM LEVEL OUTCOME WITH COURSE LEVEL OUTCOME

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

I B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	I	21BZO13C	CORE PAPER I: INVERTEBRATA	6

COURSE LEVEL OUTCOMES

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

1. Describe the diversity of life on earth with respect to non-Chordates.
2. State general characteristics of the different Phyla as exemplified in the representative types.
3. Appraise how animals progressed from a single cell to a collection of simple cells and from a simple body plan to a complex body plan.
4. Assess the morphological attributes and physiological processes that are distinct and significant to each Phyla.
5. Relate the morphological characteristics of structures with their respective functions.

UNIT – I

PHYLUM PROTOZOA

General characters and outline classification of Phylum Protozoa up to Class level with examples for each Class.

Detailed type study: *Paramecium*.

General Topics: Locomotion in Protozoa.

Reproduction in Protozoa.

PHYLUM PORIFERA

General characters and outline classification of Phylum Porifera up to Class level with examples for each Class.

Detailed type study: *Leucosolenia*.

General Topics: Canal system in sponges.

Economic importance of sponges.

UNIT – II

PHYLUM COELENTERATA

General characters and outline classification of Phylum Coelenterata up to Class level with examples for each Class.

Detailed type study: *Obelia*.

General Topics: Polymorphism in Coelenterata.

Corals and coral reef formation in Coelenterates.

PHYLUM PLATYHELMINTHES

General characters and outline classification of Phylum Platyhelminthes up to Class level with examples for each Class.

Detailed type study: *Fasciola hepatica* (Liver fluke).

General Topic: Parasitic adaptations in Platyhelminthes.

UNIT – III

PHYLUM ASCHELMINTHES

General characters and outline classification of Phylum Aschelminthes up to Class level with examples for each Class.

Detailed type study: *Ascaris lumbricoides* (Round worm).

General Topic: Occurrence and Mode of transmission (excluding life history) of certain

Nematode parasites of man and domestic animals- *Enterobius*, *Wuchereria*
Dracunculus.

PHYLUM ANNELIDA

General characters and outline classification of Phylum Annelida up to Class level with examples for each Class.

Detailed type study: Earthworm.

General Topics: Excretion in Annelida.

Adaptive radiation in Polychaetes.

UNIT – IV

PHYLUM ARTHROPODA

General characters and outline classification of Phylum Arthropoda up to Class level with examples for each Class.

Detailed type study: *Periplaneta americana* (Cockroach).

Prawn.

General Topics: Crustacean larvae.

Mouthparts in Insects.

Economic importance of Arthropods.

Social organization in insects.

UNIT – V

PHYLUM MOLLUSCA

General characters and outline classification of Phylum Mollusca up to Class level with examples for each Class.

Detailed type study: *Pila*.

General Topics: Foot in Mollusca.

Economic importance of Mollusca.

PHYLUM ECHINODERMATA

General characters and outline classification of Phylum Echinodermata up to Class level with examples for each Class.

Detailed type study: *Asterias* (Starfish).

General Topics: Water vascular system in Echinodermata.

Larval forms in Echinodermata.

PEDAGOGICAL STRATEGIES

- Board and Chalk lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Field/Museum visit

REFERENCES

1. **Jordan E.L. and Verma P.S.** (2000). Invertebrate Zoology. S. Chand Publishing Ltd., New Delhi-110 055.
2. **Kotpal R.L** (2000). Modern Textbook of Zoology - Invertebrates. Rastogi Publications.

FURTHER READING

1. **Barnes, Robert D** (1981). Invertebrate Zoology. Saunders College Publications.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

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

Ability Enhancement Compulsory Course (AECC): SEM-I

Year	Sem.	Subject Code	Title of the paper	Hours/Week
2021 -2022 onwards	I	21ENV1GE	ENVIRONMENTAL STUDIES (For all UG courses)	2

COURSE LEARNING OUTCOMES:

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

1. Recognize the role of the environment and the need to conserve it for sustaining life.
2. Enumerate the natural resources
3. Explores the adverse effects of deforestation and over exploitation of natural resources
4. Associate the components of the ecosystem and need for biodiversity conservation.
5. Evaluate the environmental pollution hazards and their effects on the living system.
6. Interpret the different disaster management procedures.
7. Analyze the climatic change and global effects
8. Infer the need for environmental laws in the constitution of India.
9. Relate the growth of the human population and its impact on the environment.

UNIT I

Environment – Introduction – Nature - Scope – Content – Need for study. Natural resources- Forest and energy resources- Use and overexploitation - deforestation. Energy resources- renewable and non-renewable energy resources.

UNIT II

Ecosystem – concept – types- Forest, Grassland, Desert and Aquatic (Pond)- Structure and function of an ecosystem – Producers- consumers and decomposers – Food chain – food web- ecological pyramids- energy flow. Biodiversity and its conservation- *in situ* and *ex situ* conservation- Mega biodiversity centres and hotspots.

UNIT III

Environmental pollution- definition- causes-effects and control measures of air, water, soil, thermal and nuclear pollution. Waste management- Industrial and solid waste. Disaster management – earthquake, cyclone, flood and landslides.

UNIT IV

Social Issues and the environment-Urbanization-Urban problems related to energy and watershed management. Environmental Ethics- Issues and possible solutions- Wasteland reclamation- Climate change - causes and effects. Global warming- Acid rain- Ozone layer depletion- Public awareness. Environmental laws- Environment Protection Act, Wildlife Protection Act, Forest Conservation Act.

UNIT V

Human population and its impact on environment- Population growth- Resettlement and Rehabilitation of project affected persons- Case studies – Sardar Sarovar Project, Maharashtra and Bandipur National Park- Project Tiger, Karnataka, NTPC, India. Role of Indian and Global religions and Cultures in environmental conservation- Case study: sacred groves in Western Ghats (kavu) & Chinese culture. Human and Wildlife Conflict.

PEDAGOGY STRATEGIES

- ❖ Board and Chalk lectures
- ❖ PowerPoint slide presentations
- ❖ Assignments

TEXTBOOKS

1. **Sharma, P. D.** (2000). Ecology & Environment. Rastogi Publications, Meerut, India.
2. **Bharucha, E.** (2003). Text book of Environmental Studies. UGC, New Delhi & Bharati Vidyapeeth Institute of Environmental Education and Research, Pune.
3. **Arumugam, M. and Kumaresan, V.** (2016). Environmental Studies (Tamil version). Saras Publications, Nagercoil.

Online/E-Resources:

<https://www.edx.org/course/subject/environmental-studies>
https://www.coursera.org/courses?_facet_changed=true&domains=life-sciences%2Cphysical-science-and-engineering%2Csocial-sciences&query=environmental%20science%20and%20sustainability&userQuery=environmental%20science%20and%20sustainability
<https://www.open.edu/openlearn/nature-environment/free-courses>

COURSE LEVEL MAPPING OF PROGRAMME LEVEL OUTCOME

Program Level Outcomes	Course Level Outcome								
	1	2	3	4	5	6	7	8	9
Disciplinary Knowledge		√	√		√	√			
Communication Skills		√		√				√	√
Critical Thinking	√		√		√		√		
Research related skills	√		√			√		√	
Analytical reasoning	√			√		√		√	
Problem Solving		√	√			√			√
Team Work				√	√		√		√
Moral and ethical awareness		√		√		√		√	√

I B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	II	21BZO23C	CORE PAPER II - CHORDATA	6

COURSE LEVEL OUTCOMES

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

1. Demonstrate a comprehensive understanding of the diversity of Phylum Chordata.
2. Arrange animals in their respective major Phyla and Classes.
3. Compare the general characteristics of the different Classes under Phylum Chordata.
4. Infer the anatomical and physiological peculiarities of each Class through the detailed study of their representative types.
5. Critically analyze the unique adaptations essential for survival in the different spheres of the biosphere.
6. Assess that in a taxonomic hierarchy, the number of common characteristics increases as we move from Phylum to species.
7. Employ the knowledge gained on the contribution of Chordates in the maintenance of global biodiversity.

UNIT – I

PHYLUM CHORDATA

General characters and outline classification of Phylum Chordata.

Advanced features of Vertebrates as compared to Prochordates.

Detailed type study: *Amphioxus* (excluding endoskeleton) and its affinities.

General Topic: Retrogressive metamorphosis in Urochordata.

CLASS PISCES

General characters of Class Pisces and outline classification up to Order level.

Detailed type study: **Shark** (excluding endoskeleton).

General Topics: Accessory respiratory organs in fishes;

Migration in fishes.

Significance of lungfishes, Coelacanth.

UNIT – II

CLASS AMPHIBIA

General characters of Class Amphibia and outline classification up to Order level.

Detailed type study: Frog (excluding endoskeleton).

General Topic: Parental care in Amphibians.

Significance of Limbless Amphibians.

UNIT – III

CLASS REPTILIA

General characters of Class Reptilia and outline classification up to Order level.

Detailed type study: *Calotes* (excluding endoskeleton).

General Topics: South Indian poisonous and non-poisonous snakes.

Golden age of Reptiles: An account of Dinosaurs.

Significance of Sphenodon.

UNIT – IV

CLASS AVES

General characters of Class Aves and outline classification up to Order level.

Detailed type study: Pigeon (excluding endoskeleton).

General Topics: Flight adaptation in birds;

Migration in birds;

Salient features and distribution of Ratitae (Flightless birds).

