Parvatibai Chowgule College of Arts and Science

Autonomous

Accredited by NAAC with Grade 'A' (CGPA Score 3.41 on a 4 Point Scale in 3rd cycle)

Best affiliated College-Goa University Silver Jubilee Year Award

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

for

Undergraduate Programme
BSc Zoology

Zoology

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS)
BSC ZOOLOGY

PREAMBLE:

Learning Outcome Based Education (LOBE), is a means of adherence to student-centric learning approach to measure student's performance based on pre-determined set of outcomes. Learning Outcome based Curriculum Framework (LOCF), is a consolidated document for Bachelor of Science in Zoology at Parvatibai Chowgule College of Arts and Science (Autonomous) which describes the processes and curriculum adopted to attain the expected outcome. Learning Outcome Based Education focuses on bringing out reforms in curriculum framework that has to be outcome based; constant up gradation of academic resources; raising quality of research and teaching; integrating technology in the teaching-learning processes, using appropriate teaching-learning pedagogies, designing appropriate assessment modes; bringing out clarity among students as to what is expected from them after completion of the programme and for teachers in bringing focus on what to teach, how to teach and evaluate.

1) INTRODUCTION:

Bachelor of Science in Zoology is an undergraduate programme has course curriculum with exciting new fields and genuine sense of engagement of lectures, practicals, field activities, projects, assignments and internships for Zoology majors. It is central to the ethos of the Department to value both teaching and research. The department aims to create Zoologists who are knowledgeable and skilled.

2) OBJECTIVES OF BSC ZOOLOGY:

The objective of BSc Zoology - an undergraduate programme, is to create Zoologists with sound knowledge of fundamental and applied Zoology and empower them with employability skills for placement in wildlife or fishery sector or pursue career as pathological and genetic technician or establish oneself as a researcher or teacher.

Curriculum of BSc Zoology at Parvatibai Chowgule College is designed to be “knowledge and skills enhancement process” rather than mere “knowledge gaining process”. The programme offers elective courses which are focused on making graduates employable considering the needs of the employment sectors. The teaching methodologies are student centric and focused on making the students independent learners. Information and Knowledge dissemination is through ICT supplemented lectures and practicals and active learning methods through group activities, cooperative learning strategies, research based learning, research assignments, research projects, group discussions, case studies, project based learning, class quiz, problem based learning, field based studies and student presentations. These methodologies foster thinking and analytical skills in students and make them understand the importance of team work, enable higher order learning and understand and adopt steps of problem solving. Internships, research project and community outreach are compulsory component of the curriculum. Industry-Academia lectures are conducted to enrich the subject knowledge and

The students completing the course may seek employment in Wildlife, Fishery, Genetic and Research Sectors. Curriculum of BSc Zoology, also facilitates students to look at entrepreneurship opportunities in Pisciculture, Ecotourism and Animal husbandry.

3) OVERVIEW OF DEPARTMENT:

i) ***Courses:*** For the undergraduate programme BSc Zoology, the courses focus on the thrust areas of wildlife, fishery, paramedical and research. Besides the fundamental core courses, the department also offers elective courses which are focused on imparting in-depth knowledge in the following employment sectors:

- Wildlife: Diversity Of Animals And Biological System, Evolutionary Biology, Ecology, Ethnology, Basic And Applied Entomology.
- Fishery: Environmental Toxicology, Aquaculture And Fishery, Economic Zoology, Fish Preservation And Processing.
- Paramedical: Endocrinology, Human Genetics, Immunology, Parasitology, Physiology, Molecular Genetics And Forensic Science, Health And Nutrition, Lab Techniques In Pathology.
- Research / teaching: Cell Culture, Animal Biotechnology, Entrepreneurship, Research Methodology, Research Project, Research based practicals, Research based activities.

ii) ***Faculty:*** Department faculty have expertise in the field of Human genetics, Genetic epidemiology, Genotoxicity, Cell culture, avian studies, Biodiversity studies, Ecological studies and wildlife monitoring. They are actively involved in research activities and have contributed to knowledge in their respective subject domain through research publications, or as resource persons for institutions/scientific associations. Faculty members have carried out 08 research projects, organised

numerous seminars/conferences/guest lectures at state and National level. Faculty are also recipient of Best Teacher Awards, Best research paper awards etc.

iii) ***Infrastructure and facilities:*** Providing the appropriate resources and infrastructure for effective teaching- learning is crucial to establish effectiveness of the curriculum. Course teaching is done in ICT enabled classrooms, flipped classroom, well equipped laboratories and Department museum harbouring diverse organisms and rare specimen. Students can carry out practicals and research work at the 'Central research lab' of the college, with tissue culture facilities and molecular biology studies. The department also has specialized Genetic Research Laboratory which offers summer-winter hands on trainings to students for Human Karyotyping, DNA damage analysis, pathological techniques and cell culture. Besides student learning experience is enhanced by Student support Service centre, Tigers Studio, Auditoriums and Library.

iv) ***Opportunities for students/Activities****:* The department organizes various activities for the students focused on executing the mission of the department. The students are given ample opportunities to enhance their academic skills as well as soft skills through the co-curricular and extracurricular activities. Concern for the environment and responsibility towards the community is a virtue taught to the students.

a) Learning platform: As per the institutional policy, learning resources are made accessible to the students by the course faculty on moodle based platform called 'CLAAP' (Chowgule's

Learn Anytime Any Place). CLAAP is a medium where course curriculum, learning objectives, Evaluation Rubrics, assessment dates and modes, laboratory manuals/journals, results of assessment and class lab policies etc are uploaded for each course by the concerned course faculty.

b) *Learning Resources*: Resources provided to the students include PowerPoint presentations of the lectures, word docs/PDFs of matter, Links to recent advances on topic taught, Animations / Videos, Worksheets, Concept maps, Ebooks, journal resources,

c) *Extensive usage of ICT:* Teaching-Learning-Evaluation processes are ICT integrated. This creates a conducive learning environment for students. Students are encouraged to use electronic gadgets in the classroom and laboratories and enhance their learning.

d) *Industry-Academia Lectures:* To acquaint the students with recent progress in specific areas and expose them to opportunities in areas of wildlife, ecotourism and research, Industry academia lectures are regularly organized for the students.

e) *Summer trainings and short term courses*: Students can also enhance their employability skills through specialized trainings and short term courses offered by the department. Specialized courses include Certificate courses in Medical Lab Techniques and Human Genetic techniques. Summer trainings offered are in the field of pathological techniques, Karyotyping, genetic research techniques, avifaunal studies

f) *Field Based Learning*: Many courses at the department are integrated with field based activities to offer experiential learning.

g) ***Linkages for research and internship****:* Associations in the form of MoUs and linkages are created to offer research and internship opportunities to students. Department has linkages with Goa Forest Department, Mhadei Research Centre, Mangrove Society of India, Entrepreneurship firms and 06 hospitals.

h) ***Social Responsibility****:* As part of social responsibility, the TYBSc students have to carry out mandatory community outreach activities. Every year under the guidance of all the faculty members of the department community outreach activities are carried out.

i) ***Extracurricular Activities***: To make students more responsible and understand the process of organizing events, the department has student focused activities. Clubs, activities and newsletters edited by students give opportunities to students to develop leadership qualities by being on committees, and understand the importance of team spirit to coordinate and methodically execute multiple events successfully. Clubs of the department include Birders Club, Butterfly garden and Vermicomposting. *Annual intercollegiate event 'Symbiosis' is organised and executed by the students.*

v) ***Student progression****:* On completion of the programme, most students pursue post graduate degree courses, while some opt to pursue professional diplomas or take up jobs. A total of 15 students have pursued PG degree in Foreign Universities in Netherland, UK, USA, Canada and Australia. Some of the universities include Groningen University Netherland; Universiity of Reading, UK; James Cook university Townsville, Queensland, Australia; Deakin University, Melbourne

Australia; St. George University, UK; University of Glasgow, UK; Edinburgh Napier University, UK; Anglia Ruskin University, Cambridge University, UK; California Baptist University, USA. Also many students pursue higher education in top universities in India.

4. GRADUATE ATTRIBUTES:

On completion of the BSC Zoology Degree programme, the students are expected to acquire the following attributes:

- ***Use of Technology and Problem Analysis and Solutions***: Should be able to apply appropriate IT tools efficiently in their daily life- professional and personal. Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals
- ***Be conscious of Environment Sustainability, Ethics and Social responsibility***: Be aware of environmental issues and commit towards sustainable development at local/ national and global context. Recognize and understand professional ethics /human values and be responsible.
- ***Individual and Team work, Communication skills and Life Skills:*** Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.

- ***Have Research Aptitude:*** Understand general research methods and be able to analyse, interpret and derive rational conclusions
- ***Sound subject knowledge:*** Have strong foundation of fundamentals and modern concepts of Zoology.
- ***Good practical procedure skills:*** Formulate plan of procedure and execute research plan and collect, collate, analyse and interpret data.
- ***Critical thinking and Problem solving skills***: Assess, analyse and argue critically, real life problems or issues in areas/fields of zoology and apply proper logical strategies to find a solution.
- ***Nurture and build Leadership quality***: Demonstrate leadership quality and be able to function well as an individual or in a team.

5. QUALIFICATION DESCRIPTORS:

Graduate of BSc Zoology need to:

- Be familiar with identification of the non-chordates from chordates and understand the functioning and mechanism of the various biological systems in the chordates
- Able to appreciate the process of evolution and understand how it progressed from simple, unicellular cells to complex, multicellular organisms.
- Have an understanding of cell, it's organelles and their function and Perform a variety of molecular and cellular biology techniques.
- Associate knowledge of genetic principles to the phenomena which

occur in humans with reference to genetic inheritance and construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

- Understand and associate malfunctions in the body to various organs and organ systems and know the basic principles that govern the functioning of living systems.
- Have the basic knowledge of developmental biology and know the concepts associated with development of embryo.
- Apply the techniques used in assessment and monitoring of wildlife and understand the basics of wildlife status, conservation, assessment and management and be familiar with the rules, regulations and factors governing wildlife.
- Associate structure of endocrine organs of human body with its functions and also associate hormones to body growth, metabolism, reproduction and development to understand the underlying principles and disorders associated with hormone functions.
- Learn techniques of histology, techniques of bacterial isolation and identification, Cell culture techniques, protocols used to assess physicochemical parameters, techniques of aquaculture, protocols of Fish processing and preservation,
- Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties.
- Understand concept of types of waste, its transport and disposal and Perform composting techniques / procedures.
- Perform primary cell culture of suspension and adherent cells and understand concepts and applications of mammalian cell culture.
- Understand the components of the immune system and their function and perform immunoassays for disease detection.
- Understand the Branches of forensic science and know the

application of molecular tools in genetic diagnosis.

- Know about nutrients and their function, read and interprete food labels, correlate role of lifestyle and food habits in causing diseases and prepare Diet Plans for different age group individuals.
- Understand concept of business Proposals, be familiar with the methodologies and regulations required to start an enterprise, Identify opportunities available in life science for start-ups and Generate Ideas and initiate a Business Plan.

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6. PROGRAMME LEARNING OUTCOME (PLOS):

PLO1	Use of Technology and Problem Analysis and Solutions	Apply appropriate IT tools efficiently in their daily life- professional and personal. Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals
PLO2	Environment and Sustainability, Ethics and Social responsibility	Be aware of environmental issues and commit towards sustainable development at local/ national and global context. Recognize and understand professional ethics /human values and be responsible.
PLO3	Individual and Team work, Communication skills and Life Skills.	Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change
PLO4	Research Aptitude	Understand general research methods and be able to analyse, interpret and derive rational conclusions
PLO5	Sound subject knowledge	Have strong foundation of fundamentals and modern concepts of Zoology.
PLO6	Good practical procedure skills	Formulate plan of procedure and execute research plan and collect, collate, analyse and interpret data.
PLO7	Critical thinking and Problem solving skills	Assess, analyse and argue critically, real life problems or issues in areas/fields of zoology and apply proper logical strategies to find a solution.
PLO8	Leadership quality	Demonstrate leadership quality and be able to function well as an individual or in a team.