UNIT – V

CLASS MAMMALIA

General characters of Class Mammalia and outline classification up to Order level.

Detailed type study: Rabbit (excluding endoskeleton).

General Topic: Distinctive features and adaptations of aquatic Mammals.

Brief description of Monotremes and Marsupials.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion

- Practical classes in real and virtual labs
- Field/Museum visit

REFERENCES

1. **Jordan E.L. and Verma P.S. (2015).** Chordata Zoology (11th Edition) S. Chand Publishing Ltd., New Delhi-110 055.
2. **Agarwal, V (2003).** Chordate Zoology, S. Chand & Co., New Delhi.
3. **Renganathan, T.K. (1996).** Chordate Zoology. Jayalakshmi Printers, Tuticorin.
4. **Bhamrah, H.S., Juneja, K., Shrivastava, S. and Joshi, S.C. (1993).** A Text book of Chordates. Anmol Publications, New Delhi.
5. **Ekambaranatha Ayyar, M. (1973).** A Manual of Zoology. Part II. S. Viswanathan Pvt.Ltd., Madras.

FURTHER READING

1. **Newman, H.H. (1981).** The Phylum Chordata. Biology of Vertebrates and their Kin. The Macmillan Company, New York.
2. **Alexander, R.M. (1977).** The Chordates. Cambridge University Press, Cambridge.
3. **J.Z. Young (2006).** The Life of Vertebrates. The Oxford University Press, New Delhi.
4. **R.L.Kotpal (2000).** Modern Textbook of Zoology, Vertebrates. Rastogi Publications, Meerut.

WEBSITE(S)

In <https://books.google.co.in/>:

- https://books.google.co.in/books?id=IgA3fKgx-NYC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=twopage&q&f=true (Chordate Zoology)
- https://books.google.co.in/books?id=Jl9TDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false (BIOLOGY OF CHORDATES)
- https://books.google.co.in/books?id=MAwrDAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=twopage&q&f=true (A Manual of Practical Zoology Chordates)
- Anatomy of shark: Shark dissection and anatomy (video)- www.neosci.com
- Physiology of Frog: Physio Ex 4.0 (CD)- www.physioex.com
- Mammalian Physiology– www.biopac.com

Other WEBSITES:

- <https://www.easybiologyclass.com/zoology-free-lecture-notes-online-tutorials-lecture-notes-ppts-mcqs/>
- <https://www.notesonzoology.com/phylum-chordata/classification-of-phylum-chordata-zoology/6251>

COURSE LEVEL MAPPING OF PROGRAM 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	✓						✓

I B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	I & II	21BZO25P	CORE PRACTICAL - I (Based on Core Papers I & II)	2

COURSE LEVEL OUTCOMES

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

1. Demonstrate the physiological systems of Cockroach and Fish.
2. Assess the structure and functioning of appendages, mouthparts and setae.
3. Interpret the phylogenetic position, biological significance and mode of life.
4. Relate structure and function of different organs as well as germ layers.
5. Compare nutrition with the dentition in animals.
6. Plan dissection.

MAJOR PRACTICAL

Dissection/ CD*/Model/Chart – To observe and comment on the anatomy

1. Cockroach – Digestive system, Reproductive system and Nervous system.
2. Fish – Digestive system.

MINOR PRACTICAL

Mounting Slides/Model/Chart – To identify, draw and label

1. Cockroach - Mouth parts.
2. Earthworm - Penial setae and Body setae.
3. Honey bee - Mouth parts and Sting apparatus.
4. Mosquito - Mouth parts.
5. Prawn - Appendages.
6. Placoid scale.

SPOTTERS

1. Study of the following specimens with reference to their phylogenetic position and mode of life

1. *Paramecium*
2. *Leucosolenia*
3. *Obelia*
4. *Fasciola hepatica*
5. *Ascaris lumbricoides*
6. Earthworm

7. Cockroach
8. *Pila*
9. Starfish
10. *Amphioxus*
11. Shark
12. Frog
13. *Calotes*
14. Pigeon
15. Rabbit

2. Study of the following specimens with reference to their biological significance

1. Sponge- gemmule
2. *Nauplius* larva
3. *Nautilus*
4. *Exocoetus*
5. *Chamaeleon*
6. *Typhlops*
7. Cobra
8. Owl
9. Bat

3. Study of the following structures with reference to their function

1. Sponge - spicules
2. Taenia - scolex
3. Nereis - parapodium
4. Prawn - appendages
5. Scorpion - book lungs
6. Turtle - carapace and plastron
7. Pigeon - quill feather

4. Study of the following labelled sketches with reference to germ layers and coelom types.

1. T.S. of *Obelia* polyp (Diploblastic)
2. T.S. of Earthworm (Triploblastic)
3. T.S. of *Fasciola* (Acoelomate)
4. T.S. of *Ascaris* (Pseudocoelomate)
5. T.S. of *Amphioxus* (Coelomate)

5. Study of the following skulls with reference to dentition

1. Rabbit
2. Dog
3. Man

Suggested list of supplementary web resources for laboratory exercises

1. Cockroach dissection- www.ento.vt.edu
2. Anatomy of earthworm: The dissection works (CD); Source – www.scienclass.com; www.neosci.com
3. Anatomy of Chordates: The Vertebrate Dissection Guide Series (CD)–Learning Development Centre, University of Portsmouth.
4. Anatomy of Frog: Pro Dissector (CD)- www.prodissector.com

REFERENCES

1. **P S Verma** (2010). A Manual of Practical Zoology – Invertebrates. S Chand & Co., New Delhi.
2. **P S Verma** (2011). A Manual of Practical Zoology – Chordates, S. Chand & Co., New Delhi.
3. **S. S. Lal** (2018). Practical Zoology - Invertebrate Vol. 1. Rastogi Publications, Meerut.
4. **S. S. Lal** (2019). Practical Zoology - Vertebrate Vol. 2. Rastogi Publications, Meerut.

MAPPING OF PROGRAM LEVEL OUTCOMES WITH COURSE LEVEL OUTCOMES

PROGRAM 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		✓	✓		✓	✓

Ability Enhancement Compulsory Course (AECC): SEM-II

Year	Sem.	Sub Code	Subject Title	Hours / Week
2021 - 2022 Onwards	II	21VAL2GE	VALUE EDUCATION – GANDHIAN THOUGHTS (For all UG courses)	2

COURSE LEVEL OUTCOMES

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

1. Interpret Gandhiji's experiments to his spiritual pursuits and search for purity, political activities through fasting protests, and even his role as an educator using diet and meals as teaching exercises.
2. Lead a life marked with humility and truthfulness and subsequent realization of the Truth as the purpose of human life.
3. Infer lessons that are fundamental to living in harmony and social progress such as respect, empathy, equality, solidarity and critical thinking.
4. Promote tolerance and understanding above and beyond our political, cultural and religious differences.
5. Create special emphasis on the defense of human rights, the protection of ethnic minorities
6. Emerge as responsible citizens with clear conviction to practice values and ethics in life.
7. Transform themselves to become good leaders.
8. Realize their role and contribution to the nation building.

UNIT I: Birth and Parentage - Childhood - At the High school - Stealing and Atonement - Glimpses of Religion - Gandhi's choice - Experiments in Dietetics - Acquaintance with Religions - The Great Exhibition.

UNIT II: The first case - Preparing for South Africa - same experiences - on the way to Pretoria – Coolie - Natal Indian Congress - Education of Children - Brahmacharya.

UNIT III: Simple life - The Boer war - Sanitary Reform and Famine Relief - Lord Curzon's Darbar - A month with Gokhale - Experiments in Earth and water treatment - Indian opinion - Coolie Locations or Ghettoes - The Black plague.

UNIT IV: The Magic spell of a Book - The Zulu Rebellion - The Birth of Satyagraha - More experiments in Dietetics - Kasturbai's Courage - Domestic Satyagraha- Fasting - Shanti Niketan - Woes of Third-Class passengers.

UNIT V: Kumbha mela - Lakshman Jhula - Founding of the Ashram - Abolition of Indentured Emigration - The Kheda Satyagraha - The Rowlatt Bills - Navajivan and young India - Congress Initiation - The Birth of Khadi.

TEXT BOOKS

1. **M.K. GANDHI**, “The Story of My Experiments with Truth”, An Autobiography Apple publishing International(P) Ltd, Chennai.

. மகாத்மா காந்தியின் சுயசரிதை - சத்தியசோதனை தமிழாக்கம் -
-ரா.வேங்கடராஜ்*லு, நவஜீவன் பரசுராலயம், அகமதாபாத

PEDAGOGY STRATEGIES

- Board and Chalk lecture
- Powerpoint slide presentations
- Seminar
- Assignments
- Quizes
- Group discussion

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES.

			Course Level Outcomes							
			1	2	3	4	5	6	7	8
Program Level Outcomes	1	Reflective thinking	✓	✓			✓		✓	✓
	2	Communication skills		✓		✓	✓	✓	✓	✓
	3	Critical thinking	✓			✓		✓	✓	✓
	4	Multicultural competence				✓	✓	✓	✓	✓
	5	Analytical reasoning		✓	✓	✓		✓		
	6	Problem solving		✓	✓	✓		✓	✓	✓
	7	Team work	✓		✓		✓	✓	✓	
	8	Leadership readiness/qualities			✓		✓	✓		✓
	9	Moral and ethical awareness	✓		✓		✓	✓		✓

II B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	III	21BZO33C	CORE PAPER III – CELL BIOLOGY & BIOTECHNIQUES	4

COURSE LEVEL OUTCOMES

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

1. Describe the central role played by Cell Biology in current biological science.
2. Recognize the organization and functions of the different cell organelles.
3. Infer cell cycle, cell division, cell differentiation (stem cells) and cell aging.
4. Analyze the nature, expression and regulation of the genetic materials at the molecular level.
5. Apply Biotechnic principles in instrumentation and study cell biology.

UNIT – I INSTRUMENTATION

Cytological techniques – Fixation, Sectioning and Staining.

Microscopy – Compound and Dissection Microscope- Principle and Application.

Centrifuge – Principle, Types and Application.

Electrophoresis – Principle, Types and Application.

Chromatography – Principle, Types and Application.

UNIT – II STRUCTURAL ORGANIZATION OF THE CELL

Ultrastructure and organization of a prokaryotic, eukaryotic and mesokaryotic cell.

Plasma membrane (Tri lamellar model, unit membrane concept- fluid mosaic model) – Endoplasmic reticulum – Ribosomes – Golgi complex, Lysosomes, Centrioles and Mitochondria, Nucleus and Nucleolus.

UNIT – III CELL CYCLE AND CELL REPRODUCTION

Cell cycle- Events, Growth Factors and Regulation; Prokaryotic Fission – E. coli – Eukaryotic Cell division – Mitosis, Meiosis , Cytokinesis and Karyokinesis; Sexual and Asexual Reproduction; Cell Differentiation; Cell -cell Interactions; Cell signalling.

UNIT – IV NUCLEIC ACIDS AND PROTEIN SYNTHESIS

DNA-Structure (Watson and Crick model), Properties, and Functions, DNA synthesis, DNA replication, DNA repair.

RNA- Types, structure, functions- central dogma, gene and protein relationship, Protein synthesis- transcription, processing, translation. Post-translational modification.

UNIT – V SENESENCE, STEM CELLS AND CANCER CELLS

Senescence - Aging, cellular changes during aging, causes of aging -Apoptosis.

Stem cells- Types, properties, application, culture of stem cells.

Cancer cells - Origin of cancer, types, tumor progression, metastasis, diagnosis and treatment.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Institution visit

REFERENCES

1. **P.S. Verma & Agarwal** (2001). Concepts of Cell Biology. S. Chand & Co.
2. **Ajay Paul** (2011). Cell and Molecular Biology. Books and Allied Pvt, Kolkata.
3. **Powar, C.B.** (2002). Cell Biology. Himalaya Publishing House.

FURTHER READING

1. **Cohn, N.S** (1979). Elements of Cytology, Freeman Book Co., New Delhi.
2. **De Robertis, E.D.P. And De Robertis, E.M.F.** (1987), Cell and Molecular Biology, VIII Ed., Lea and Febiger, Philadelphia.
3. **Lodish, H., Berk A., Matsudaira, P., Kaiser, C.A., Krieger, M., Scott, M.P., Zipursky, S.L.And Darnell, J.** (2004). Molecular Cell Biology. W.H. Freeman & Co., New York.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

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

II B. Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	III	21BZO35S	SKILL BASED SUBJECT III: SERICULTURE	4

COURSE LEVEL OUTCOME

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

1. Describe the scope and economics of sericulture.
2. Demonstrate a comprehensive understanding of the types, biology and diseases that afflict the silkworm.
3. Justify various aspects of mulberry cultivation.
4. Propose various steps involved in silkworm rearing and the appliances required in rearing.
5. Perform silkworm reeling.
6. Recommend the characteristics and advantages of silk.
7. Assess the economic aspects in the Sericulture industry.

UNIT – I HISTORY AND SCOPE OF SERICULTURE

History of Sericulture.

Introduction to textile fibres – types - natural/synthetic and their properties, importance of silk fibre.

Characteristic features and advantages of sericulture.

Scope of sericulture in India, employment potential and income generation.

Role of Sericulture extension - Central Silk Board, State Sericulture Departments.

UNIT – II THE SILKWORM

Classification based on the number of Larval Moults, Moultnism and Voltinism.

Types of Silkworms- Tasar, Muga and Eri.

Races of mulberry silkworm.

Morphology and Life cycle of *Bombyx mori*.

Diseases of Silkworm - Pebrine, Flacherie, Grasserie

UNIT – III MULBERRY CULTIVATION

Mulberry cultivars - tropical and temperate regions, irrigated and rainfed conditions

Mulberry cultivation - Preparation of land, Propagation of mulberry plants, Irrigation and Pruning.

Harvesting and Storage of mulberry leaves.

Pests of mulberry plants.

UNIT – IV REARING OF SILKWORM

Rearing of Silkworm - Rearing room, Incubation of eggs, Rearing of worms, Feeding, Cleaning, Spacing, Mounting.

Rearing appliances.

Harvesting of Cocoons.

UNIT – V SILK REELING, SILK AND THE ECONOMICS OF THE

SERICULTURE INDUSTRY

Silk Reeling and Appliances.

Silk properties and uses.

Organic Silk, Dyeing of silk.

Biomedical importance of silk.

Economics of Sericulture – Future and progress of Sericulture Industry in India.

Prospects of Sericulture as Self-Employment venture.

REFERENCES

1. **Ganga G. and Sulochana Chetty J. (2010).** An Introduction to Sericulture, 2nd Edition, Oxford and IBH Publishing House Co. Pvt. Ltd., New Delhi.
2. **Venkatanarasaiah P. (2002).** Sericulture, Daya Publishing House, New Delhi.

FURTHER READING

1. **Kumar A. and Nigam P. M. (2008).** Economic and Applied Entomology, Emkay Publications.
2. **Upadhyay V. B. and Shukla G. S. (2014).** Applied and Economic Zoology, 5th Edition, Rastogi Publications, Meerut.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Field and Sericulture unit visit

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	✓	✓	✓	✓	✓	✓	✓
Entrepreneurial Skills			✓	✓	✓	✓	✓
Lifelong Learning		✓			✓		✓
Reflective Thinking	✓	✓		✓	✓		✓
Moral and Ethical							✓

II B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	IV	21BZO43C	CORE PAPER IV – ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	4

COURSE LEVEL OUTCOME

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

1. Recall the digestion and absorption of biomolecules, role of haemoglobin in respiration, gaseous exchange and the mechanism of urine formation.
2. Evaluate the importance of circulation, muscles contraction, conduction of nerve impulse and the mechanism of vision and hearing.
3. Assess the role of hormones in normal health.
4. Infer the functioning of eyes and ear.
5. Discuss the structure, classification and biological functions of carbohydrates, proteins and lipids.
6. Explain biological importance of enzymes, vitamins and minerals.

ANIMAL PHYSIOLOGY

UNIT – I DIGESTION, RESPIRATION AND CIRCULATION

Digestion and absorption of carbohydrates, proteins and lipids.

Respiration – Structure and functions of Haemoglobin, transport of O₂ and CO₂.

Circulation – Types, structure of the human heart, composition of blood, cardiac cycle and cardiac rhythm.

UNIT – II EXCRETION, MUSCLE CONTRACTION AND NERVE CONDUCTION

Excretion – Structure and functions of the kidney, mechanism of urine formation.

Muscles – Types, chemical composition and mechanism of muscle contraction.

Nerve conduction system – Structure of neuron, conduction of nerve impulse and synaptic transmission.

UNIT – III SENSORY PERCEPTION, REPRODUCTION AND ENDOCRINE GLANDS

Physiology of vision and hearing.

Physiology of male and female reproduction.

Endocrine glands – General structure and functions of Pituitary, Thyroid, Parathyroid, Pancreas, and Adrenal glands.

An account of the reproductive hormones.

BIOCHEMISTRY

UNIT – IV CARBOHYDRATES, PROTEINS AND LIPIDS

Carbohydrates - Classification, structure and biological importance.

Carbohydrate metabolism - Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogenesis, Glycogenolysis, Hexose monophosphate shunt.

Proteins - Classification, structure and biological importance, properties of amino acids.

Protein metabolism - Transamination and deamination.

Lipids - Classification, structure and properties of triacylglycerol.

Lipid metabolism - Beta oxidation of fatty acids.

UNIT – V ENZYMES, VITAMINS AND MINERALS

Enzymes - Classification, mechanism of enzyme action, factors influencing enzyme activity and coenzymes.

Vitamins - Fat soluble and water-soluble vitamins.

Minerals - Biological importance of macro and micro minerals.

REFERENCES

1. **Verma, Tyagi and Agarwal** (1986). Animal Physiology. Chand & Co., New Delhi.
2. **William. S. Hoar** (1976). General and Comparative Physiology, Prentice Hall of India Pvt. Ltd., New Delhi-110 001.
3. **Wood. D. W** (1983). Principles of Animal Physiology. 3rd edition. Houlder & Stroughton Educational.

4. **Prosser and Brown (1985).** Comparative Animal Physiology. Satish Book Enterprise, Agra.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Institution visit

COURSE LEVEL MAPPING OF PROGRAM 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	✓	✓	✓	✓	✓	✓
Reflective Thinking	✓		✓	✓		
Lifelong Learning	✓		✓			✓

II B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	IV	21BZO47S	SKILL BASED SUBJECT II: CLINICAL LABORATORY TECHNIQUES	4

COURSE LEVEL OUTCOMES

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

1. Demonstrate an understanding of the immense practical scope of the subject.
2. Evaluate the essential components and practices in a laboratory.
3. Explain the procedures involved in Hematology, Bacteriology and Parasitology.
4. Examine body fluids and exudates.
5. Contrast the normal values/state from abnormal values/state and thereby be able to assess laboratory reports.
6. Employ the knowledge gained in the establishment of a laboratory.