7. COURSE STRUCTURE: PROGRAMME BSC ZOOLOGY

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** Evolutionary Biology ** **ZOO-III.SE-1** Waste Management Techniques
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Parasitology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI.GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16/ ** ZOO-III.SE-2** Bio Entrepreneurship
***Generic Elective(GE) / ** Skill Enhancement (SE) courses**						

AO-3.1.2 Course Structure

STRUCTURE		CREDITS	SUBJECT SPECIFIC COURSES	Major(Core) + Project	Minor	Elective (Major/ Generic)
Component A (92 Credits)	CHOICE 1 : Single Major	32+4	8 Core Courses (Major) + Project Paper	8 + 1		
		48	12 Elective Courses (Major)			12
		8	2 Generic Elective Courses			2
	CHOICE 2 : Major - Minor	32+4	8 Core courses (Major) + Project Paper	8 + 1		
		24	6 Elective Courses (Major)			6
		24	6 Core Courses (Minor)		6	
		8	2 Generic Elective Courses			2
	CHOICE 3 : Double Major	32+4	8 Core Courses (Major-1) + Project Paper	8 + 1		
		32	8 Core Courses (Major-2)	8		
		16	2 Elective Courses (Major-1) + 2 Elective Courses(Major-2)			4
		8	2 Generic Elective Courses			2
STRUCTURE		CREDITS	FOUNDATION COURSES	Compulsory		Elective
Component B (28 Credits)	Foundation Courses	4	Language	1		
		4	Academic Writing (AW)	1		
		4	Research Writing (RW)	1		
		4	*Statistical Methods/ (SM) **Elements of Basic Statistics	1		
		4	Environmental Studies (EVS)	1		
		8=(4+4 or 4+2+2 or 2+2+2+2)	Skill Enhancement Courses (SEC) of 2 or 4 credits (Internal Option Offered)			2 to 4

8. COURSE DESCRIPTION:

Course Code & Name	Course Description
ZOO-I-C.1: Animal Diversity: Non-Chordates	This course is designed to enable the students to identify the different non-chordates upto class level. In addition, the students are able to understand the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms.
ZOO-I-C.2: Cell and Molecular Biology	This course is intended to provide solid understanding of concepts and principles of cell and molecular biology as it applies to animals and humans. On successful completion of the course the students will be able to understand the ultra-structure of each cell organelle and their functions. This course will also help students to perform variety of molecular and cellular biology techniques.
ZOO-II-C.3: Diversity and Biological systems of Chordates	This course is designed to enable the students to identify the different chordates upto the order. In addition, the students are able to understand the functioning and mechanism of the various biological systems in the chordates.
ZOO-II-C.4: Fundamentals of Animal and Human Genetics	This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. On successful completion of the course the students will be ableto understand the structure of gene and chromosome. The students also be able to understand the different ways of sec determination.
ZOO-III-C-5: Human Physiology	This course helps students to gain basic knowledge on the major organ systems and their functions in the human body. In addition, it also helps to comprehend and understand the physiology of digestion, respiration, excretion, circulation, nervous system, muscles and the reproductive system.
ZOO-IV-C-6: Biochemistry and metabolic regulations	This course helps students to understand the chemical basis in life. In addition, it also helps to comprehend and understand the interaction between the biological molecules. The various topics covered under this course includes fundamentals of biochemistry and carbohydrate metabolism, lipid and protein metabolism and nucleotide metabolism.

ZOO-V-C.7: Developmental Biology	This course will enable students to understand the basic plan of animal development. In addition, the students will also be familiarised with the processes which occur during the development in invertebrates and vertebrates. The various topics covered under this course include early embryonic development in sea urchin, early development in chick, growth and regeneration
ZOO-VI-C-8: Wildlife Biology	This course is designed to enable the students to understand the basics of wildlife status, assessment, conservation and management. On successful completion of the course, the students will able to understand the techniques used in the assessment and monitoring of wildlife, and the diversity, extent and range of wildlife population dynamics.
ZOO-III-E-1: Vertebrate Endocrinology	The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders. On successful completion of the course students will understand the underlying principles of hormone function and gain an insight into the current and important issues in endocrinology
ZOO-III-E-2: Basic Microbiology and Fundamentals of Animal Biotechnology	This course is intended to provide a basic understanding of microbiology and basic tools in biotechnology. On successful completion of this course the students will be able to understand the different techniques and tools used in genetic engineering and their applications.
ZOO-III-3: Environmental Toxicology	This course helps the students develop a strong foundation in the theoretical and practical aspect of environmental toxicology. In addition, it will also help students. On successful completion of the course, students will be able to distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties, identify potential solutions to anthropogenic pollution.
ZOO-IV-E-5: Animal Cell Culture and Application	This course is intended to provide solid understanding of concepts and applications of animal cell culture. This course also teaches the students to learn the different techniques of culturing the specific type of cells.

ZOO-IV-E-6: Aquaculture and Fisheries	This course is designed to enable the students to understand the role of aquaculture in rural development and in solving problems related to fisheries. In addition, the students are taught various techniques of culturing fish so as to impart entrepreneurial knowledge in this sector. The various topics covered under this course include inland fisheries, marine fisheries, crustacean and molluscan fisheries, fishing methods used in India
ZOO.-IV-07: Immunology	Immunology provides the students with the fundamental knowledge of the immune system and its protective roles against diseases. On successful completion of the course students will know the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
ZOO-V-E.9: Molecular genetics and forensic science	This course will inform you about the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose the students to the basics of forensic science to understand diagnostic genetics**.**
ZOO-V-E-11: Basic and Applied Entomology	This course will help you develop a strong foundation in entomology, including understanding of the importance of insects to the human society. On successful completion of the course, students will be able to dwell into the various entrepreneur opportunities in entomology as well as gain knowledge on bionomically important insects and their products, and insects' pests of public health and veterinary importance and their management.
ZOO-V-E-12: Fish Preservation and Processing	This course helps the students develop a strong foundation in the theoretical and practical aspects of fish preservation and processing. On successful completion of the course, the students will be familiar with the economic benefits of fishes. The various topics covered under this course include fishery development, fish handling and preservation, value of fish.
Z00-VI-E.13: Health and Nutrition	This course focuses on the nutrients needed for sustainable development of the human body. The role and functions of the nutrients is given importance as it helps in understanding the growth of the individuals at different levels. It will also focus on the different diets needed to lead a healthy life.

Z00-VI-E.14: Ecology and Ethology	This course informs the ecological aspects of interrelations between the biotic and abiotic components of the environment. In addition, the students are also introduced with the concepts of animal behaviour. The various topics covered under this course include an introduction to ecology, biodiversity & conservation, introduction and concepts of ethology, approaches to studying behaviour, patterns of behaviour and communication behaviour.
Z00-VI- E.16: Bioentrepreneurship	Bio entrepreneurship is the integration of 2 different disciplines of science and entrepreneurship. It uses biological entities or idea related to science to acquire profit and establish business. In this course the students acquire necessary skills and knowledge required for organising and carrying out entrepreneurial activities, developing the ability of analysing and understanding business situations in which entrepreneurs act. It will help students master the knowledge necessary to plan entrepreneurial activities.

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9. COURSE LEARNING OBJECTIVES (CLOS):

SEMESTER	COURSE CODE	COURSE TITLE	COURSE OUTCOME: Upon successful completion of the course, students will be able to:
I	ZOO-I.C-1	Animal Diversity : Non Chordates	CLO1: Be familiar with identification of the non-chordates from chordates. CLO2: Identify the invertebrates and classify them upto the class level. CLO3: Understand the basis of life processes in the non-chordates. CLO4: Able to appreciate the process of evolution and understand how it progressed from simple, unicellular cells to complex, multicellular organisms.
I	ZOO-I.C-2	Cell and Molecular Biology	CLO1: Have an understanding of cell, it's organelles and their function. CLO2: Demonstrate deeper understanding of what 'life is and how it functions at cellular level. CLO3: Contrast cellular membrane structure and function, fine structure and function of cell organelles. CLO4: Perform a variety of molecular and cellular biology techniques.
II	ZOO-II.C-3	Diversity and Biological Systems of Chordates	CLO1: Be familiar with identification of the non-chordates from chordates with justification. CLO2: Identify the different chordates upto the order. CLO3: Understand the functioning and mechanism of the various biological systems in the chordates. CLO4: Able to appreciate the process of evolution of chordates from nonchordates and understand how it progressed from simple vertebrates to highly complex vertebrates.
II	ZOO-II.C-4	Fundamentals of Animal and Human Genetics	CLO1: Describe the basic structure of genes and chromosomes. CLO2: Relate an organism's genotype and phenotype and explain the role of genes in inheritance. CLO3: Associate knowledge of genetic principles to the phenomena which occur in humans with reference to genetic inheritance. CLO4: Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

SEMESTER	COURSE CODE	COURSE TITLE	COURSE OUTCOME: Upon successful completion of the course, students will be able to:
III	**ZOO-III.C-5**	Human Physiology	CLO1: Describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body. CLO2: Develop understanding of the functional relationships of anatomical structures to one another. CLO3: Know the disorders associated with the different systems. CLO4: Understand and associate malfunctions in the body to various organs and organ systems.
IV	**ZOO-IV.C-6**	Biochemistry and Metabolic Regulation	CLO1: Understand better the chemical basis in life. CLO2: Know the basic principles that govern the functioning of living systems CLO3: Be familiar with enzymes and their activities CLO4: Appreciate better the interactions between the biological molecules.
V	**ZOO-V.C-7**	Developmental Biology	CLO1: Understand the basic plan of animal development. CLO2: Know the processes which occur during the course of development in invertebrates and vertebrates. CLO3: Have the basic knowledge of developmental biology. CLO4: Know the concepts associated with development of embryo.
VI	**ZOO-VI.C-8**	Wildlife Biology	CLO1: Apply the techniques used in assessment and monitoring of wildlife. CLO2: Understand the basics of wildlife status, conservation, assessment and management. CLO3: Know about the diversity, extent, range of wildlife population dynamics. CLO4: Know the rules, regulations and factors governing wildlife.
III	**ZOO-III.E-1**	Vertebrate Endocrinology	CLO1: Be familiar with all the endocrine organs of human body. CLO2: Associate hormones to body growth, metabolism, reproduction and development. CLO3: To understand the underlying principles and disorders associated with hormone functions CLO4: Learn techniques of histology and tissue identification.

SEMESTER	COURSE CODE	COURSE TITLE	COURSE OUTCOME: Upon successful completion of the course, students will be able to:
III	**ZOO-III.E-2**	Basic microbiology and Fundamentals of Animal Biotechnology	CLO1: Gain working knowledge of basic bacterial laboratory techniques and use of microorganism in biotechnology. CLO2: Perform techniques of bacterial isolation and identification. CLO3: Have knowledge about various molecular techniques of gene manipulation. CLO4: Should be able to Perform techniques of isolate DNA, bring about transformation and identification of recombinants.
III	**ZOO-III.E-3**	Environmental Toxicology	CLO1: Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties. CLO2: Identify the main sources and types of environmental pollutants and assess their potential environmental fate. CLO3: Understand mechanisms of detoxification of various varieties of toxicants. CLO4: Know the procedures/protocols used to assess physicochemical parameters and environmental contaminants.
III	**ZOO-III.E-4 / *ZOO-III-SEC-1**	Waste management techniques	CLO1: Understand concept of types of waste,its transport and disposal. CLO2: Perform composting techniques / procedures. CLO3: Identify means of reducing waste production. CLO4: Plan and conduct research in areas of waste management
IV	**ZOO-IV.E-5**	Animal cell culture and Applications	CLO1: Operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory; CLO2: Prepare and sterilize media and solutions used in cell culture. CLO3: Understand concepts and applications of mammalian cell culture. CLO4: Perform primary cell culture of suspension and adherent cells.
IV	**ZOO-IV.E-6**	Aquaculture and Fisheries	CLO1: Understand conservation and sustainability of aquaculture resources. CLO2: Acquainted with various techniques of aquaculture. CLO3: Know strategies of improving the social and economic benefits derived from aquaculture and fisheries. CLO4: Initiate business enterprise in area of aquaculture.
IV	**ZOO-IV.E-**	Immunology	CLO1: Understand the components of the

SEMESTER	COURSE CODE	COURSE TITLE	COURSE OUTCOME: Upon successful completion of the course, students will be able to:
	7		immune system and their function. CLO2: Explain the mechanisms of immune response. CLO3: Know about the techniques used in detecting immunological diagnosis. CLO4: Perform immunoassays for disease detection.
IV	**ZOO-IV.E-8**	Parasitology	CLO1: Know about the parasites and their lifecycles. CLO2: Get acquainted with dimensions of public health viz . a viz. parasitic diversity, epidemiology and community prophylaxis. CLO3: Be familiar with the parasite host interactions. CLO4: Gain knowledge on diagnosis of parasite infections and preventive measures.
V	**ZOO-V.E-9**	Molecular Genetics and Forensic Science	CLO1: Understand and explain the process of replication, transcription and translation CLO2: Differentiate between the gene expression in prokaryotes and eukaryotes CLO3: Understand the Branches of forensic science CLO4: know the application of molecular tools in genetic diagnosis
V	**ZOO-V.E-10**	Economic Zoology	CLO1: Understand how zoological species contribute to economic sources. CLO2: Gain working knowledge of techniques of rearing organisms. CLO3: Get acquainted with maintenance of the species CLO4: Understand the underlying principles of harvesting products from species.
V	**ZOO-V.E-11**	Basic and Applied Entomology	CLO1: Be familiar with the identification of bio economical species. CLO2: Identify entrepreneurial opportunities in entomology. CLO3: Important insects and their products. CLO4: Insect pests of public health and veterinary importance and their management.
V	**ZOO-V.E-12**	Fish Preservation and Processing	CLO1: gain understanding of the economic benefits of fishes. CLO2: They will also be able to understand the nutritional values of the fishes CLO3: Perform some protocols of Fish processing and preservation. CLO4: Acquaint oneself with the processes at fish processing industry

SEMESTER	COURSE CODE	COURSE TITLE	COURSE OUTCOME: Upon successful completion of the course, students will be able to:
VI	**ZOO-VI.E-13/ *ZOO-VI-GE-1**	Health and Nutrition	CLO1: Know about nutrients and their function CLO2: Read and interprete food labels. CLO3: Correlate role of lifestyle and food habits in causing diseases. CLO4: Prepare Diet Plans for different age group individuals.
VI	**ZOO-VI.E-14**	Ecology and Ethology	CLO1: gain better understanding of concepts of ecology. CLO2: Acquainted with the basics of animal behaviours CLO3: Know strategies of biodiversity conservation, CLO4: Understand mechanisms of sustainable development.
VI	**ZOO-VI.E-15**	Laboratory Techniques in Pathology	CLO1: Perform basic techniques of cell/tissue processing CLO2: Be Familiar with procedures of tests done for disease detection CLO3: Process various body fluids and tissues for disease detection.. CLO4: Understand the clinical implication of the pathological tests.
VI	**ZOO-VI.E-16 / *ZOO-VI-SE-2**	Bio Entrepreneurship	CLO1: understand concept of business Proposals CLO2: familiar with the methodologies and regulations required to start an enterprise CLO3: Identify opportunities available in life science for start-ups. CLO4: Generate Ideas and initiate a Business Plan.

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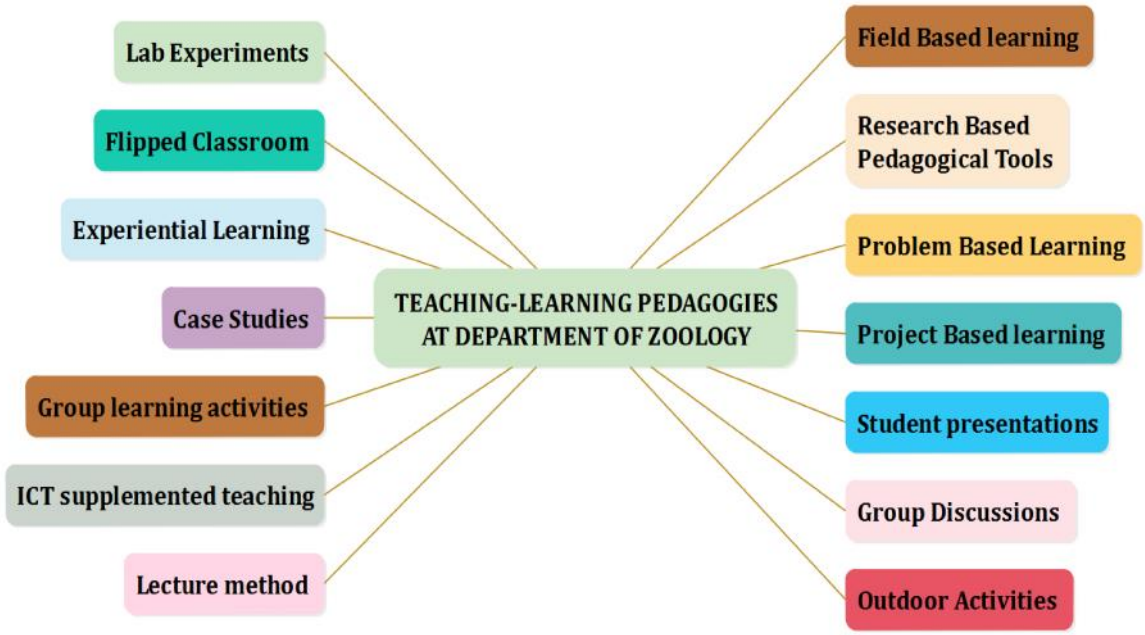
10. TEACHING-LEARNING-EVALUATION PEDAGOGIES:

Achievement of learning outcomes does not solely depend upon one single type of assessment at the end of the term. It is an integration of strong learning culture, identification of competencies, appropriate teaching pedagogy, design of holistic learning experiences and choice of assessment in the form of continuous internal evaluation that is formative in nature. The system of assessment to be adopted needs to be inherently linked to programme /curriculum goals as one can objectively assess student performance by relating assessment type to Program Learning Outcomes and Program Education Objectives.

Course Learning Outcomes (CLOs) are set for all courses, and matrices are prepared to map the teaching-learning processes at the department with the CLOs and PLOs, inorder to measure attainment of these outcomes. The assessment tools for each course is also mapped to the revised Bloom'staxonomy.

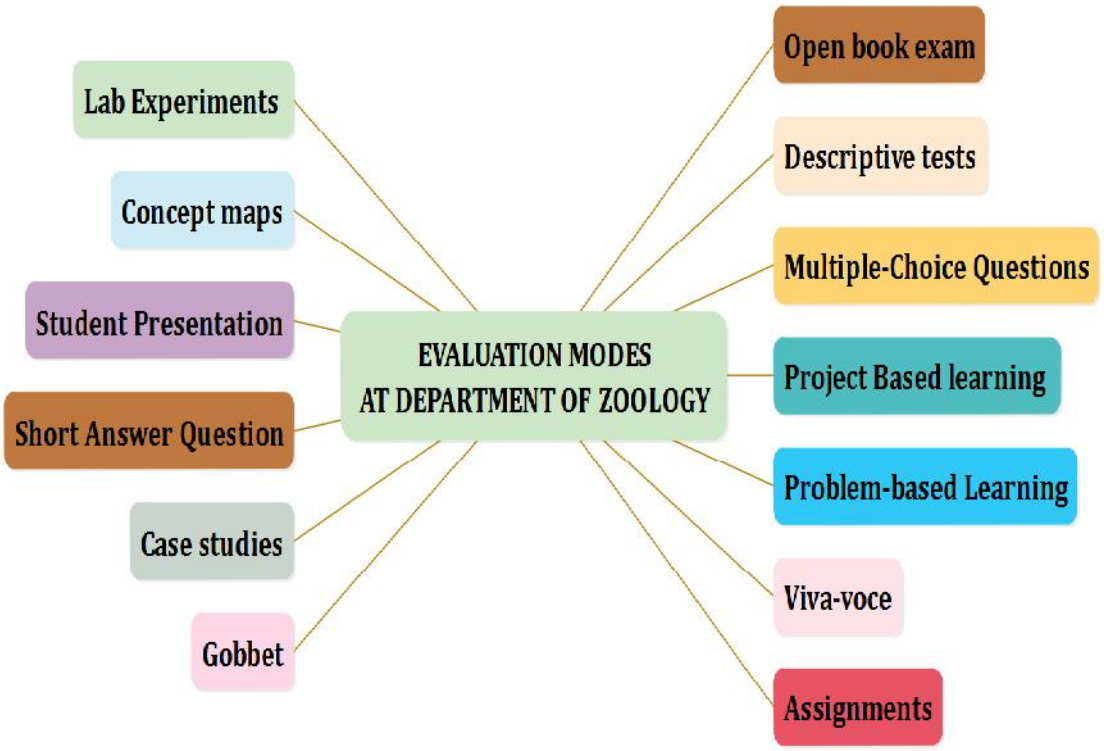
Teaching –Learning Pedagogies at the Department:



EVALUATION MODES ADOPTED FOR COUSES AT THE DEPARTMENT:

To check the understanding of the students and to improve student learning, measuring the learning outcomes in knowledge, skills, attitudes and beliefs becomes an important factor. Assessment modes used at the department therefore is an on-going evaluation process aimed at checking the same. The design of assessment indirectly determines the quality of their learning.

Assessment modes adopted at the department include the following:



11. ACTIVITIES OF THE DEPARTMENT:

(Indirect assessors of attainment of PLOs and attaining Graduate attributes).

Various activities are conducted at the department, to provide opportunities to the students to attain the graduate attributes and the programme learning outcome. Enhancing skills and building the right qualities and soft skills, besides imparting recent knowledge is the major focus of these activities. The activities of the department and its objectives are listed below:

Sr. no.	Activity	Objective
1.	Chowgule's Birders Club	• Environment and Sustainability, Ethics and Social responsibility Be aware of environmental issues and commit towards sustainable development at local context. Recognize and understand professional ethics /human values and be responsible. • Individual and Teamwork, Communication skills and Life Skills Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. • Leadership quality Demonstrate leadership quality and be able to function well as an individual or in a team.
2.	Symbiosis – Zoology Event festival	• Individual and Team work, Communication skills and Life Skills Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change • Leadership quality Demonstrate leadership quality and be able to function well as an individual or in a team.
3.	Industry-Academia lecture series with Forest Department	• Research Aptitude Understand general research methods and be able to analyse, interpret and derive rational conclusions • Sound subject knowledge Have strong foundation of fundamentals and modern concepts of Zoology.
4.	Workshops / Seminars/ Conferences	• Research Aptitude Understand general research methods and be able to analyse, interpret and derive rational conclusions • Sound subject knowledge Have strong foundation of fundamentals and modern concepts of Zoology.

5.	Certificate courses	• Sound subject knowledge Have strong foundation of fundamentals and modern concepts of Zoology. • Good practical procedure skills Formulate plan of procedure and execute research plan and collect, collate, analyse and interpret data. • Use of Technology and Problem Analysis and Solutions Apply appropriate IT tools efficiently in their daily life- professional and personal.
6.	Summer trainings	• Individual and Team work, Communication skills and Life Skills. Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. Ability to engage in independent and life-long learning in the broadest context of domain specific change • Good practical procedure skills Formulate plan of procedure and execute research plan and collect, collate, analyse and interpret data.
7.	Internships (Mandatory)	• Individual and Team work, Communication skills and Life Skills. Function effectively at various levels, capacities and situations. Communicate proficiently (oral and written) as a responsible member of society. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change • Good practical procedure skills Formulate plan of procedure and execute research plan and collect, collate, analyse and interpret data. • Use of Technology and Problem Analysis and Solutions Apply appropriate IT tools efficiently in their daily life- professional and personal. Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals.

8.	Community Out reach activities	• Environment and Sustainability, Ethics and Social responsibility Be aware of environmental issues and commit towards sustainable development at local/ national and global context. Recognize and understand professional ethics /human values and be responsible.
9.	Green initiatives (Butterfly Garden, Composting)	• Environment and Sustainability, Ethics and Social responsibility Be aware of environmental issues and commit towards sustainable development at local/ national and global context. Recognize and understand professional ethics /human values and be responsible.

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)

COURSE CURRICULUM

OF

PROGRAMME

BSC ZOOLOGY

COURSE STRUCTURE
PROGRAMME BSC ZOOLOGY

SEMESTER	CORE COURSES		ELECTIVE COURSES			
I	**ZOO-I.C-1** Animal Diversity : Non Chordates	**ZOO-I.C-2** Cell and Molecular Biology	--------	--------	--------	--------
II	**ZOO-II.C-3** Diversity and Biological Systems of Chordates	**ZOO-II.C-4** Fundamentals of Animal and Human Genetics	--------	--------	--------	--------
III	**ZOO-III.C-5** Human Physiology		**ZOO-III.E-1** Vertebrate Endocrinology	**ZOO-III.E-2** Basic microbiology and Fundamentals of Animal Biotechnology	**ZOO-III.E-3** Environmental Toxicology	**ZOO-III.E-4** Evolutionary Biology ** **ZOO-III.SE-1** Waste Management Techniques
IV	**ZOO-IV.C-6** Biochemistry and Metabolic Regulation		**ZOO-IV.E-5** Animal cell culture and Applications	**ZOO-IV.E-6** Aquaculture and Fisheries	**ZOO-IV.E-7** Immunology	**ZOO-IV.E-8** Parasitology
V	**ZOO-V.C-7** Developmental Biology		**ZOO-V.E-9** Molecular Genetics and Forensic Science	**ZOO-V.E-10** Economic Zoology	**ZOO-VI.E-11** Basic and Applied Entomology	**ZOO-V.E-12** Fish Preservation and Processing
VI	**ZOO-VI.C-8** Wildlife Biology		**ZOO-VI.E-13** Health and Nutrition ***ZOO-VI.GE-1** Health and Nutrition	**ZOO-V.E-14** Ecology and Ethology	**ZOO-VI.E-15** Laboratory Techniques in Pathology	**ZOO-VI.E-16/ ** ZOO-III.SE-2** Bio Entrepreneurship
***Generic Elective(GE) / ** Skill Enhancement (SE) courses**						

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY
COURSE CURRICULUM

SEMESTER I and II:

SEMESTER	COURSE CODE	CORE COURSES	NUMBER OF CREDITS	CONTACT HOURS
Semester I	ZOO-I.C-1	Animal Diversity : Non Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-I.C-2	Cell and Molecular Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Semester II	ZOO-II.C-3	Diversity and Biological Systems of Chordates	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-II.C-4	Fundamentals of Animal and Human Genetics	Theory = 03 Practicals =01	Theory = 45 Practicals =30

SEMESTER I

CORE COURSE : ANIMAL DIVERSITY: NON CHORDATES	
COURSE CODE:	ZOO-I.C-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different non-chordate phyla. • To know the general and distinguishing characters of each of them. • To study how the different systems evolved in their complexity. • To compare and contrasts the life processes in different phyla.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Be familiar with identification of the non-chordates from chordates. CO2: Identify the invertebrates and classify them upto the class level. CO3: Understand the basis of life processes in the non-chordates. CO4: Able to appreciate the process of evolution and understand how it progressed from simple, unicellular cells to complex, multicellular organisms..

ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
Module 1: Evolution of Animal Diversity and Diversity of lower non chordates	• Non chordate evolution and diversity • Taxonomy and phylogeny of animals • Invertebrate cladogram • Protista Classification and general characters upto class for the following phyla: • Porifera • Cnidaria • Platyhelminthes • Aschelminthes • Annelida	15
Module 2: Diversity of higher Non Chordates	Classification and general characters upto class for the following phyla: • Onycophora • Arthropoda • Mollusca • Echinodermata • Hemichordata	15
Module 3: Biological systems of Non Chordates 2	• Comparison of life processes such as nutrition, sensory and neural control and coordination, blood vascular system, exoskeleton, endoskeleton, locomotion and muscular system, respiration, excretion, reproduction and development of phylum Porifera to Hemichordata.	15

PRACTICAL COMPONENT OF ZOO-I.C-1: ANIMAL DIVERSITY: NON CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	Practical	No. of Practicals
1.	Identification of organisms from phylum protozoa to phylum Hemichordata	06
2.	Observation of permanent slides	03
3.	Mountings: Cockroach mouth parts, prawn appendages	02
4.	Field trip to terrestrial environment to study the invertebrates in their natural habitats	01

REFERENCE BOOKS:

1. *Barnes R.D. (2000). Invertebrate Zoology.Hall Saunders International Edition, London.*

2. Barrington E.J.W. 1979. Invertebrate structure and Function.John Wiley and Sons Inc.

3. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.