UNIT – I INTRODUCTION

Scope for the study of Clinical Laboratory Techniques.

Functional components of a clinical laboratory.

Cleaning, Sterilization and Disposal of infected materials.

Storage and handling of chemicals and biological samples.

Safety regulation and first – aid in laboratories.

Quality control in a clinical laboratory.

UNIT – II HAEMATOLOGY

ABO blood grouping, Rh blood typing.

Collection of blood sample, Isolation of plasma and serum.

Enumeration of Total RBC and Estimation of Haemoglobin.

Enumeration of Total WBC and Differential Leucocyte Count.

Determination of blood glucose (hypoglycemia and hyperglycemia), blood cholesterol, blood urea, blood albumin.

UNIT – III MEDICAL BACTERIOLOGY

General characteristics and ultrastructure of bacteria.

Bacteria – Types based on shape and arrangement.

Biochemical tests for bacterial identification.

Culture preparation and staining of microorganisms - *Streptococcus pneumoniae*,
Mycobacterium tuberculosis, *Vibrio cholerae*, *Salmonella* sp.

UNIT – IV PATHOLOGY AND PATHOGENESIS OF PARASITIC INFECTIONS

Protozoan and Helminthic infections with emphasis on - Malaria, Amoebiasis, Leishmaniasis, Schistosomiasis, Filariasis.

Immunoprophylaxis in parasitic infections (vaccination) with emphasis on - Malarial vaccine, Schistosoma vaccine, Leishmania vaccine.

UNIT – V EXAMINATION OF BIOLOGICAL SPECIMENS

Analysis of semen, pus, sputum and stool.

Liver function test.

Estimation of cholesterol.

Urine analysis – Sugar, Urea and Creatinine.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Laboratory visit

REFERENCES

1. **Kani, L. Mukerjee.** Medical Laboratory Technology, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
2. **Samuel, K.M.** Notes on Clinical Lab Techniques. Pub. M.K. Gopalan, Chrompet, Chennai.
3. **Ramnik Sood, M.D.** Medical Laboratory Technology – Jaypee Brothers, Medical Publishers (P) Ltd., New Delhi.
4. **Arumugam, N.** Microbiology (General and Applied). Saras Publications, Kanyakumari.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
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				✓	✓	✓

II B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	IV	21BZO45P	CORE PRACTICAL - II (Based on Core Papers III - Cell Biology and Biotechniques & IV - Animal Physiology and Biochemistry)	2

COURSE LEVEL OUTCOMES

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

1. Prepare smears of body fluids and observe cell types.
2. Assess the stages of cell division by preparing slides or by observing prepared slides.
3. Compare about various tissues.
4. Operate biotechnical equipment.
5. Estimate oxygen intake of fishes.
6. Measure blood parameters.
7. Estimate biochemical parameters and products.

CELL BIOLOGY

Preparation of blood smear and observation of cell types.

Preparation of buccal smear and study of cell types.

Squash preparation of onion root tip to observe the stages of Mitosis.

Study of Grasshopper testis slide and observation of stages of Meiosis.

SPOTTERS

Study of prepared slides of histology - columnar epithelium, cardiac muscle, bone tissue and nerve tissue.

Stages of mitosis.

Compound and binocular microscope.

Centrifuge.

Microtome

Stains

Chromatography.

ANIMAL PHYSIOLOGY AND BIOCHEMISTRY

Estimation of oxygen consumption in fresh water fish.

Qualitative detection of nitrogenous excretory products.

Enumeration of red blood corpuscles using haemocytometer - Demonstration only

Preparation of haemin crystals.

Determination of bleeding and clotting time of blood.

Qualitative estimation of carbohydrates, proteins and lipids.

SPOTTERS

Haemocytometer.

Haemoglobinometer.

Glucometer.

Colorimeter.

REFERENCES

1. **S.S. Lal** (2014). Practical Zoology Volume 3. Rastogi Publications, New Delhi.
2. **N. Arumugam, Jayasurya, Dulsy Fatima, et al.**, (2013). Practical Zoology Volume 3. Saras Publications, Sivakasi.

FURTHER READING

1. **Tembhare BD** (2017). Techniques in Life Sciences. Himalaya Publishing House Pvt. Ltd. Mumbai.
2. **A.S. Ansari and K. S. Kohli** (2016). Practical Zoology Part II. RBD Publishing House, New Delhi.
3. **P. S. Verma and P.C. Srivastava.** (2012). Advanced Practical Zoology. S. Chand & Co., Meerut.

MAPPING OF PROGRAM LEVEL OUTCOMES WITH COURSE LEVEL OUTCOMES

PROGRAM 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 Awareness						✓	
Lifelong Learning	✓			✓		✓	✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	V	21BZO51C	CORE PAPER V- EMBRYOLOGY	5

COURSE LEVEL OUTCOMES

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

1. Describe the process of gametogenesis and fertilization.
2. Illustrate the changes that take place during cleavage.
3. Compare the process of cleavage in frog, chick and pig.
4. Examine the movements that take place during gastrulation.
5. Compare the process of gastrulation in frog, chick and pig.
6. Explain formation of certain organs in the embryo.
7. Interpret the phenomena integral to developmental biology.

UNIT – I GAMETOGENESIS AND FERTILIZATION

Spermatogenesis and types of sperms.

Oogenesis, types and classification of eggs.

Types, Process and physiological events of fertilization. Theories of fertilization.

UNIT-II CLEAVAGE

Planes and Patterns of cleavage.

Salient features of cleavage.

Cleavage in frog, chick and pig.

Spemann's hair-loop experiment.

Molecular changes during cleavage.

UNIT – III GASTRULATION

Morphogenetic movements in

gastrulation. Gastrulation in frog.

Gastrulation in chick.

Gastrulation in pig.

UNIT– IV EMBRYONIC AND POST-EMBRYONIC DEVELOPMENT

Organizer - Types, nature of inductors, mechanism of induction.

Organogenesis – Development of brain and optic cup.

Regeneration – Types of regeneration, origin of blastema cells, events in regeneration.

UNIT –V EMBRYONIC DEVELOPMENT AND FERTILITY CONCEPTS

Nuclear transplantation in Acetabularia.

Extra-embryonic membranes in Chick.

Placentation in mammals.

Infertility and Birth control.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Institutional visit

REFERENCES

1. **Verma P. S. and Agarwal V. K. (2014).** Chordate Embryology, S. Chand and Company Ltd., New Delhi.
2. **Arumugam N. (2019).** A Text Book of Embryology, Saras Publication, Kanyakumari, Tamil Nadu.

FURTHER READING

1. **Balinsky B. I. and Fabian B.C. (2012).** An Introduction to Embryology, 5th Edition, Cengage Learning.
2. **Scott F. Gilbert (2019).** Developmental Biology, Sinauer Associates.

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	✓	✓	✓	✓	✓	✓	✓
Lifelong Learning							✓
Reflective Thinking	✓	✓			✓		
Moral and Ethical							✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	V	21BZO52C	CORE PAPER VI – GENETICS	5

COURSE LEVEL OUTCOMES:

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

1. Summarize the basic concepts of classical genetics and immunogenetics.
2. Explain the processes of linkage, crossing over, sex determination and sex- linked inheritance.
3. Illustrate and differentiate the characteristics and function of DNA, genes, and genetic code.
4. Discuss the major types, causes, and detection of mutation, and the syndromes in man occurring due to chromosomal non-disjunction.
5. Infer human inheritance patterns, and the mechanism underlying certain genetic diseases and inborn errors of metabolism, and the methods of diagnosis.
6. Develop insight about modern concepts of cytogenetics, pedigree analysis, and cancer genetics, and its applications.
7. Compare genome structure and function, DNA and protein sequences, and extrapolate this knowledge for further identification of biological molecules, with perception about scope for advanced studies, research and career.

UNIT I

Mendelian laws – Monohybrid and Dihybrid experiments.

Chromosome theory of heredity (Sutton-Boveri).

Genic interactions – Complementary genes – Supplementary genes (Coat color in mice) – Epistasis (Dominant & Recessive) – Complete dominance – Incomplete dominance – Codominance (Coat color in cattle).

Multiple alleles – definition – ABO blood groups – Rh factor.

UNIT II

Linkage – Coupling and repulsion – Types of linkage – Linkage in *Drosophila*.

Crossing over – Mechanism – Tetrads – Theories – Significance of crossing over.

Sex determination – Theories – Chromosomal theory – Theory of heterogametes – Genic balance theory – Barr body - Male haploidy – Gynandromorphs – Cytological basis of sex determination – Environmental sex determination – Hormonal theory – Free martins.

Sex-linked inheritance in man – Hemophilia and colour blindness.

UNIT III

Genetic code - Gene concept – Cistron, Muton, Recon. DNA as genetic material – Griffith's experiment.

Mutation - Gene mutation - Types (transition, transversion, frame shift, nonsense, missense, null, lethal, forward, backward, suppressor, enhancer) - Chromosomal aberrations and Ploidy - Mutagens and their effects – Detection of X-linked mutation in *Drosophila* by CIB method.

Non-disjunction – Klinefelter’s syndrome – Turner’s syndrome – Down’s syndrome.