4. Marshall A.J.and W.D. Williams. 1974. Textbook of Zoology. Macmillan.

5. Pechenik J.A.(2002). Biology of the invertebrates. Tata McGraw hill Publishing company limited, New Delhi .

REFERENCE BOOKS FOR PRACTICALS:

1) Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual.Morton Publishing Co. Austin Community College.

2) Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.

CORE COURSE : CELL AND MOLECULAR BIOLOGY	
COURSE CODE:	ZOO-I.C-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course will give firm and rigorous foundation in the principles of modern molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: • CO1: Have an understanding of cell, it's organelles and their function. • CO2: Demonstrate deeper understanding of what 'life is and how it functions at cellular level. • CO3: Contrast cellular membrane structure and function, fine structure and function of cell organelles. • CO4: Perform a variety of molecular and cellular biology techniques.

Z00-I.C-2 : CELL AND MOLECULAR BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY (15 Hrs)	Unit 1: MICROSCOPY • Light Microscopy • Electron Microscopy.	15
	Unit 2: CELL STUDY METHODS • Cell Fractionation, Chromatography and electrophoresis.	
	Unit 3: MOLECULES IN CELL. • Micromolecules in cells: Sugars, Fatty acids, aminoacids, Nucleotides. • Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.	
	Unit 4: CHEMICAL BONDS IN BIOMOLECULES • covalent bonds, ionic bonds, noncovalent interactions	
MODULE 2: CELL ARCHITECTURE (15 Hrs)	Unit 5: MEMBRANE STRUCTURE AND MEMBRANE PROTEINS • lipid bilayer – composition and structural organization (amphipathic phospholipids, Fluidity of cell membrane) • Membrane Proteins –structure and function (transmembrane proteins, peripheral membrane proteins) • Phospholipids, sphingolipids, Cholesterol in cell membrane.	15
	Unit 6: MOLECULAR STRUCTURE AND FUNCTION • Plasma Membrane • Cell matrix: Physical nature and Properties. • Nucleus: Ultra Structure and function • Mitochondria: Ultra Structure and functions • Endoplasmic Reticulum: ultra structure, modifications, functions	
	UNIT 7: MOLECULAR STRUCTURE AND FUNCTION • Golgi Complex, Ribosomes, Microsomes, Cytoskeleton	
MODULE 3: CELLULAR TRANSPORT OF PROTEINS AND VESICLES (15 Hrs)	Unit 8: TRANSPORT ACROSS CELLL MEMBRANES • Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis) • Transporters and their function- passive transporters, Pumps (Na^+, K^+, Ca) • Ion Channels - ion channels activities, regulation of opening and closing of channels. • Protein transport into organelles (nucleus, mitochondria,ER).	15
	Unit 9: VESICULAR TRANSPORT. • Vesicular transport – transport of soluble proteins, vesicle budding, vesicle docking, endocytic pathways.	

PRACTICAL COMPONENT OF ZOO-I.C-2: CELL AND MOLECULAR BIOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Introduction to Lab techniques – Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices	02
2)	Cytochemistry: Localisation of Proteins, Carbohydrates & fats using different stains.	03
3)	Comparison of membrane permeability – Cellophane and Chick intestine.	02
4)	Osmotic studies – Using Human Red blood cells.	01
5)	Permament slides: - Mitotic stages - Meiotic stages (mounting from grasshopper testes) - Histology - Study of different cell types (animal cells)	03
6)	Technique of Agarose gel electrophoresis (Observation of technique)	01

REFERENCE BOOKS:

Essential books:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Lodish H, Berk A, Kaiser CA, Krienger M, Scott MP, Anthony, Bretscher A, Amon A. Scott MP (2013): Molecular Cell Biology, Seventh Edition, W. H. Freeman and Company New York.*

Supplementary Reading:

3) *Gupta PK (2003): Cell and Molecular Biology, Second Edition, Rakesh Kumar Rastogi for Rastogi Publications, Meerut, New Delhi, India.*
4) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, Fourth Edition, Graland Science Taylor & Francis Group, UK.*
2) *Bolsover SR, Shephard EA, Hugh AW, Hyams JS (2011): Cell Biology, Third Edition, Wiley Blackwell, A John Wiley & Sons, Inc., Publications.*
3) *Verma PS and Agarwal VK (2007): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*

SEMESTER – II

CORE COURSE: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES	
COURSE CODE:	ZOO-II.C-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the different Chordate phyla. • To know the general and distinguishing characters of each of them. • To compare and contrast the major biological systems amongst them.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Be familiar with identification of the non-chordates from chordates with justification. CO2: Identify the different chordates upto the order. CO3: Understand the functioning and mechanism of the various biological systems in the chordates. CO4: Able to appreciate the process of evolution of chordates from nonchordates and understand how it progressed from simple vertebrates to highly complex vertebrates.

ZOO-II.C-3: DIVERSITY AND BIOLOGICAL SYSTEMS OF CHORDATES		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Diversity of chordates(upto order)	1.1: Chordata: General plan of organization and Outline classification 1.2: General characters and classification of Protochordates 1.3: General characters and classification of Agnatha (upto class) 1.4: General characters and classification of Pisces, Amphibia, Reptilia, Aves, Mammalia upto orders	15
MODULE 2: Biological Systems I	3.1: Integument: Pisces, Amphibia, Reptilia, Aves, Mammalia 3.2:Locomotory apparatus: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Digestive system: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.4: Respiratory system: Pisces , Lungs in Amphibia, Reptilia , Aves, Mammalia	15
MODULE 3: Biological systems - II	3.1: Circulatory system: Pisces , Amphibia, Reptilia Aves, Mammalia 3.2: Brain and cranial nerves: Pisces , Amphibia, Reptilia , Aves, Mammalia 3.3: Reproductive system: Pisces , Amphibia, Reptilia , Aves, Mammalia	15

PRACTICAL COMPONENT OF ZOO-II.C-3: DIVERSITY OF CHORDATES (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1.	Identification and Systematic classification of organisms from protochordates to mammalia	05
2.	Mounting of scales and chromatophores in fishes	01
3.	Observation of general viscera of chordate phyla	01
4.	Identification of Indian venomous and non venomous snakes with the help of keys provided (four each)	01
5.	Observation of pectin of eye (chick), skulls of representatives of pisces, amphibian, aves and mammals.	01
6.	Observation of permanent slides (amphioxus, doliolum, salpa) and observation of hyoid apparatus of chick; reptiles and mammals	01
7.	Field trip to wild life sanctuary	02

REFERENCE BOOKS:

1. *Cleveland Hickman Jr., Roberts Larry, Susan Keen, Allan Larson and Eisenhour D (2014). Animal Diversity. McGraw Hill Science.*
2. *Kardong K(2011). Vertebrates: Comparative anatomy, evolution, function. McGraw-Hill Higher Education.*
3. *Kent G.C. and Carr R.K. (2000). Comparative anatomy of the vertebrates. McGraw-Hill Higher Education.*
4. *Young J.Z. (2006). The life of vertebrates. Radha Press Delhi, Indian Edition.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Ziser. W.S (2014) Biology 1413 Introductory Zoology Lab Manual. Morton Publishing Co. Austin Community College.*
2) *Lal S.S. (2004) A textbook of practical zoology vertebrate. Rastogi publications, Meerut India.*

CORE COURSE: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS	
COURSE CODE:	ZOO-II.C-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Describe the basic structure of genes and chromosomes. CO2: Relate an organism's genotype and phenotype and explain the role of genes in inheritance. CO3: Associate knowledge of genetic principles to the phenomena which occur in humans with reference to genetic inheritance. CO4: Construct and analyze pedigrees to determine mode of inheritance of disorders and traits.

ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Transmission Genetics	UNIT 1: MODES OF INHERITANCE • Mendels laws of inheritance , test cross, back cross • Gene interactions: 9:3:3:1/12:3:1 / 9:3:4 /9:6:1 / 9:7 / 15:1 / 13:3. lethal genes, penetrance. • Inheritance of Multiple Alleles and Multiple genes	15
	UNIT 2: PATTERN OF INHERITANCE BY PEDIGREES • Construction of Pedigrees • Analysis of Pedigree analysis : autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance • Sex limited and Sex influenced and multifactorial inheritance disorders in humans	
MODULE 2: Chromosome Structure and Abnormalities in Humans	UNIT 3: CHROMOSOME STRUCTURE • Chromosome morphology- chromatid, Centromere, secondary constriction, chromomere • Heterochromatin and euchromatin • Chromosome structure and organization. • Human chromosomes and karyotype.	15
	UNIT 4: CHROMOSOMAL ABERRATION • Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism, • Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications.	
MODULE 3: Gene Mutations, Sex Determination .	UNIT 5: GENETIC MUTATIONS. • characteristics of mutations • classification of mutations (Spontaneous, Induced) molecular basis of mutations • Mutagens – physical and chemical	15
	UNIT 6: SEX DETERMINATION. • Environmental Sex Determination – hormonal, egg size, incubation temperature. • Chromosomal sex determination - XX ♀and XO ♂, XO ♀ and XX ♂, ZW ♀ and ZZ ♂, XX ♀and XY ♂, Diploid female and Haploid male, single gene effect. • Molecular basis of sex determination: Geneic imbalance, Sex index, Intersex and gynandomorphs, X/A Ratio. • Sex determination by Y linked genes, Dosage compensation, X-inactivation	

PRACTICAL COMPONENT OF ZOO-II.C-4: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS. DURATION - 02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Verification of Mendel's laws - monohybrid cross	01
2)	Verification of Mendel's laws - dihybrid cross	01
3)	Manual Karyotyping of human chromosome plates: 1) Normal Male and Female 2) Downs syndrome	03
4)	Drosophila Culture technique	01
5)	Study of Mutants of Drosophila	01
6)	Exercises for Multiple alleles and Multiple genes	02
7)	Construction and analysis of pedigrees	03

REFERENCE BOOKS FOR THEORY:

1) *Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.*
2) *De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.*
3) *Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.*
4) *Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.*
5) *Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.*
6) *Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.*
7) *Marcus A(2011): Genetics, MJP Publishers, Chennai.*
8) *Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
9) *Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.*
2) *Marcus A(2011): Genetics, MJP Publishers, Chennai.*
3) *Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.*
4) *Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.*

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY

COURSE CURRICULUM OF SEMESTER 3

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
Semester III	ZOO-III.C-5	Human Physiology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-1	Vertebrate Endocrinology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-2	Basic microbiology and Fundamentals of Animal Biotechnology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-3	Environmental Toxicology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-III.E-4	Parasitology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Skill enhancement course (SEC) **(Odd and Even semester)**	ZOO-SE-1	Waste management techniques	Theory and practice = 4 credits	Theory = 15 hrs Practice = 45 hrs

SEMESTER –III

CORE COURSE :HUMAN PHYSIOLOGY	
COURSE CODE:	ZOO-III.C-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	The primary goal of this course is to offer an in-depth presentation of the function of the major organs and organ systems of the human body. The course is designed to expand physiological concepts presented in prerequisite courses.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body. CO2: Develop understanding of the functional relationships of anatomical structures to one another. CO3: Know the disorders associated with the different systems. CO4: Understand and associate malfunctions in the body to various organs and organ systems.

ZOO-III.C-5: HUMAN PHYSIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Physiology Of Digestion And Respiration	UNIT 1: *DIGESTIVE SYSTEM* • Structural organization, histology and functions of gastrointestinal tract and its associated glands; • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins.	15
	UNIT 2: *RESPIRATORY SYSTEM* • Histology of trachea and lung; • Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; • Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; • Buffering action of blood and haemoglobin Control of respiration	
MODULE 2: Physiology Of Excretion And Circulation	UNIT 3: *EXCRETORY SYSTEM* • Structure of kidney and its histological details, Renal blood supply; Mechanism urine • Formation and its regulation, Regulation of acid-base balance.	15
	UNIT 4: *CIRCULATORY SYSTEM* • An outline structure of heart and working of heart. • Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram • Components of blood and their functions; Haemopoiesis.	
MODULE 3: Physiology Of Nervous System, Muscles And Reproductive System	UNIT 5: *NERVOUS SYSTEM* • Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; • types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types - reflex arc • Physiology of hearing and vision	15
	UNIT 6: *MUSCLE* • Histology of different types of muscle; • Ultra structure of skeletal muscle; • Molecular and chemical basis of muscle contraction; • Characteristics of muscle twitch; Motor Unit, summation & tetanus	
	UNIT 7: *REPRODUCTIVE SYSTEM* • Histology of male and female reproductive systems. • Puberty, Physiology of male and female reproduction.	