Inborn errors of metabolism – Phenylketonuria - Sickle cell anemia.

UNIT IV

Genomes – genomes of model organisms (*C. elegans*, *Drosophila melanogaster*, Zebra fish, etc.), types of genomes.

Genomics – Comparative genomics - Functional genomics.

Human Genome Project (HGP) – Overview of the project - Goals - Major scientific strategies & approaches - Scientific & medical benefits - Technologies used (Basic outline of RFLP, microsatellite markers, STS, EST, DNA sequencing, DNA microarray).

Human inheritance patterns (Basics of Sex-linked, Autosomal, Mitochondrial, Unifactorial, Multi-factorial).

UNIT V

Human Cyto-Genetics – Human karyotype - Banding techniques - Use of human cytogenetics in medical science.

Cancer Genetics – Oncogenes, activation of proto-oncogenes, Tumour suppressor genes.

Pedigree analysis – Symbols of Pedigree - Pedigrees of Sex-linked & Autosomal (dominant & recessive), Mitochondrial, Incomplete dominance & Penetrance.

Molecular Taxonomy in relation to DNA characteristics & Protein sequences – Biological identification through DNA barcodes - Chromosome painting.

Visit to laboratories.

REFERENCES

1. **PS Verma & VK Agarwal (2005)**. Genetics. S Chand & Co., New Delhi.
2. **PS Verma & VK Agarwal (2005)**. Cytology. S Chand & Co., New Delhi.
3. **RP Meyyan (2001)**. Genetics. Saras Publications, Kanyakumari.
4. **PK Gupta (2009)**. Genetics. Rastogi Publications, Meerut.
5. **U Goodenough (1984)**. Genetics. Saunders College Publishing Co., London.

FURTHER READING

1. **DP Snustad, MJ Simmons & RH Tamarin (2012)**. Principles of Genetics. Wiley Publishing Co.
2. **JE Krebs, ST Kilpatrick & ES Goldstein (2013)**. Lewin’s Genes XI. Jones & Bartlett Learning.
3. **Klug & Cummings (1983)**. Concepts of Genetics. Merrill Pub Com., Ohio.
4. **MW Strickberger (2015)**. Genetics. 3rd Edition. MacMillan.
5. **T Strachan & A. Read (2018)**. Human Molecular Genetics. 5th Edition. Garland Science.
6. **G Prasad (2013)**. Introduction to Cytogenetics. Kalyani Publishers.

E-MATERIAL

G Osuri, 2003. Bioinformatics Tutorial. <https://www.bioinformatics.org>

PRACTICALS

- Observation and analysis of websites of NCBI, EMB Net, PDB, and SWISS PROT.
- Perform BLAST search with DNA and protein sequences.
- Analysis and visualization of DNA barcodes at BOLD database.

PEDAGOGY STRATEGIES

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

COURSE LEVEL OUTCOME 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, Self-directed Learning						√	√
Moral and Ethical Awareness				√		√	√
Lifelong Learning			√		√	√	√

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	V	21BZO53C	CORE PAPER VII - EVOLUTION	4

COURSE LEVEL OUTCOMES

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

1. Define the meaning of life, the characteristics of living things.
2. Assimilate and elaborate on the various evidences of evolution.
3. Discuss the various theories of evolution.
4. Discuss the origin of mankind based on various characteristics.
5. Appreciate the Indian fossil systems.
6. Contrast the concepts of evolution.

UNIT – I ORIGIN OF LIFE

1. Defining life, Characteristics of living things.
2. Theories of origin of life -Abiogenesis, biogenesis, Cosmozoic, special creation and organic evolution.
3. Biochemical origin of life - Evolution of chemicals and evolution of first life with experimental support.
4. Geological Time Scale - Eras, periods and epoch.

UNIT – II EVIDENCES OF EVOLUTION

1. Morphological - Homologous and analogous structures, vestigial organs, atavism, adaptive radiation (mammals).
2. Embryological - Developmental stages, similarities of embryos, biogenetic law.
3. Physiological evidences - Enzymes, hormones, blood groups, phosphagens, visual pigments, excretory products and precipitin test.
4. Paleontological - Methods of fossil formation, dating of fossils, fossil connecting links (Archaeopteryx, Seymouria).

UNIT – III THEORIES OF EVOLUTION

1. Lamarckism - Principles, examples and criticisms, Neo-Lamarckism.
2. Darwinism - Brief life history of Charles Darwin, natural selection theory, sexual selection theory, artificial selection theory, Darwin's finches.
3. Neo Darwinism - Experimental evidences in support of Darwinism and explanations to objections.
4. Mutationism - Salient features, examples and evolutionary significance of mutation.

UNIT – IV HUMAN EVOLUTION

1. Biological evolution - Time, place and causes, ancestors of man, Salient features of man and apes, stages of human evolution.
2. Fossil records of man -Propliopithecus, Ramapithecus, Australopithecus, Homo erectus, Neanderthal, Cro- magnon.
3. Cultural evolution of man - Phases -Palaeolithic, mesolithic and neolithic, fire use, hunting, agriculture, burial system, domestication of animals, village life, speech and family organization.
4. Future evolution - Artificial intelligence, Cyborgs.

UNIT – V CONCEPTS OF EVOLUTION

1. Hardy - Weinberg Law - Gene pool, gene frequency, Hardy-Weinberg law and evolution.
2. Speciation - Allopatric, Sympatric, Factors affecting speciation.
3. Isolating mechanisms - Geographic and reproductive isolations, isolation and evolution.
4. Indian fossil systems - Ariyalur and Siwalik, important Indian fossils.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Field/Museum visit

REFERENCES

1. **Veer Bala Rastogi** (2016), Organic Evolution, MedTech Pub. New Delhi.
2. **Arumugam. N** (2014), Organic Evolution, Saras Pub. Kanyakumari.

3. **Chattopadhyay. C**, (2012), Life: Evolution, Adaptation, Ethology, Books and Allied (P) Ltd. Third Edition, Kolkata.

FURTHER READING

1. **Roderick D, M, and Edward, C.H**, (2000). Molecular Evolution: A Phylogenetic Approach: Blackwell science.
2. **Stebbins GL** (1966). Process of organic evolution, Prentice Hall, New Delhi
3. **Dobzhansky T, Ayala FA, Stebbins GL and Valentine JW** (1977). Evolution, Surjeet Publishers, New Delhi.

COURSE LEVEL MAPPING OF PROGRAM 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	✓		✓			
Moral and Ethical					✓	✓
Lifelong Learning	✓	✓				

III B.Sc. ZOOLOGY

Year	Sem	Subject Code	Title of the Paper	Hours/Week
2021-2022 onwards	V	21BZO54C	CORE PAPER VIII: BIOINFORMATICS, BIOSTATISTICS & COMPUTER APPLICATIONS	5

COURSE LEVEL OUTCOME

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

1. Distinguish biological databases, proteomics and genomics.
2. Summarize the tools to retrieve data and the applications of biological data.
3. Classify the methods to represent data.
4. Interpret the measures of central tendency, dispersion and distribution.
5. Utilize office automation tools and also have an introduction to computational biology and artificial intelligence.

BIOINFORMATICS

UNIT I - DATABASES

Bioinformatics-Definition-Literature, databases-NCBI-Pubmed, Medline,

Protein and nucleic acid sequence databases-PIR, Swiss-prot, GeneBank,

DDBJ-structure databases - PDB, SCOP, CATH, structure visualization Tools, RasMol, Swiss PDB viewer.

UNIT II

Pairwise sequence Alignment – Scoring Matrice-PAM and BLOSUM-

Statistics of alignment scored Dot plot – local and global alignment –

Database Searching – FASTA and BLAST multiple sequence alignment clustal W-

Phylogenetic trees-PHYLIP.

BIOSTATISTICS

UNIT – III DATA AND ITS REPRESENTATION

Data - types of data, collection of data, methods of collecting primary data, sources of secondary data.

Classification and tabulation of data.

Diagrammatic representation of data- line diagram, bar diagram (simple, component and percentage), pie diagram and pictogram.

Graphic representation of data – histogram, frequency polygon, frequency curve and Ogive.

UNIT – IV MEASURES OF CENTRAL TENDENCY, DISPERSION AND DISTRIBUTION

Measures of central tendency - Arithmetic mean (Normal and short cut methods alone).

Measures of dispersion – Standard deviation and Standard error.

Student's 't' test and Chi-square test.

UNIT – V COMPUTER APPLICATIONS

Components of computer.

MS Word, MS Excel, MS Power point.

Internet – Search engines (Google, Yahoo), Applications, Cybersecurity.

Computational biology and Artificial Intelligence - Definitions and applications.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs

REFERENCES

1. **Palanichamy and Manohar S** (2014). Statistics for Biologists, Paramount Publications, Palani.
2. **Ignacimuthu S** (2013). Basic Bioinformatics, 2 nd Edition, Alpha Science International Ltd., Narosa Publishing House, New Delhi.

FURTHER READING

1. **Gupta S.P.** (2014). Statistical Methods, 44th Edition, Sultan Chand and Sons Pvt. Ltd., New Delhi.
2. **Rastogi S.C., Mendiratta, N. and Rastogi P.** (2013). Bioinformatics – Methods and Applications, 4 th Edition, PHI Learning Press, New Delhi.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME				
	1	2	3	4	5
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	✓		✓		✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	V	21BZO55S	SKILL BASED PAPER III: APPLIED ZOOLOGY	4

COURSE LEVEL OUTCOMES

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

1. Discuss the concept of lac insect and its cultivation.
2. Design different pearl culture techniques.
3. Analyze the feasibility and viability of integrated fish farming.
4. Infer essentials for the establishment of aquaponic systems.
5. Assess the demand for infusoria and understand the culture of infusoria as a small-scale industry.
6. Propose avenues available for the establishment of small businesses.

UNIT – I LAC CULTURE

Lac Insect - systematic position, distribution, life cycle.

Cultivation of lac insect - host plants, natural and artificial inoculation.

Harvesting and processing of lac.

Composition and properties of lac.

UNIT – II PEARL CULTURE

Pearl producing molluscs - systematic position, process of pearl formation.

Pearl industry - programming and artificial insertion of nucleus.

Harvesting, clearing and composition of pearl.

UNIT – III INTEGRATED FISH FARMING

Definition, advantages, types.

Agriculture cum fish culture - paddy cum fish culture.

Animal husbandry cum fish culture - poultry cum fish culture, dairy cum fish culture, duck cum fish culture, pig cum fish culture.

UNIT – IV AQUAPONICS

Aquaponic systems- Types and components.

Water chemistry- nitrogen cycle, nutrient flow, pH, water quality.

Fish introduction, Fish health, Fish management.

Plant introduction, Plant health, Plant management.

Aquaponic systems maintenance.

UNIT – V CULTURE OF INFUSORIA

Introduction – definition, advantages of Infusoria

Culture of Infusoria – using banana skin, using sliced potato, using hay infusion, using lettuce leaves, using droppings of freshwater snail.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Field/Institution visit

REFERENCES

1. **G.S.Shukla & V.B.Upadhyay** (1988). Economic Zoology. Rastogi Publication, Meerut.
2. **N. Arumugam** (2014). Aquaculture. Saras publication, Sivakasi.

FURTHER READING

1. **Meenakshi Jindal, N.K.Yadava and R.K Gupta** (2010). Freshwater Ornamental Fishes. Mangalam Publications, New Delhi.
2. **Sylvia Bernstein** (2017). Aquaponics Gardening: A step-by-step guide to raising vegetables and fish together. New Society Publishers.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
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				✓	✓	✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/ Week
2021 -2022 onwards	V	21BZO5EL	NON-MAJOR ELECTIVE PAPER I: BIOFARMING-I (For non-Zoology major students only)	3

COURSE LEVEL OUTCOMES

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

1. Describe the types of bees, biology and behavior of bees and bee keeping
2. Infer the lifecycle of silkworms and the properties and uses of silk.
3. Propose vermicomposting technique and appreciate its contribution to solid waste management.
4. Establish a mushroom cultivation enterprise.
5. Justify the role of biofertilizers and the basics of biofertilizer production.

UNIT – I APICULTURE

Scope of Apiculture.

Types of honey bees (*Apis dorsata*, *Apis florea*, *Apis indica*, Dammer bee).

Bee colony- Bee keeping – Modern hives (Langstroth ten frame hive, Newton’s hive).

Bee keeping Equipments.

Honey, bee wax.

UNIT – II SERICULTURE

Silkworm varieties (Eri, Muga, Tassar)

Life cycle of *Bombyx mori*.

Rearing of Silkworm.

Silk – properties and uses.

UNIT – III VERMICULTURE

Types of earthworms employed in vermicomposting.

Methods of vermicomposting.

Role of earthworms in waste management.

UNIT – IV MUSHROOM CULTURE

Cultivable edible mushrooms.

Cultivation of oyster mushroom and white button mushroom.

Storage of mushrooms.

Economic importance –Nutritive and medicinal value and other uses of mushrooms.

UNIT – V BIOFERTILIZERS

Introduction to green manures.

Production and application of Bacteria-*Rhizobium*.

Production and application of Azolla.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Field/ Institution visit

REFERENCES

1. **Shukla G.S.** (2014) Economic Zoology, Restogi Publication, Meerut.
2. **Arumugam N** (2015). Economic Zoology, Saras Publication, Kanyakumari, Tamil Nadu.
3. **Dubey R.C.** (2014). A textbook of biotechnology. S.Chand Publishing. New Delhi.
4. **Kumaresan V.** (2009). Biotechnology, Saras Publication, Kanyakumari, Tamil Nadu.

FURTHER READING

1. **Upadhyay V.B. and Shukla G.S.** (2014). Applied and economic zoology.5th edition. Rastogi Publications, Meerut.
2. **Vinita Jaiswal and Kamal Kumar Jaiswal** (2014). Economic Zoology, Prentice Hall of India Publishers, New Delhi.
3. **Sarkar Kundu Chaki** (2002). Introduction to Economic Zoology. New Central Book Agency (P) Ltd. Pub., New Delhi.

WEBSITES

1. <https://www.osbeehives.com>
2. <https://agritech.tnac.ac.in>
3. <https://www.earthwormsoc.org.uk>
4. <https://mushroomcouncil.com>
5. <https://www.toppr.com>

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES.

PROGRAM LEVEL OUTCOME	COURSE LEVEL OUTCOME				
	1	2	3	4	5
Disciplinary Knowledge	✓	✓	✓	✓	✓
Communication Skills		✓	✓		
Critical Thinking	✓	✓	✓	✓	✓
Analytical Reasoning	✓	✓	✓		✓
Research Related Skills	✓	✓	✓	✓	✓
Scientific Reasoning				✓	✓
Entrepreneurial Skills	✓	✓	✓	✓	✓
Reflective Thinking	✓	✓	✓	✓	✓
Lifelong Learning	✓			✓	

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO61C	CORE PAPER IX: IMMUNOLOGY AND MICROBIOLOGY	5

COURSE LEVEL OUTCOMES

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

1. Describe immunity and contributions of the organs and cells in immune responses.
2. Demonstrate the production of antibodies.
3. Illustrate the mechanisms involved in initiation of specific immune responses.
4. Infer vaccines and immune disorders.
5. Explore the role of microbes in food processing, spoilage and preservation.
6. Judge the importance of microbes in industries.

IMMUNOLOGY

UNIT – I TYPES OF IMMUNITY

Immunity – Innate immunity - Physical factors, Mechanical factors, Biochemical factors, Cellular factors, Genetic factors.

Acquired immunity – Natural, Artificial, Active, Passive.

Cell mediated immunity.

UNIT – II LYMPHOID ORGANS AND CONSTITUENT CELL TYPES

Lymphoid organs – Primary Lymphoid organs - Thymus, Bursa of *Fabricius*, Bone marrow.

Secondary Lymphoid organs - Lymph node, Spleen, MALT, Peyer's patches, Tonsils.

Cells of the immune system - Lymphoid lineage, Myeloid lineage.

UNIT – III EFFECTOR MOLECULES OF THE IMMUNE SYSTEM, VACCINES AND IMMUNE DISORDERS

Antigens – haptens - chemical nature of antigens – Antigenic determinants – factors of antigenicity.

Antibody – Immunoglobulin - Types and functions of Immunoglobulins - Structure and biological properties of Immunoglobulin G.

Immunizing agents – Vaccines - Types of Vaccines - Common Vaccines.

Concept of herd immunity.

Auto immune disorders – Definition, Characteristics -Systemic lupus erythematosus, Rheumatoid arthritis.

MICROBIOLOGY

UNIT – IV BACTERIA, VIRUS AND ASSOCIATED DISEASES

Classification – Whittaker’s five kingdom concept.

Structure and Reproduction of Bacteria.

Bacterial diseases in Man – Typhoid, Cholera, Tuberculosis.

Structure and Reproduction of T4 Phage.

Viral diseases in Man – AIDS, Polio, Rabies, Ebola, COVID 19.

Host-hijack mechanism.

UNIT – V FOOD AND INDUSTRIAL MICROBIOLOGY

Role of microbes in food production - Microbiology of fermented food and dairy products – cheese, yogurt, Alcoholic beverages-beer, wine etc.

Food spoilage and preservation processes.

Microbes as source of food - single cell protein.

Application of microbes in industries- production of antibiotics (penicillin, streptomycin), amino acid (glutamic acid) organic Acids (citric acid and lactic acid).

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Industrial visit

REFERENCE BOOKS

1. **Ananthanarayan R. and Paniker C.K.J.** (2009). Textbook of Microbiology. University Press Publication.

2. **Frazier WC and Westhoff DC.** (1992). Food Microbiology. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
3. **Ivan M. Roitt, J. Brostoff and D. K. Male** (1993). Immunology, Gower Medical Publishing, London.
4. **Janis Kuby** (1993). Immunology, II edition. W. H. Freeman and Company, New York.
5. **Janeway Travers** (1997). Immunobiology- the immune system in health and disease. Current Biology Ltd. London, New York.
6. **Tortora GJ, Funke BR, and Case CL.** (2008). Microbiology: An introduction. Pearson Education. 9th Edition.

FURTHER READING

1. **Goering R., Dockrell H., Zuckerman M. and Wakelin D., Mims** (2007). Medical Microbiology. Elsevier.
2. **Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A., Jawetz, Melnick and Adelberg** (2013). Medical Microbiology. McGraw Hill Publication.
3. **Wiley JM, Sherwood LM AND Woolverton CJ, Prescott, Harley and Klein** (2013). Microbiology. McGraw Hill Higher education.