PRACTICAL COMPONENT OF ZOO-III.C-5: HUMAN PHYSIOLOGY (DURATION -02 HRS /WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Enumeration of red blood cells / WBC using haemocytometer	02
2)	Estimation of haemoglobin using Sahli's haemoglobinometer	01
3)	Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)	02
4)	Temporary preparation of Striated muscle fibers and nerve cells.	02
5)	Urine analysis (for organic, inorganic and abnormal components)	03
6)	Examination of sections of mammalian tissues: Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage	02

REFERENCE BOOKS:

Essential books:

1. *Singh HD(2011):Textbook of Human Physiology, S Chand Publishers, New Delhi.*
2. *Widmaier, Raff, & Strang(2008), Vander's Human Physiology: The Mechanisms of Body Function, 12thedition, McGraw Hill,. ISBN 978-0-07-337810-7*
3. *Tortara G J and Derrickson BH(2009). Principles of Anatomy and physiology, 12th Edition. John Wiley & sons, Inc.*
4. *Guyton Ac and Hall JE(2011). Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company.*

Supplementary Reading:

5. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook)*
6. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
7. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook*
2. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
3. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

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ELECTIVE COURSE: VERTEBRATE ENDOCRINOLOGY	
COURSE CODE:	ZOO-III.E-1
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the endocrine organs of vertebrates • To understand the underlying principles of hormone functions • To gain an insight into the current and important issues in endocrinology
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Be familiar with all the endocrine organs of human body. CO2: Associate hormones to body growth, metabolism, reproduction and development. CO3: To understand the underlying principles and disorders associated with hormone functions CO4: Learn techniques of histology and tissue identification

ZOO-III.E-1: VERTEBRATE ENDOCRINOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Anatomy and histology	Unit 1: • Aim and scope of endocrinology, • techniques in endocrinology - histology, histochemistry, immunocytochemistry, in situ hybridisation, radio immune assay, surgical techniques, • Regulation of hormone secretion: feedback mechanisms - positive, negative, short loop, long loop	15
	Unit 2: • Anatomy and histology of endocrine glands- • Pituitary, Pineal gland, Thyroid, Parathyroid, • Thymus, Adrenal, Endocrine pancreas, GI tract, • Endocrine hypothalamus, Gonads, Placenta	
MODULE 2: Hormones	Unit 3: • Classification of hormones • Hormone structure • Biological actions of hormones	15
	Unit 4: • Mechanisms of hormone action • Receptor and it regulation • Steroid and peptide hormones actions	
	Unit 5: Hormones and Homeostasis - Calcium and glucose	
MODULE 3: Pathological conditions	Unit 6: Biosynthesis and secretion of hormones - steroid hormones, thyroid hormones	15
	Unit 7: Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors	
	Unit 8: Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insepidus	

PRACTICAL COMPONENT OF ZOO-III.E-1: Vertebrate Endocrinology (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Histological slides ofEndocrine hypothalamus, Gonads, Placenta pituitary, Pineal gland, thyroid gland, Parathyroid,Thymus, adrenal gland, pancreas, ovary, testis	04
2)	Display of Pituitary and gonads in fishes/chick	03
3)	Preparation of histological slides using microtomy	05

REFERENCE BOOKS:

1. *David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.*
2. *Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.*
3. *Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.*
4. *Yadav, P.R. (2004) Endocrinology. Discovery Publishing House, New Delhi.*
5. *Hadley, M (1992) Endocrinology, Third edition, prentice Hall, New Jersey.*
6. *Matsumoto, A. and S. Ishi, (1992)(eds). Atlas of endocrine organs, vertebrates and Invertebrates springier verlag, Germany.*
7. *Norris D. O., Vertebrate Endocrinology, Elsevier Academic Press.*
8. *Turner, C.D and Bagnara, J.T., (1994) General Endocrinology, 6th Edition, WB Saunder's company, Philadelphia (Saunder's International Students edition).*
9. *5. Wilson J.D and Foster D.W (1992) William's textbook of endocrinology, 8th edition, WB saunders company, Philadelphia.*
10. *Yadav, P.R (2004) Endocrinology. Discovery Publishing House, New Delhi.*

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ELECTIVE COURSE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	
COURSE CODE:	ZOO-III-E-2
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	To provide a comprehensive survey of microbiology with basic information on bacteria and learn the fundamentals of biotechnological techniques.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Gain working knowledge of basic bacterial laboratory techniques and use of microorganism in biotechnology. CO2: Perform techniques of bacterial isolation and identification. CO3: Have knowledge about various molecular techniques of gene manipulation. CO4: Should be able to Perform techniques of isolate DNA, bring about transformation and identification of recombinants

ZOO-III-E-2: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Microbiology	1: Introduction to Microorganisms-Bacteria o Structure and Identification of bacteria(morphological types) o Nutritional types o Nutritional requirements	15
	2: Isolation and Culture of Bacteria: o Cultivation of bacteria o Different methods of isolation and maintenance of pure cultures o Culture characteristics	
	3: Use of microorganisms in biotechnology-An overview: o Production of valuable substances o Fuel Production, recovery of minerals and oils o Microorganisms in bioassays o Food and agriculture sector o Medicine and health	
MODULE 2: Tools in Biotechnology	4: Scope and importance of Biotechnology o Definition o Contribution and importance of biotechnology	15
	5: Nucleic Acid Enzymology: o Restriction enzymes, Ligases, Alkaline phosphatase o Polynucleotide kinase, Terminal Transferases, S1 Nuclease o Polymerases, Reverse transcriptase	
	6: Gene Cloning vectors: o Plasmids, Bacteriophage, cosmids o Shuttle and expression vectors	
MODULE 3: Genetic Engineering	7: Techniques in genetic engineering: o Gene transfer methods o Methods of Labeling Nucleic acids o Nucleic acid Hybridization o Polymerase chain reaction	15
	8: Recombinant DNA technology: o Procedure / Technique	
	9: Blotting Techniques: o Southern Blotting o Northern Blotting o Western Blotting	
	10: DNA sequencing techniques: o Chemical Degradation method o Chain termination method o Automated Sequencing	

PRACTICAL COMPONENT OF ZOO-III-E-2: BASIC MICROBIOLOGY & FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY DURATION - 02 HRS /WEEK		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Preparation of culture media for bacteria (Plates, Slants, deeps, Broth).	03
2)	Staining of Microorganisms (Gram staining, negative staining).	02
3)	Isolation of pure colonies of Bacteria (streak plate method – 3 Quadrant And 5 Quadrant methods)	03
4)	Identification of Products of metabolic pathways of microbial cells.	02
5)	Bacteriological testing of Milk.	01
6)	DNA sequencing - Analysis of prints.	01

REFERENCE BOOKS:

Essential books:

1) *Pelczar MJ, Chan ECS, Krieg NR(2009). Microbiology. Tata Mc Graw Hill, New York.*
2) *Dubey RC and Maheshwari DK (2012). A test book of Microbiology. S Chand Publishers, New Delhi.*
3) *Prave P, Faust U, Sittig W and Sukatsh DA(2004). Fundamentals of Biotechnolgy.*
4) *Purohit SS(2008). BiotechnologyFundamentals and applications. Agrobios, Jodhpur India.*
5) *Ranga MM(2012): Animal Biotechnology. Agrobios, Jodhpur India.*

Supplementary reading:

6) *Black JG(2005). Microbiology principles and explorations. John Wiley and sons Inc.*
7) *Sullia SB and Shantharam S(2006). General Microbiology. Oxford and IBH Publishing Co Pvt Ltd, NewDelhi.*

REFERENCE BOOKS FOR PRACTICALS*:*

1) *Gunasekaran P(2009). Lab Manual in Microbiology. New Age International Ltd. Publishers, New Delhi.*

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ELECTIVE COURSE: ENVIRONMENTAL TOXICOLOGY	
COURSE CODE:	ZOO-III-E-3
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To study the different environmental pollutants and their toxicity. • To know the physiological effects of toxicant exposure.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Distinguish, classify and characterize a variety of environmental pollutants based on their biological and physical properties. CO2: Identify the main sources and types of environmental pollutants and assess their potential environmental fate. CO3: Understand mechanisms of detoxification of various varieties of toxicants. CO4: Know the procedures/protocols used to assess physicochemical parameters and environmental contaminants.

ZOO-III-E-3: ENVIRONMENTAL TOXICOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1: Introduction To Toxicology	**1.1Introduction To Toxicology:** o Definition and History of Toxicology and Toxicity o Disciplines of Toxicology o Biouptake,Bioaccumulation,Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology **1.2: Classes Of Toxicant:** • Define Toxicant and Toxins, their classification • Toxicants in Air, Water and Soil • Toxicants in Domestic and Occupational Settings • Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse,Combustion products,Cosmetics • Movement and fate of Toxicants in the environment	15
MODULE 2: Environmental Impact Mitigation	**2.1: Toxicity Of Heavy Metals:** • Toxicity of Arsenic, Lead, Mercury, • Cadmium,Copper, Zinc, Aluminium,Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals **2.2: Agro-Chemical Pesticides And Their Environmental Impact Mitigation** • Definition and Classification • Organochlorine Insecticides, Organophosphate Insecticides, Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide • Control of Pesticide Pollution; Integrated Pest management	15
MODULE 3: Food Additives AND Toxicity tests.	**3.2: Food Additives:** • General account of Food Additives: • Incidental or Indirect additives • Intentional or Direct additives: **a.**Antioxidants b. Emulsifiers c. Enzymes d. Flavouring agents e. Colour and preservatives f. Artificial sweetening agents i)Saccharine ii)Urea derivatives • Types of toxicity tests; Test types based on number and species; Test types based on exposure of toxicant; Test types based on length of exposure acute , sub acute, chronic)	15

PRACTICAL COMPONENT OF ZOO-III.E-3:ENVIRONMENTAL TOXICOLOGY (DURATION-02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	To determine the effect of temperature on the toxicity of a pollutant	01
2.	To determine the effect of pH on the toxicity of a pollutant.	01
3.	To evaluate qualitatively the presence of pesticide residues in vegetable samples.	02
4.	Estimation of total dissolved solids in given water sample.	01
5.	To determine Lc^{50} of a pollutant on mosquito larvae .	01
6.	Effect of pesticides on Oxygen consumption in fish	02
7.	Estimation of Phosphorus in given water sample by Spectrophotometer	01
8.	Estimation of Boron from given water/soil sample by spectrophotometer	01
9.	Determination of Nitrates from given water sample.	01
10.	Field trip (case study of polluted water body)	01

REFERENCE BOOKS FOR THEORY:

1. Ernst Hodgson(2004) A Text Book of Modern Toxicology ,A John Wiley and sons Inc,Publication.
2. Gupta P.K.(2010) Modern Toxicology, Pharma Med Press, Hyderabad.
3. Omkar(2007) Concepts of Toxicology ,Vishal Publishing Co, Jalandhar
4. Pandey K,Shukla J.P. and Trivedi S.P. (2011)Fundamentals of Toxicology,New Central Book Agency(P) Ltd.
5. P.D.Sharma (2011)Environmental Biology and Toxicology (Third edition),Rastogi Publications,Meerut-250002.

REFERENCE BOOKS FOR PRACTICALS:

1. Wooley, A (2008) A Guide to Practical Toxicology: Evaluation, Prediction, and Risk IInd Edition, Informa Healthcare U.S.A.,Inc.New York.
2. Rao K.S. (1998) Practical Ecology, Anmol Publications Pvt. Ltd. New Delhi.
3. Subramanian M.A. (2004) Toxicology Principles and Methods(Second Revised Edition),M.J.P. Publishers, Triplicane Chennai.
4. Sunita Hooda and Sumanjeet Kaur(1999)Laboratory Manual for Environmental Chemistry, S. Chand and Comp. Ltd. New Delhi.

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ELECTIVE COURSE: PARASITOLOGY	
PAPER CODE:	ZOO-III.E-4
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To be familiar with the parasite host interactions. • To gain knowledge on diagnosis of parasite infections and also to learn about the preventive measures.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Know about the parasites and their lifecycles. CO2: Get acquainted with dimensions of public health viz . a viz. parasitic diversity, epidemiology and community prophylaxis. CO3: Be familiar with the parasite host interactions. CO4: Gain knowledge on diagnosis of parasite infections and preventive measures.

ZOO-III.E-4: PARASITOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Basic Principles of Parasitology and parasitic protozoans	1.1 Parasite systematics, Ecology and Evolution 1.2 Immunology and Pathology 1.3 Symbiosis and parasitism 1.4 Parasite host interactions Form, function, classification, life cycle, diagnosis and preventive measures *1.5 Trypanosoma gambiens* 1.6 Amoebas –*Entamoeba histolytica* *1.7* Malaria organisms - *Plasmodium vivax* 1.8 Sexually transmitted parasite – *Trichomonas vaginalis*	15
MODULE 2: Parasitic Platyhelmithes and Nematodes	Form, function, classification, life cycle, diagnosis and preventive measures 2.1 Trematoda(liver fluke - *Fasciola hepatica*, intestinal fluke – *Fasciolopsis buski*, lung fluke – *Paragonimus westermani*); 2.2 Cestoda (Tape worm - *Taeniasolium*) 2.3 Hook worms- *Ancyclostoma duodena* 2.4Guinea worm- *Dracanculus medinensis* 2.5Round worm *Ascaris lumbricoids, Enterobias vermicularis* 2.6 *Wuchereria bancrofti*	15
MODULE 3: Parasitic arthropods and Parasites of domestic livestock	Form, function, classification , life cycle, diagnosis and preventive measures: Copepods, Barnacles, Amphipods, Isopods, Flea, Ticks, Mites, Head and pubic lice	15

PRACTICAL COMPONENT OF ZOO-III.E-4: PARASITOLOGY (DURATION -02 HRS /WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1)	Study of*Trypanosomagambiens, Entamoebahistolytica, Plasmodiumvivax, Trichomonasvaginalis, Fasciola hepatica,Taeniasolium, Ancyclostoma duodena, Dracanculusmedinensis, Ascarislumbricoids, Wuchereriabancrofti*, copepod, barnacle, amphipod, isopod from permanent slides with respect to parasitic adaptations.	06
2)	Preparation of peripheral blood smear from the perspective of detection of haemoparasites	01
3)	Study of parasites of domestic livestock(parasite, pathogenicity)	04
4)	Study of fish parasites	01

REFERENCE BOOKS:

1. Chatterjee, K.D. (2009) Parasitology (Protozoology and Helminthology) with two hundred fourteen illustrations. CBS, 13th edition.
2. Dey, N.C., Dey, T.K. and D.M. Sinha (1995) Medical Parasitology. New Central book agency private limited, Calcutta.
3. Paniker, J.C.K. (2007) Textbook of medical parasitology. Jaypee Brothers, New Delhi.
4. Schmidt, G.D. (1990) Essentials of Parasitology. Universal Book Stall, New Delhi.

REFERENCE BOOK FOR PRACTICALS :

1. Halton, D.W., Behnke, J.M. and I. Marshall (2005) Practical exercises in parasitology. Cambridge University Press.

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SKILL ENHANCEMENT COURSE: WASTE MANAGEMENT TECHNIQUES	
COURSE CODE	Skill Enhancement Course(SEC): ZOO-III-SE-1
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS.
COURSE OBJECTIVES	• To familiarize students with the techniques of waste management. • To encourage students to get hands on experience on techniques of managing waste. • To help students understand the importance of reducing, reusing and recycling
COURSE OUTCOME	CO1: Understand concept of types of waste, its transport and disposal. CO2: Perform composting techniques / procedures. CO3: Identify means of reducing waste production. CO4: Plan and conduct research in areas of waste management

ZOO-SE-1: WASTE MANAGEMENT TECHNIQUES (SEC- Skill Enhancement Course)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction to waste management	UNIT 1: Overview of types of waste, collection, transport, treatment and disposal of waste. UNIT 2: Waste generated- sources, and management, Storage and collection of different kinds of wastes. UNIT 3: Need for Waste management and effect on the community. UNIT 4: Waste treatment methods: Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes, Biological Treatment of Solid and Hazardous Waste, 3 Rs- Reuse Reduce and Recycle.	05
MODULE 2: Composting Techniques	UNIT 5: Soil structure and its maintenance. UNIT 6: Organic composting- Methods, Procedure - Microorganisms, materials used, design and maintenance, Biogas. UNIT 7: Vermicomposting- Earthworms – biology- life cycle and feeding. Types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species, Nutrient value of worm cast/vermicompost, requirements of vermicomposting. Maintenance of composting – Collection of vermicompost Small Scale Earthworm farming for home gardens. Marketing the products of vermiculture. Predator/pathogen control.	05
MODULE 3: Waste management Techniques and Rules	UNIT 8: Sewage disposal; Medical waste management. Sources, measures and health effects; disposal options UNIT 9: Bioremediation, ground water contamination and remediation Landfill designing and Incineration. UNIT 10: Radioactive and E- waste management-Sources, measures and health effects. UNIT 11: Relevant Regulations- • Municipal solid waste (management and handling) rules (SWM 2000 and amendments of 2016: SO.1357 (E) Sec. 3(II). • Hazardous waste (management and handling) rules 2015(Chapter II and IV; Schedule I,II,III and IV). • Biomedical waste handling rules 2016 (GSPCB – Schedule I and II). • Plastic waste management rules 2016 (Part-II, Section-3, Sub-section (i)])	05
MODULE 4: PRACTICE BASED	Practice of the following: The students of this course are expected to work on these different waste management practice activities: 1) Leaf composting on campus 2) Vermicomposting 3) Awareness on waste segregation. 4) Waste collection Drives. 5) Research on waste management. 6) Case studies/ mini projects. The report of the same will be submitted as portfolio.	45

REFERENCE BOOKS:

1. *Edwards CA, Hendrix P and Arancon N (2014) Biology and Ecology of Earthworms, Springer Publishers.*
2. *Karaca A (2011) Soil Biology: Biology of Earthworms. Springer Publishers.*
3. *Edwards CA, Arancon NQ and Sherman RL (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management, CRC Press, USA.*
4. *Ranganathan LS (2006) Vermibiotechnology– From Soil Health to Human Health. Agrobios, India.*
5. *Ismail SA (2005) The Earthworm Book. Edition, Other India Press, Apusa, Goa, India.*
6. *Ismail SA (1997) Vermicology: The Biology of Earthworms. Orient Longman, India.*
7. *A. D.Bhide and B.B.Sundaresan, "Solid Waste Management –Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.*
8. *Biomedical waste (Management and Handling) Rules, 1998.*

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY

COURSE CURRICULUM OF SEMESTER 4

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
Semester IV	ZOO-IV.C-6	Biochemistry and Metabolic Regulation	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-5	Animal cell culture and Applications	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-6	Aquaculture and Fisheries	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-7	Immunology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-IV.E-8	Evolutionary Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
Skill enhancement course (SEC) **(Odd and Even semester)**	ZOO-SE-1	Waste management techniques	Theory and practice = 4 credits	Theory = 15 hrs Practice = 45 hrs

SEMESTER IV:

CORE COURSE: BIOCHEMISTRY AND METABOLIC REGULATION	
COURSE CODE:	ZOO-IV.C-6
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the basic principles that govern the functioning of living systems • To know the structure of biomolecules and the role they play in governing life processes through the pathways • To be familiar with enzymes and their activities
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand better the chemical basis in life. CO2: Know the basic principles that govern the functioning of living systems CO3: Be familiar with enzymes and their activities CO4: Appreciate better the interactions between the biological molecules.

ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fundamentals of biochemistry and Carbohydrate metabolism	1.1 Principles of pH, buffer, thermodynamics 1.2Enzymes: classification, properties of enzyme, enzyme kinetics, MichaelisMenten Equation, enzyme inhibition 1.3 Carbohydrate structure, aerobic and anaerobic glycolysis, Citric acid cycle, glycogenesis, glycogenolysis, Pentose phosphate pathway, 1.4 Diabetes mellitus	15
MODULE 2: Lipid and Protein metabolism	2.1: Lipid: -structure and classification, -fatty acid synthesis -fatty acidoxidation(saturated and unsaturated), - metabolism of glycerophospholipids, sphingolipids, cholesterol - disorders: fatty liver types (NAFL, AFL) 2.2 Protein: - structure(primary, secondary, tertiary) and classification -amino acid biosynthesis, nucleotide biosynthesis, - amino acid catabolism, urea cycle, Fate of carbamoyl P, - Hyper uricemia	15
MODULE 3: Nucleotide metabolism and integration of metabolism	3.1Biosynthesis of purine and pyrimidine (de novo and salvage pathway) 3.2 Degrdation of purine and pyrimidine 3.3 Interconversions between the three principal components 3.4 Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)	15

PRACTICAL COMPONENT OF ZOO-IV.C-6: BIOCHEMISTRY AND METABOLIC REGULATION (DURATION -02 HRS /WEEK		
Sr. No	Practical	No. of Practicals
1)	Principle and working of spectrophotometer	01
2)	Estimation of reducing sugars DNSA method	01
3)	Estimation of protein – Folin Lowry's method	01
4)	Estimation of fatty acids by titration method	01
5)	Separation of lipids by thin layer chromatography	02
6)	Colorimetric estimation of liver glycogen of chick by Anthrone method	02
7)	Effect of substrate concentration on amylase activity	02
8)	Estimation of DNA by DPA method	02

REFERENCE BOOKS:

1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.
2. Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.
3. Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.
4. Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition.

REFERENCE BOOKS FOR PRACTICALS:

Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry.Tata McGraw Hill Education ,UK.

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ELECTIVE COURSE: ANIMAL CELL CULTURE AND APPLICATIONS	
COURSE CODE:	ZOO-IV-E-5
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	This course is an introduction to the theory, standard practices, and methodologies of animal cell culture. The laboratory emphasizes the principles and practices of initiation, cultivation, maintenance of cell lines.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Operate, calibrate, and maintain standard equipment found in an animal cell culture laboratory; CO2: Prepare and sterilize media and solutions used in cell culture. CO3: Understand concepts and applications of mammalian cell culture. CO4: Perform primary cell culture of suspension and adherent cells.

Z00-IV-E-5: ANIMAL CELL CULTURE AND APPLICATIONS		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: LAB REQUIREMENTS FOR CELL CULTURE	1: Historical background of Cell culture:	15
	2: Biology of cells in culture: Origin and characteristics, Differentiation, kinetics of cell growth, Genetics of Cultured cells, Problems associated with cell culture	
	3: Lab requirements for animal cell culture: o Lab facilities and setup for cell culture o Major and minor equipments o Environmental conditions o Substrates for Culturing and sub culturing	
	4: Animal tissue culture media o Natural media – biological fluids, tissue extracts o Chemically defined media- characteristic and composition o Media supplements – L Glutamine, serum. Advantages and disadvantages of serum in media / serum free media	
MODULE 2: CELL CULTURE TECHNIQUES	5: Primary cell culture: o Mechanical disaggregation o Enzymatic disaggregation o Protocol for primary cell culture	15
	6: Secondary cell culture/ Sub culturing: o Protocol for sub culturing of suspension culture o Protocol for sub culturing of adherent o Established cell lines	
	7: Scale up of animal cell culture: o Techniques of Scale up of suspension cultures o Techniques of Scale up of Monolayer cultures	
MODULE 3: CELL CULTURE APPLICATIONS	8: Cell Hybridoma Technology : o Steps of cell Hybridoma technology o Procedure o Production of monoclonal antibodies o Applications of monoclonal antibodies	15
	9: Valuable Products through cultured cells: Production of Tissue plasminogen, growth factor, Erythropoietin, Factor VIII, Interferons.	
	10: Other Application: Vaccines through cultured cells, Cytotoxicity testing, Fluorescent In-Situ Hybridization for disease detection, Cell culture in biomedical research.	

PRACTICAL COMPONENT OF ZOO-IV-E-5: DURATION -02 HRS /WEEK ANIMAL CELL CULTURE AND APPLICATIONS		
Sr. No	**Practical**	**No. of Practicals**
1.	Packing and sterilization of glass and plastic wares for cell culture & Lab Precautions and Biosafety measures	02
2.	Preparation of reagents and media for cell culture. ▪ Reagents ▪ Media / Buffers	02
3.	Setting up of primary cell culture - Methods used for cell disaggregation – Mechanical and Enzymatic - Quantification of cells (Viable cell count) by Tryphan blue exclusion dye. - Suspension culture - Adherent cell culture - Chicken embryo fibroblast culture	07
4.	Biological waste disposal methods	01

REFERENCE BOOKS:

1) *Ranga MM(2012). Animal Biotechnology. Agrobios India Ltd. Jodhpur.*
2) *Mathur S(2006). Animal Cell and Tissue Culture. Agrobios India Ltd. Jodhpur.*
3) *Masters W(2005). Animal Cell Culture. Oxford University Press Inc., NewYork*
4) *Gangal S(2010). Principles and practices of Animal Tissue Culture. Second Edition. University Press PVT. LTD., Hyderabad India.*
5) *Freshney I R(2007). Culture of animal Cells: A manual of Basic Techniques. 5th edition, John Wiley & Sons Inc Pte Ltd*

REFERENCE BOOKS FOR PRACTICALS:

1) *E Book- Fletcher L, Goss E. Phelps P and Wheeler A(2014). Introduction to Biotechnology – Laboratory Manual.*
2) *Harisson M A and Rae IF(1997):General Techniques of Cell Culture Handbook in Practical animal cell biology. Cambridge University Press.*
3) *Ebook- Cell Culture basics. From www.invitrogen.com/cellculture basics.*

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ELECTIVE COURSE : AQUACULTURE AND FISHERIES	
COURSE CODE:	ZOO-IV.E-6
MARKS:	100[75- Theory; 25- Practicals]
CREDITS:	04 [03-Theory;01- Practical)
CONTACT HOURS	Theory :45 Hours(03 LEC/WEEK) Practicals: 30 Hours(01 PRACTICAL/WEEK)
COURSE OBJECTIVES:	• To improve the understanding of conservation and sustainability of living resources • To improve the social and economic benefits derived from aquaculture and fisheries. • To study the role of aquaculture in rural development in solving nutritional security and unemployment. • Empowerment of fishery and entrepreneurship development
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand conservation and sustainability of aquaculture resources. CO2: Acquainted with various techniques of aquaculture. CO3: Know strategies of improving the social and economic benefits derived from aquaculture and fisheries. CO4: Initiate business enterprise in area of aquaculture.