MAPPING OF PROGRAMME LEVEL OUTCOME WITH COURSE 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	✓		✓			
Moral and Ethical Awareness					✓	✓
Lifelong Learning	✓	✓		✓	✓	✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO62C	CORE PAPER X: BIOTECHNOLOGY	5

COURSE LEVEL OUTCOMES

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

1. Discuss the molecular tools of genetic engineering namely enzymes, vectors and probes.
2. Examine the essential techniques involved in DNA isolation and purification, DNA sequencing, DNA amplification, DNA synthesis.
3. Apply the understanding of the tools and techniques in the protocols employed for gene cloning in Prokaryotes and Eukaryotes.
4. Demonstrate cell culture and organ culture techniques.
5. Apply the methods of biotechnology in Assisted Reproductive Technology.
6. Justify the nuclear transfer method of gene cloning with the example of cloning in Dolly.
7. Analyze the contribution of biotechnology in medicine, agriculture, industry, food science and environmental protection.

UNIT – I MOLECULAR TOOLS OF GENETIC ENGINEERING

Scope of Biotechnology – Biotechnology tree.

Enzymes – Restriction endonuclease, Reverse transcriptase, Ligase, Alkaline phosphatase, DNA Polymerase - Klenow fragment.

Cloning Vectors – Bacterial vector (Plasmid -pBR322), Bacteriophage vector (λ gt 10), Cosmid (pJB8), Animal viral vector (SV40), Yeast vector (YAC vector), Shuttle vector (pJDB219).

Molecular Probes – Construction and Labelling.

UNIT – II TECHNIQUES IN GENETIC ENGINEERING

Technique for the Isolation and Purification of genomic DNA.

Blotting Technique – Southern Blotting.

DNA Sequencing Technique – Sangar and Coulson method.

DNA Amplification Technique – PCR - Technique and Application.

UNIT – III GENE CLONING

In Prokaryotes– Preparation of desired DNA (Restriction digestion, cDNA synthesis, Chemical synthesis - Phosphoramidite method).

Insertion of rDNA (Linkers, Adaptors, Homopolymer tailing).

Introduction of r DNA (Transformation, Transduction, Electroporation).

Selection of rDNA (Direct selection, Colony hybridization).

In Eukaryotes–Introduction of rDNA (Transfection, Liposome mediated gene transfer, Particle bombardment, Virus vector method and Microinjection).

UNIT—IV ANIMAL BIOTECHNOLOGY AND REPRODUCTIVE BIOTECHNOLOGY

Cell culture – Steps involved in the cell culture technique.

Organ culture – Methods and Application.

Animal Cloning – Nuclear Transfer Method – Cloning in Sheep (DOLLY).

Assisted Reproductive Technology in man – Artificial insemination (AI), In vitro fertilization (IVF), Embryo transfer (ET), Gamete intra – fallopian transfer (GIFT), Zygote intra – fallopian transfer (ZIFT) and Intra-cytoplasmic sperm injection (ICSI).

UNIT – V APPLIED BIOTECHNOLOGY

Medical Biotechnology – Production of Hepatitis B Vaccine, Monoclonal Antibodies (mABs) and Human insulin.

Agricultural Biotechnology – Production of Bio-fertilizer (Rhizobium) and Bioinsecticide (Bacillus thuringiensis).

Industrial Biotechnology – Production of Antibiotic (Pencillin) and Alcohol (Ethanol).

Food Biotechnology – Production of SCP (Spirulina) and Mushroom (White Button).

Environmental Biotechnology – Biodegradation of Hydrocarbons, Pesticides, Polychlorinated Biphenyls (PCBs) – Super Bug.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation

- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Institution visit

REFERENCES

1. **Kumaresan V.** (2009). Biotechnology, Saras Publication, Kanyakumari, Tamil Nadu.
2. **Satyanarayana U.** (2005). Biotechnology, 1st Edition, Books and Allied (P) Ltd., Kolkata.
3. **Dubey R.C.** (2014). A Textbook of Biotechnology, S. Chand Publishing, New Delhi.

FURTHER READING

1. **Das H.K.** (2017). Textbook of Biotechnology, 5th Edition, Wiley India Pvt. Ltd., New Delhi.

WEBSITES

<https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod4.pdf>

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES

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	✓	✓					✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO63C	CORE PAPER XI – ECOLOGY AND ETHOLOGY	5

COURSE LEVEL OUTCOME

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

1. Describe the significance of environment.
2. Illustrate the structure and functions of ecosystems.
3. Discuss the impact of the various kinds of pollution.
4. Analyze the sleeping patterns of animals.
5. Interpret the learning processes of animals.
6. Investigate the nesting behavior of birds and tool-using behavior of apes.

UNIT – I ECOLOGICAL FACTORS

1. Man and environment - Uses, threats and conservation.
2. Environment - Abiotic factors - Atmosphere and temperature.
3. Biotic factors - Interspecific relationships of animals.
4. Biogeochemical cycles - Oxygen, Carbon, Nitrogen, Phosphorus, Sulphur.

UNIT – II COMMUNITY ECOLOGY

1. Ecosystem - Structure and function of pond and estuarine ecosystems.
2. Food chain, Food web, Ecological pyramids.
3. Community ecology - Characteristics, types and pattern of succession, ecotone and edge effect, climax.
4. Population ecology - Density, natality, mortality, growth, equilibrium, dispersal.

UNIT – III HABITAT ECOLOGY

1. Fresh water - Lotic - Characteristic and adaptations.
2. Marine - Stratification, Intertidal shores, deep sea - adaptations.
3. Terrestrial - Desert - characteristics and adaptations.
4. Pollution - Air, Water, Land, Noise - Ecological effects and control measures.

UNIT – IV BEHAVIOUR PATTERNS

1. Historical perspectives - Classical (Darwin), Modern (Niko Tinbergen, Karl von Frisch and Konrod Lorenz)
2. Patterns of behavior - Fixed action pattern and acquired behaviour.
3. Chronobiology - Biological clock, Circadian rhythm.
4. Communication - Dance language of Honeybees, Gestures in man.

UNIT – V LEARNING BEHAVIOUR

1. Pheromones and behavior - Alarm, trail, sex attractant, aggression and territorial pheromones.
2. Learning behavior - Simple learning (Sensitization, Habituation) and associative learning (Conditioning, Insight and imprinting).
3. Tool- using behavior in Chimpanzees.
4. Nesting behavior of birds.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Field/Museum visit

REFERENCES

1. **N.Arumugam** (2019). Concepts of Ecology, Saras Publication, Tamil Nadu.
2. **Nataraja.P, N.Arumugam** (2018). Ethology (Animal Behaviour), Saras Publication, Tamil Nadu.
3. **Rastogi V.B and Jayaraj.M.S.** (1998). Animal Ecology and Distribution of Animals, Kedarnath Ramnath Publishers, Meerut.

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1. **Eugene P Odum and Gary W Barrett** (2005). Fundamentals of Ecology, 5th Edition, Cengage Publishers.
2. **Gundevia H.S. and Hare Govind Singh** (2013). A Text book of Animal

Behaviour, 7th Edition, S. Chand Publishing, New Delhi.

3. **Chattopadhyay.C** (2012). Life: Evolution, Adaptation, Ethology, Books and Allied (P) Ltd. Third Edition, Calcutta.

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES.

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

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO64P	CORE PRACTICAL III (Based on Paper VII Evolution and Paper VIII Bioinformatics, Biostatistics and Computer applications & Paper XI Ecology & Ethology)	2

COURSE LEVEL OUTCOME

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

1. Distinguish Homologous organs, Analogous organs and Fossil formation.
2. Estimate pH, salinity as well as oxygen content in water samples.
3. Undertake plankton culture and study animal associations as well as fauna.
4. Analyze data and give its representations.
5. Browse and collect data from Bioinformatic sites.
6. Create data as Word, Excel or Power point document.

EVOLUTION

Homologous organs.

Analogous organs.

Study of fossils – Living fossils.

ECOLOGY and ETHOLOGY

Measurement of pH of water samples.

Estimation of salinity of water samples.

Estimation of dissolved oxygen in water samples.

Study of planktons- Marine and Freshwater- Culture of planktons

Animal associations.

Study of fauna: a. Intertidal rocky shore b. Sandy shore c. Muddy shore

BIOSTATISTICS

Collection of biological data.

Construction of frequency distribution.

Representation of data – Histogram, Frequency polygon.

BIOINFORMATICS

Browsing of different sites related to bioinformatics.

Collection of data from different sources.

Entry page of SWISS PROT and BLAST.

COMPUTER APPLICATIONS

MS – Word.

MS – Excel

MS – Power point.

PRACTICALS

- Observation and analysis of websites of NCBI, EMB Net, PDB, and SWISS PROT.
- Perform BLAST search with DNA and protein sequences.

Analysis and visualization of DNA barcodes at BOLD database.

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2. **N. Arumugam, Jayasurya, Dulsy Fatima, et al.**, (2013). Practical Zoology Volume 3. Saras Publications, Sivakasi.
3. **A.S. Ansari and K. S. Kohli** (2016). Practical Zoology Part II. RBD Publishing House, New Delhi.
4. **P. S. Verma and P.C. Srivastava**. (2012). Advanced Practical Zoology. S. Chand & Co., Meerut.