ZOO-IV.E-6: AQUACULTURE AND FISHERIES		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1:	**1.1:Inland Fisheries:** • Riverine ;Reservoir fisheries; Lakesterine fisheries; Cold water fisheries **1.2: Marine Fisheries:** • Estuarine fisheries:The catadromous fishes (*Polynemous indicus,P.tetradactylus*) and anadromous fishes(*Hilsa ilisha,Pama pama,Polynemous paradiseus*) • Coastal fisheries or Inshore fisheries: Elasmobrach fishery and Teleost fishery • Offshore and Deep sea fisheries: Pomfrets(*Pampus,Stromateus) Eleutheronema tetradactylus*(rava). **1.3: Crustacean And Molluscan Fisheries:** • Prawn fisheries in Goa: Penaeid and Palaemonid groups. • Crab fisheries in Goa • Edible oyster fisheries in Goa • Mussel fisheries in Goa	15
MODULE 2:	**2.1: Integrated Fish Farming Systems:** • Principle of integrated Fish farming; Integration with animal husbandry and farming systems. **2.2:Induced Breeding:** • Selection of site; Design and Layout of fish farm; Freshwater and brackish water; pond construction; Pond maintenance; Prevention of fish diseases; Control of aquatic weeds, predatory and Weed fishes, Aquatic insect; Harvesting. **.4 :Fishing Methods:** • Marine Fishing Crafts and Gears used in Goa. • Inland Fishing Crafts and Gears used in Goa	15
MODULE 3:	**3.1: Fish Culture System:** • Overview of Mono culture, polyculture, composite culture, raceway culture, extensive, semi intensive, intensive, zero water exchange, Objective of fish culture, Pond preparation, Selection of species, Stocking of seed, Feed and feeding, Harvesting, Bionomics of fish culture **3.2: Cage And Pen Culture:** • Advantage of Fish culture in cages, Selection of species for cage culture, Installation of cage - shape ,size and types of cages, Pen culture, Maintenance of cage and pen	**15**

PRACTICAL COMPONENT OF ZOO-IV.E-6: AQUACULTURE AND FISHERIES (DURATION – 02 HRS/ WEEK)		
Sr. No.	**Practical**	**No. of Practicals**
1.	Morphometric and Meristic study : a key for fish Identification	04
2.	Identification of : -Important edible prawns, shrimps and crabs(anytwo) - Important Freshwater and Marine edible fishes- oil sardine, sole fish, white sardine,mullet,Scianera	03
5.	Estimation of Fecundity by Frequency Polygon method from a Marine Fish	01
6.	Food and Feeding of Fish by analysis of gut content	01
7.	Field based: • To study different types of gear and craft • To study fish breeding • Study of aquarium and larvivorous fishes	03

REFERENCE BOOKS FOR THEORY:

1. Bal D.V.,RaoVirbhadra,K (1984) Marine Fisheries, Tata McGraw- Hill Publishing Company Ltd.New Delhi.
2. Cushing D.H. (1975) Marine Ecology and Fisheries , Cambridge University Press.
3. Day,F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols., Taylor and Francis London.
4. Khanna S.S.(1984) An Introduction to Fishes, Central Book Depot Allahabad.
5. Pandey K and Shukla J.P.(2015) Fish and Fisheries. Rastogi Publications Meerut-250002
6. Sakhare B. Viswas (2007) Applied Fisheries.Daya Publishing House Delhi-110035
7. Santhanam R (1990) Fisheries Science,Daya Publishing House Delhi.
8. SanthanamR,Ramanathan N and Jagatheesan G(1990) Coastal Aquaculture in India,CBS Publishers and distributers,Delhi.
9. Shrivastava C.B.L.(1996) A Text Book of Fishery Science and Indian Fisheries. KitabMahal22 A,S.N.Marg, Allahabad.
10. Singh B.K.(2008) Applied Fisheries and Aquaculture.Swastik Publishers and distributers,Delhi.

REFERENCE BOOKS FOR PRACTICALS:

1. Chandy.M (1970) Fishes,National Book Trust,India,New Delhi.
2. Day.F. (1889) The Fauna of British India including Ceylon and Burma. Fishes. 2Vols.,Taylor and Francis London.
3. R.J.Ranjit Daniels (2002) Freshwater Fishes of Peninsular India, Universities Press (India)Pvt.Ltd. Hyderabad.
4. SakhareViswasB. (2007) Applied Fisheries ,Daya Publishing House Delhi.
5. Sharma U and S.P.Grover (1982) An Introduction to Indian Fisheries,Dehradun India.
6. Srivasava C.B.L.(1986) A Text Book of Fishery Science and Indian Fisheries ,KitabMahal Allahabad

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ELECTIVE COURSE: IMMUNOLOGY	
COURSE CODE:	ZOO-IV.E-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	Familiarize students and make them learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand the components of the immune system and their function. CO2: Explain the mechanisms of immune response. CO3: Know about the techniques used in detecting immunological diagnosis. CO4: Perform immunoassays for disease detection.

ZOO-IV-E-7: IMMUNOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Immunology	1: OVERVIEW OF IMMUNE SYSTEM: • Basic concepts in immunology • Components of the immune system	15
	2: INNATE AND ADAPTIVE IMMUNITY. • Innate immunity-Anatomical barriers/ layers of defense, cells and molecules involved in innate immunity • Adaptive immunity-cell mediated and humoral immunity, passive immunity (artificial and natural), Active(artificial and natural), Immune dysfunction	
MODULE 2: Antigens And Immunoglobulins	3: ANTIGENS. • Antigenicity and immunogenicity, Immunogens, adjuvants and haptens • Factors influencing immunogenicity • B and T cell epitopes	15
	4: IMMUNOGLOBULINS • Structure and function of different classes of Immunoglobulin. • Antigen-Antibody interactions • Immunoassays, monoclonal & polyclonal antibodies	
	5: MAJOR HISTOCOMPATIBILITY COMPLEX. • Structure and function of endogenous and exogenous pathways of antigen presentation	
MODULE 3: Immune Response	6: CYTOKINES AND COMPLEMENT SYSTEM • Properties and functions of cytokines, cytokine based therapies • Components and pathways of complement activation	15
	7: HYPERSENSITIVITIES, AUTOIMMUNITY AND TRANSPLANTATION • Gell and coombs' classification, types of hypersensitivities(overview) • Autoimmune responses against self antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection, types and mechanisms of transplant rejection	
	8: VACCINES • Types of vaccines -inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines	

PRACTICAL COMPONENT OF ZOO-IV-E-7: IMMUNOLOGY (DURATION -02 hrs/WEEK)		
Sr. No	**Practical**	**No. of Practicals**
1	Preparation of serum from goat blood.	02
2	Slide Agglutination Reaction(blood groups – A / AB / O with Rh)	02
3	Differential count of leukocytes	01
4	Detection of presence of antigen / antibody - Simple immunodiffusion	01
5	Antibody Titre determination - Ouchterlony immunodiffusion	02
5	Antigen –antibody reaction by immunoelectrophoresis	02
6	Elisa TEST- pregnancy test	01
7	Phagocytosis – WBC (demonstration)	01

REFERENCE BOOKS:

Essential books:

1) *Abbas KA, Lechtman HA(2007). Basic Immunology, Updated Edition 2006-2007: with STUDENT CONSULT. Access (Paperback).*
2) *David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.*
3) *Abbas KA, Lechtman HA(2003). Cellular and Molecular Immunology. Saunders Publication.*
4) *Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). Immunology. VI edition. W H Freeman and company.*

*Ebooks**:***

5) *Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.*
6) *Zabriskie JB(2009). Essential Clinical Immunology. Cambridge University Press.*

REFERENCE BOOKS FOR PRACTICALS:

1) *Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.*

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ELECTIVE COURSE : ZOO-IV-E-8: EVOLUTIONARY BIOLOGY	
COURSE CODE:	ZOO-IV-E-8
MARKS	100 [75 –Theory ; 25- Practicals]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVE:	• The study aims to discover the history of life and the causes of the diversity and characteristics of organisms. • To show the important contributions of evolutionary biology to other biological disciplines such as medicine
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand the concepts of evolutionary processes. CO2: Understand mechanism of evolution. CO3: Able to correlate adaptations in organisms to evolutionary sequences. CO4: Correlate evolutionary phenomena with population genetics.

ZOO-IV.E-8: EVOLUTIONARY BIOLOGY

MODULE	TOPICS	CONTACT HOURS
MODULE 1: Evolutionary processes	**1.1: EVOLUTIONARY BIOLOGY:AN OVERVIEW** • What Is Evolution, History Of Evolutionary Biology, Pre Darwinian, Darwin's Evolutionary Theory, Evolutionary Theories After Darwin • Famous contributions to evolutionary Biology: CarlLinneaus,Lamarck,Malthus,Darwin,Thomas Huxley,R.A.Fisher,Haldane,sewall Wright, G.G.Simpson, Dobzanhasky,Ernst Mayr, M.Kimura. **1.2: THE NATURAL SELECTION:** • The Nature of Natural Selection • Postulates of natural selection • Evidences of Natural selection • Types of natural selection(Stabilizing,Directional and Disruptive selection) • Natural Selection in action(Darwin's finches, Endler's guppies examples) • Sexual Selection **1.3: RANDOM PROCESS IN EVOLUTION:** • Mutation :types of mutation • Genetic drift(bottle neck effect,founder's effect) • Gene flow(migration/emmigration **1.4: SYNTHETIC THEORY OF EVOLUTION** • Neo-Darwinis	**15**
MODULE 2: Speciation and Population genetics	**2.1: NON- DARWINISM** • Neutral theory of evolution • Molecular polymorphism-nucleic acids and proteins • Molecular clocks **2.2: SPECIATION** • different concepts of speciation • Concept Of Biological Speciation(Allopatric/Sympatric) • Consequence Of Speciation • Factors involved in Biological Speciation(pre and post- zygotic mechanisms) **2.3: POPULATION GENETICS** • Hardy-Weinberg's Law(H-W) • Genes And Genotype Frequencies • Factors Affecting H-W **2.4:ADAPTATIONS :** • Definition and kinds of adaptations with some examples. • Pre , Post adaptations	**15**

	• Coadaptations and Parallel adaptations	
MODULE 3: Patterns of evolution	**3.1: PATTERNS OF EVOLUTION:** • Sequential and Convergent Evolution • Microevolution • Macroevolution(Adaptive radiation) • Megaevolution • Gradualism And Punctuated Equilibrium **3.2: EVOLUTION AND HUMAN HEALTH AND DISEASES** • Design defects • Defence mechanisms-Allergy,morning sickness • Evolution of antibiotic resistance • Evolution of behaviour,Anxiety,fear and depression.	**15**

PRACTICAL COMPONENT OF ZOO-IV.E-8: EVOLUTIONARY BIOLOGY (DURATION -02 HRS/WEEK)		
Sr.No.	**Practical**	**No.of Practicals**
1.	Study of homology and analogy from suitable specimens	01
2	Serial homology	01
3	Variations are basis for evolution	01
4	To demonstrate the role of Natural Selection in Fixing Favoured Adaptation and Eliminating Maladaptation.	02
5	Problems based on Population Genetics (PTC /blood group)	04
6.	An exercise to illustrate the concepts of Genetic drift	02
1.	Vestigial organs or Vestiges in animals and humans.	01

REFERENCE BOOKS:

1. Bipin Kumar(2001) Organic Evolution; Campus Books International, New Delhi.
2. Charlotte J. Avers (1989)Process and pattern in Evolution ; New York Oxford University Press.
3. Douglas J. Futuyma(2013) Evolution IIIrd edition; Sinaue Associates,Inc.Publishers Sunderland , Massachusetts U.S.A.
4. E.Peter Volpe(1989) Understanding Evolution Vth edition Universal Book Stall.
5. S.Osawa ,T.Honjo(Eds.)(1991) Evolution of life,Springer-Verlag Tokyo .
6. Savage Jay M (1969) Evolution , Amerind Publishing Co-Pvt. Ltd. New Delhi.
7. Veer Bala Rastogi (2004) Organic Evolution ,Eleventh revised edition; Kedarnath Ramnath Delhi.
8. Pranab K. Banerjee (2011) Problems on Genetics,Molecular Genetics and Evolutionary Genetics, New Central Book Agency (P) Ltd. Delhi

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SKILL ENHANCEMENT COURSE: WASTE MANAGEMENT TECHNIQUES	
COURSE CODE	Skill Enhancement Course(SEC): ZOO-III-SE-1
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS.
COURSE OBJECTIVES	• To familiarize students with the techniques of waste management. • To encourage students to get hands on experience on techniques of managing waste. • To help students understand the importance of reducing, reusing and recycling
COURSE OUTCOME	CO1: Understand concept of types of waste, its transport and disposal. CO2: Perform composting techniques / procedures. CO3: Identify means of reducing waste production. CO4: Plan and conduct research in areas of waste management

ZOO-SE-1: WASTE MANAGEMENT TECHNIQUES (SEC- Skill Enhancement Course)		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction to waste management	UNIT 1: Overview of types of waste, collection, transport, treatment and disposal of waste. UNIT 2: Waste generated- sources, and management, Storage and collection of different kinds of wastes. UNIT 3: Need for Waste management and effect on the community. UNIT 4: Waste treatment methods: Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes, Biological Treatment of Solid and Hazardous Waste, 3 Rs- Reuse Reduce and Recycle.	05
MODULE 2: Composting Techniques	UNIT 5: Soil structure and its maintenance. UNIT 6: Organic composting- Methods, Procedure - Microorganisms, materials used, design and maintenance, Biogas. UNIT 7: Vermicomposting- Earthworms – biology- life cycle and feeding. Types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species, Nutrient value of worm cast/vermicompost, requirements of vermicomposting. Maintenance of composting – Collection of vermicompost Small Scale Earthworm farming for home gardens. Marketing the products of vermiculture. Predator/pathogen control.	05
MODULE 3: Waste management Techniques and Rules	UNIT 8: Sewage disposal; Medical waste management. Sources, measures and health effects; disposal options UNIT 9: Bioremediation, ground water contamination and remediation Landfill designing and Incineration. UNIT 10: Radioactive and E- waste management-Sources, measures and health effects. UNIT 11: Relevant Regulations- • Municipal solid waste (management and handling) rules (SWM 2000 and amendments of 2016: SO.1357 (E) Sec. 3(II). • Hazardous waste (management and handling) rules 2015(Chapter II and IV; Schedule I,II,III and IV). • Biomedical waste handling rules 2016 (GSPCB – Schedule I and II). • Plastic waste management rules 2016 (Part-II, Section-3, Sub-section (i)])	05
MODULE 4: PRACTICE BASED	Practice of the following: The students of this course are expected to work on these different waste management practice activities: 1) Leaf composting on campus 2) Vermicomposting 3) Awareness on waste segregation. 4) Waste collection Drives. 5) Research on waste management. 6) Case studies/ mini projects. The report of the same will be submitted as portfolio.	45

REFERENCE BOOKS:

1. *Edwards CA, Hendrix P and Arancon N (2014) Biology and Ecology of Earthworms, Springer Publishers.*
2. *Karaca A (2011) Soil Biology: Biology of Earthworms. Springer Publishers.*
3. *Edwards CA, Arancon NQ and Sherman RL (2011) Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management, CRC Press, USA.*
4. *Ranganathan LS (2006) Vermibiotechnology– From Soil Health to Human Health. Agrobios, India.*
5. *Ismail SA (2005) The Earthworm Book. Edition, Other India Press, Apusa, Goa, India.*
6. *Ismail SA (1997) Vermicology: The Biology of Earthworms. Orient Longman, India.*
7. *A. D.Bhide and B.B.Sundaresan, "Solid Waste Management –Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.*
8. *Biomedical waste (Management and Handling) Rules, 1998.*

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PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY

COURSE CURRICULUM OF SEMESTER 5

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
SEMESTER V	ZOO-V.C-7	Developmental Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-9	Molecular Genetics and Forensic Science	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-10	Economic Zoology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-V.E-11	Basic and Applied Entomology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
		*Basic and Applied Entomology (as Non-practical based course)	Theory = 04	Theory = 60
	ZOO-V.E-12	Fish Preservation and Processing	Theory = 03 Practicals =01	Theory = 45 Practicals =30
		*Fish Preservation and Processing(as Non-practical based course)	Theory = 04	Theory = 60

SEMESTER V

CORE COURSE:DEVELOPMENTAL BIOLOGY	
COURSE CODE:	ZOO-V.C-7
MARKS:	100 [75 –Theory ; 25- Practicals]
CREDITS:	04 [03 –Theory; 01- Practical]
CONTACT HOURS:	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES:	• To understand the processes of fertilization, polyspermy and activation of egg metabolism • To know the basics of animal development, specifically in sea urchin and chick • To be familiar with the processes that help in the establishment of basic plan of development
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand the basic plan of animal development. CO2: Know the processes which occur during the course of development in invertebrates and vertebrates. CO3: Have the basic knowledge of developmental biology. CO4: Know the concepts associated with development of embryo.