MAPPING OF PROGRAM LEVEL OUTCOMES WITH COURSE LEVEL OUTCOME

PROGRAM 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					✓	✓
Lifelong Learning	✓			✓		

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO65P	CORE PRACTICAL IV (Based on Paper V Embryology, Paper VI Genetics, Paper IX Immunology and Microbiology & Paper X Biotechnology)	2

COURSE LEVEL OUTCOME

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

1. Culture and Identify *Drosophila* species.
2. Undertake blood grouping and fingerprint identification in man.
3. Examine the development of chick and frog.
4. Investigate the formation of fetal membranes in mammals.
5. Differentiate the slides of Lymphoid organs.
6. Calibrate and measure size of organisms.
7. Design microbial media prepare and follow subsequent procedures.
8. Identify Equipment needed for Microbiology and Biotechnology.

EMBRYOLOGY

1. Observation of prepared slides
 - a. Different Developmental stages of Chick
 - b. Cleavage in frog
2. Foetal Membranes and Placenta
 - a. Pig
 - b. Sheep
 - c. Rabbit

GENETICS

Culture of *Drosophila* and Identification of male and female *Drosophila*.

Study of *Drosophila* culture.

Blood Grouping in man.

Identification of Finger prints (whorl, arch, loop)

IMMUNOLOGY

1. Observation of slides of primary and secondary Lymphoid organs
 - a. Thymus
 - b. Bone marrow

- c. Spleen
- d. Lymph node

MICROBIOLOGY AND BIOTECHNOLOGY

1. Calibration of the ocular micrometer. Measurement of the diameter of Paramecium.
2. Preparation of microbial culture media - a. Slab b. Slant c. Agar plate
3. Methylene blue reduction test – MBR.
4. Study of bread mould.
5. Isolation of DNA from squamous epithelial cells.
6. Immobilization of yeast cells.

SPOTTERS

Inoculation loop

Inoculation needle

Agar plate

Autoclave

Hot air oven

Laminar Air flow

Polymerase Chain Reaction - PCR

SDS-PAGE – DNA

REFERENCES

3. **S.S. Lal** (2014). Practical Zoology Volume 3. Rastogi Publications, New Delhi.
4. **N. Arumugam, Jayasurya, Dulsy Fatima, et al.**, (2013). Practical Zoology Volume 3. Saras Publications, Sivakasi.

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2. **Tembhare BD** (2017). Techniques in Life Sciences. Himalaya Publishing House Pvt. Ltd. Mumbai.

3. **A.S. Ansari and K. S. Kohli** (2016). Practical Zoology Part II. RBD Publishing House, New Delhi.
4. **P. S. Verma and P.C. Srivastava.** (2012). Advanced Practical Zoology. S. Chand & Co., Meerut.

MAPPING OF PROGRAM LEVEL OUTCOMES WITH COURSE LEVEL OUTCOMES

PROGRAM 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			✓		✓	✓	✓	✓
Lifelong Learning	✓			✓				✓

III B.Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO67S	SKILL BASED SUBJECT III: ORNAMENTAL FISH CULTURE	4

COURSE LEVEL OUTCOME

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

1. Describe the scope of ornamental fish culture.
2. Summarize the steps involved and the equipment required in the establishment of an aquarium.
3. Investigate the breeding of ornamental fishes (live bearers and egg layers).
4. Prepare live feed and artificial feed.
5. Assess the common diseases that afflict the ornamental fish.
6. Evaluate the economics of ornamental fish culture.

UNIT-I ORNAMENTAL FISHES AND THEIR BIOLOGY

Introduction and scope of Ornamental fish culture.

Taxonomy of five aquarium fishes – marine, fresh water fishes.

Water tolerance in fishes.

UNIT-II CONSTRUCTION OF AN ORNAMENTAL FISH TANK

Design and construction of ornamental fish tank.

Aquarium setting.

Aquarium accessories and decorative items –natural and artificial aquatic plants, insects, aerators and heaters.

Maintenance of aquarium - Cleaning, Control of algal growth.

Water filtration system -types of filters - biological, mechanical and chemical.

Water quality management in aquarium fishes- Ammonia oxidation- Microorganisms.

UNIT-III BREEDING OF ORNAMENTAL FISHES

Commercially important

ornamental fishes. Selection of species.

Breeding of livebearers. Breeding of egg layers.

Application of genetics and biotechnology for producing quality strains.

UNIT –IV FISH FEED AND FISH DISEASES

Culture of live feeds.

Methods of preparation of artificial feeds.

Common Diseases and their control.

Viral - carp pox, spring viraemia of carp (SCV).

Bacterial-fin rot and fish dropsy

Fungal - *Saprolegnia* and *Ichthyophonus hoferi*

Protozoan - white spot disease (Ich) and velvet disease.

UNIT –V COMMERCIAL ASPECTS OF ORNAMENTAL FISH CULTURE

Transportation of ornamental Fishes.

Economics of ornamental fish culture-setting up of an export-oriented unit- (financial viability)- financial assistance – NABARD.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- PowerPoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Practical classes in real and virtual labs
- Visit to an ornamental fish culture unit

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1. **Thara Devi C.S., Jayashree K.V., Arumugam N. (2015).** Home Aquarium and Ornamental Fish Culture, Saras Publication, Kanyakumari, Tamil Nadu.
2. **Arumugam N. (2014).** Aquaculture. Saras Publication, Kanyakumari, Tamil Nadu.
3. **Venugopal S. (2006).** Aquaculture, Pointer Publishers, Jaipur.

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1. **Ahilan B., Felix N. and Santhanam R. (2008).** Textbook of Aquaculture, Daya

- Publishing House, New Delhi.
2. **Gupta S. K. and Gupta P. C. (2006).** General and Applied Ichthyology, S. Chand Publishing, New Delhi.
 3. **Saroj K. Swain Sarangi N. and Ayyappan S. (2010).** Ornamental Fish Farming, Indian Council of Agricultural Research, New Delhi.
 4. **Hawkins A. D. (1981)** Aquarium System, Academic Press.
 5. **Rataj. K. and R. Zukal (1971)** Aquarium Fishes and plants. Himalaya publication. Bew Delhi.

MAPPING OF PROGRAMME LEVEL OUTCOME WITH COURSE LEVEL OUTCOME

PROGRAMME LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
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		✓	✓			✓

III B. Sc. ZOOLOGY

Year	Sem.	Subject Code	Title of the Paper	Hours/Week
2021 -2022 onwards	VI	21BZO6EL	NON-MAJOR ELECTIVE PAPER II: BIOFARMING-II (For non-Zoology major students only)	3

COURSE LEVEL OUTCOME

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

1. Recall the potential avenues for the commercial application of Zoology.
2. Design aquarium and perform ornamental fish rearing.
3. Understand the essentials of rearing chickens and the breeds commonly reared in India.
4. Justify dairy farming.
5. Prescribe the knowhow of establishing a rabbit farm.
6. Establish a pig farm.

UNIT – I ORNAMENTAL FISH CULTURE

Aquarium – aims of aquarium.

Requirements in setting of an aquarium.

Aquarium fishes.

UNIT – II POULTRY KEEPING

Fowl breeds (White Leghorn, Ancona, Black Minorca, Australorp)

Construction of poultry house.

Rearing of chickens - layers, broilers, growers,

Food and feeding.

Poultry products - eggs, meat.

UNIT – III CATTLE FARMING

Scope of dairy farming.

Breeds of dairy animals - cow (Gir, Red Sindhi, Jersey), buffaloes (Murrah), goat

Jamunapari, Malabari).

Food and feeding - buffaloes, goat.

Management of cow- feeding management, reproductive management.

Milk and milk products (curd, butter, ghee).

UNIT – IV RABBIT FARMING

Breeds of rabbits.

Care and Management of rabbit farms.

Products-meat, fur and wool.

UNIT – V PIG FARMING

Breeds of pig.

Feeding and reproductive management of pig breeds.

Products of piggery.

PEDAGOGICAL STRATEGIES

- Chalk and Board lecture
- Powerpoint slide presentation
- Seminar
- Assignment
- Quiz
- Group discussion
- Field/ Institution visit

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1. **Shukla G.S.** (2014) Economic Zoology, Rastogi Publications, Meerut.
2. **Arumugam N.,** (2015). Economic Zoology, Saras Publication, Kanyakumari, Tamil Nadu.
3. **Kumaresan V.** (2009). Biotechnology, Saras Publication, Kanyakumari, Tamil Nadu.
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2. **Sarkar Kundu Chaki** (2002). Introduction to Economic Zoology. New Central Book Agency (P) Ltd. Publishers.
3. **Dinesh Kumamaznee and Ashok Kumar Rathoure** (2015). Applied and Economic Zoology, Daya Publishing House.

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2. <https://www.britannica.com>
3. <https://www.dairydiscoveryzone.com>
4. <https://agritech.tnac.ac.in>
5. <https://www.agrifarming.in>

COURSE LEVEL MAPPING OF PROGRAM LEVEL OUTCOMES.

PROGRAM LEVEL OUTCOME	COURSE LEVEL OUTCOME					
	1	2	3	4	5	6
Disciplinary Knowledge	✓	✓	✓	✓	✓	✓
Communication Skills	✓		✓			✓
Critical Thinking	✓	✓	✓	✓	✓	
Problem Solving		✓	✓	✓		✓
Analytical Reasoning	✓	✓	✓	✓	✓	✓
Research Related Skills	✓	✓	✓	✓	✓	✓
Scientific Reasoning		✓		✓		
Entrepreneurial Skills	✓	✓	✓	✓	✓	✓
Reflective Thinking	✓			✓		
Lifelong Learning	✓		✓		✓	