ZOO-V.C-7: CORE COURSE:DEVELOPMENTAL BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Early embryonic development and early development of model organism: sea urchin	1.1: Introduction to cell division: mitosis and meiosis 1.2: Fertilization: structure of the gametes 1.3: Species recognition specificity of egg and sperm 1.4: Gamete fusion and the prevention of polyspermy 1.5: The activation of egg metabolism 1.6: Fusion of the genetic material 1.7: Rearrangement of the egg cytoplasm 1.8: Sea Urchin: cleavage, gastrulation, blastula formation 1.9: Fate maps and the determination of sea urchin blastomeres, gastrulation 1.10: Embryonic stem cells: Pluripotency and tutipotency	15
MODULE 2: Early development of model organism: chick	2.1: Chick: cleavage, gastrulation, primitive streak, epiboly 2.2: Development upto three days of incubation 2.3: Extra embryonic membranes of chick development, structure and functions of yolk sac, amnion, chorion and allantois	15
MODULE 3: Growth and regeneration	3.1: Nuclear transplantations and embryonic inductions 3.2: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation 3.3: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates 3.4: Hejmadi Mohanty's experiment	15

PRACTICAL COMPONENT OF ZOO-V.C-7 (DURATION -02 HRS /WEEK)		
SR. NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Observation of developmental stages of sea urchin: cleavage, blastula, gastrula (permanent slides)	01
2)	Study of morphogenetic movement *in vivo* in hens egg using vital staining technique by preparing window opening	02
3)	*In vitro* observation of different extra embryonic membrane in a six days old chick embryo	01
4)	Preparation of permanent slides of chick embryo: 24 hours, 36 hours,48 hours, 72 hours	06
5)	Effect of retinoic acid on regeneration of fin in fish	01
6)	Mounting of eye vesicles and limb buds of six day old chick embryo	01

REFERENCE BOOKS:

1. *Gilberts, S.F. (2013). Developmental Biology, Sinauer Associates, Sunderland.*
2. *Jain, P.C. (2013). Elements of developmental biology, Vishal Publications, Jalandhar*
3. *Slack, J.M.W. (2006). Essential developmental biology. Blackwell Publishing, U.K.*

REFERENCE BOOKS FOR PRACTICALS:

1. *Beffa – Mari, M. And J. Knight (2005) Key experiments in practical developmental biology. Cambridge University Press.*
2. *Tyler, M.S. (2000) Developmental biology, a guide for experimental study. Sinauer Associates, Inc. Publishers, Sunderland, MA.*

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ELECTIVE COURSE: MOLECULAR GENETICS AND FORENSIC SCIENCE	
COURSE CODE	ZOO-V.E-9
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand and explain the process of replication, transcription and translation CO2: Differentiate between the gene expression in prokaryotes and eukaryotes CO3: Understand the Branches of forensic science CO4: know the application of molecular tools in genetic diagnosis

ZOO-V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Gene Expression and Gene Regulation	1.1 : DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication 1.2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors 1.3 : Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and eukaryotic translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA 1.4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators,repressors, enhancers, silencers elements; Gene silencing	15
MODULE 2 : Basics of Forensic Science	2.1 : Definition, overview of Disciplines of Forensic science 2.2: Crime and Crime Scene management: Types of crime scenes – indoor and outdoor. Securing and isolating the crime scene. Crime scene search methods. Safety measures at crime scenes. Legal considerations at crime scenes. Documentation of crime scenes – photography, videography, sketching and recording notes. 2.3: Forms of forensic evidences: -Biological evidence: Bloodstains, hair, semen, DNA -Physical and trace evidence –pattern of blood stains, fingerprints, fibres, weapons - Documents- types of forensic documents (genuine /forged),methods of detecting forged documents(handwriting analysis, Analysis of paper and inks)	15
MODULE 3 : Diagnostic Genetics	3.1 : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening 3.2: Cytogenetics/ Molecular Cytogenetics/ Molecular methods of detecting genetic disorders – Prenatal and Preimplantation screening 3.3: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification	15

PRACTICAL COMPONENT OF ZOO–V.E-9: MOLECULAR GENETICS AND FORENSIC SCIENCE (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Isolation of DNA from peripheral blood/tissue (chick liver).	01
2	Microscopic examination of Hair a. Human scalp Hair b. Animal Hair	03
3	Sketching and Photography of various type of crime scene.	03
4	Presumptive Tests for Blood a. Phenolphthalin Assay	01
6	To perform ridge tracings and ridge counting	01
7	Analysis of DNA fingerprints	03

REFERENCE BOOKS :

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science + Business Media, LLC (Ebook available)*
2) *Robert Schleif (1993). Genetics and Molecular Biology. S E C O N D E D I T I O N. Department of Biology,The Johns Hopkins University, Baltimore, Maryland. The Johns Hopkins University Press 2715 North Charles Street Baltimore, Maryland 21218-4319, The Johns Hopkins Press Ltd., London (Ebook available)*
3) *Richard Saferstein (2011); Forensic Science,II Edition, Prentice Hall publishers, Sanfrancisco*
4) *Griffith A, Wesseler S, Lewontin R Gelbart W, Suzuki D and Miller J(2000). Introduction to Genetic Analysis. Eigth Edition.(Ebook available)*
5) *Tom Strachan and Read A (2010): Human Molecular Genetics. Fourth Edition. Garland Science Publisher, New York, NY 10017*

REFERENCES BOOKS FOR PRACTICALS:

1) *J. Prahlow (2010); Forensic Pathology for Police, Death Investigators, Attorneys, 17 and Forensic Scientists, DOI 10.1007/978-1-59745-404-9_2, C Springer Science+Business Media, LLC (Ebook available.)*

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ELECTIVE COURSE: ECONOMIC ZOOLOGY	
COURSE CODE	ZOO-V.E-10
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	To study the various aspects of economic zoology To study the species of economic importance, classification To gain an insight whether own business can be started based on studying the zoological species and their products
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Understand how zoological species contribute to economic sources. CO2: Gain working knowledge of techniques of rearing organisms. CO3: Get acquainted with maintenance of the species CO4: Understand the underlying principles of harvesting products from species.

ZOO-V.E- 10 : ECONOMIC ZOOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Scope of Economic Zoology	1.1 : Economic Zoology, History, Scope, 1.2 : Species of bionomic importance (Honey bee, Silkworm, lac insect, mackerel, domestic fowl, goat, sheep, cow, buffalo, pig, rats, mice) 1.3 : Source, properties, constituents and nutritive value of products of bionomic importance: eggs of poultry, milk, meat, honey, medicinal value of synthetic insulin (recombinant), significance of wool, silk, lac 1.4 : Organizations and their functions: agricultural and processed food products export development authority (APEDA), the marine products exports developmental authority (MPEDA), central silk board (CSB), central bee research and training institute (CBRTI), pharmaceutical and biotechnology industries (Lupin) and contract research organizations (Intox), and research institutes (NIN, Hyderabad)	15
MODULE 2 : Models in Economic Zoology	2.1 : Insects, products and applications : lac insects, honey bees, silkworms 2.2 : Vermiculture: Rearing and maintenance of earthworms 2.3 : Aquaculture : rearing and maintenance of prawns,oysters, edible and ornamental fishes 2.4 : Poultry : rearing and maintenance of domestic fowl, applications and products 2.5 : Business models of apiculture, sericulture, aquaculture and poultry	15
MODULE 3 : Pharma products and biological control	3.1 : Pharmaceuticals from animals and their Applications (antiserum), from transgenic animals (malaria vaccine, alpha 1 antitrypsin, lactoferrin, fibrinogen) 3.2 : Species used in biological control : *Casnoidea indica*, Trichogramma, *Poecilia reticulata / Gambusia affinis* 3.3 : Maintenance and breeding of animals for research: mice, rats, guinea pigs, rabbits, marmosets, guidelines given by committee for the purpose of control and supervision of experiments on animals (CPCSEA)	15

PRACTICAL COMPONENT OF ZOO-V.E-10 ECONOMIC ZOOLOGY (DURATION - 02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Vermicomposting	05
2	Preparation of dairy products from milk : cheese and butter	02
3	Laboratory observations of insects – Honeybee, Silk moth, Lac insect	01
4	Visit to dairy industry/poultry/ piggery/apiary/silk industry/ biotechnology industry/pharmaceutical industry/research institute	04

REFERENCE BOOKS :

1) *G. S. Shukla, V. B. Upadhyay (2008) Economic Zoology, Rastogi Publications, Meerut*
2) *H. Osborn (1908) Economic Zoology an introductory text book in zoology with special reference to its applications in agriculture, commerce and medicine The Macmillan Company*
3) *K. P. Shrivastava, Gs Dhaliwal (2015) Text Book of Applied Entomology Kalyani Publishers*
4) *P. K. Gupta (2011) Vermicomposting for Sustainable Agriculture, Agrobios India Ltd*
5) *S. Singh (1962) Bee-Keeping in India ICAR New Delhi p. 214*

REFERENCE BOOKS FOR PRACTICALS:

1) *A. K. Tripathi(2009) Mulberry Sericulture: Problems And Prospects Aph Publishing Corporation*
2) *C.L. Metcalf and W.P Flint (1962) Destructive and Useful Insects New York, N.Y. : McGraw-Hill*

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ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY	
COURSE CODE	ZOO-VI.E-11
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Be familiar with the identification of bio economical species. CO2: Identify entrepreneurial opportunities in entomology. CO3: Important insects and their products. CO4: Insect pests of public health and veterinary importance and their management.

ZOO-VI.E-11: BASIC AND APPLIED ENTOMOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: • of antenna, wings, legs, Mouth parts Unit 3: Techniques: • Collection of insects • Preservation of insects	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: • Paddy pests, cashew pests, coconut pests, areca nut pests, stored grain pest, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6:Termites: • social organization, termitaria and termite control measures	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15

PRACTICAL COMPONENT OF BASIC AND APPLIED ENTOMOLOGY ZOO-VI.E-14 PRACTICAL (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS (12)**
1.	Collection techniques of Insects – light traps, sweep net, Berlese funnel	02
2.	Identification and study of economically important insects.	02
3.	Field trips to ICAR Old Goa / Govt. of Goa agriculture department/ National Malaria Research Institute (NMRI).	02
4.	Study of insects of college campus dragon fly/ pests of different plants.	03
5.	Study of local insect pests of agriculture.	03

REFERENCE BOOKS:

1) *Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.*
2) *Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.*
3) *David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.*
4) *Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications*

REFERENCE BOOKS FOR PRACTICALS:

1. *Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.*
2. *Varasi, M.S. (1992): Text book of entomology, Himalaya Publishing House, 1st edition.*

***ELECTIVE COURSE: BASIC AND APPLIED ENTOMOLOGY (AS NON PRACTICAL BSED COURSE)**	
COURSE CODE	ZOO-VI.E-11
MARKS	100 [75 -Theory; 25- Fieldbased]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVE	• To develop a strong foundation in entomology, including understanding of the importance of insects to the human society. • To review important areas in insect biology such as morphology, physiology, ecology, behaviour, genetics, phylogeny, ontogeny and population biology. • To develop a sufficient background for advanced entomology.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Be familiar with the identification of bio economical species. CO2: Identify entrepreneurial opportunities in entomology. CO3: Important insects and their products. CO4: Insect pests of public health and veterinary importance and their management.

ZOO-VI.E-11: BASIC AND APPLIED ENTOMOLOGY		
MODULE	**TOPIC**	**CONTACT HOURS**
MODULE 1 Fundamentals of Entomology	Unit 1: Class Insecta: • Salient features • Classification of insects up to orders – an overview Unit 2: Morphological studies: • of antenna, wings, legs, Mouth parts Unit 3: Techniques: • Collection of insects • Preservation of insects	15
MODULE 2 Bionomics and control of crop pests and medically important pests	Unit 4: Pest of agricultural importance: • Paddy pests, cashew pests, coconut pests, areca nut pests, stored grain pest, sugarcane pests, vegetable pests, fruit pests (two pests from each of the above) Unit 5: Insects of medicinal importance: • mosquitoes, housefly, sand fly, cockroaches, human lice, bed bug, rat fleas Unit 6:Termites: • social organization, termitaria and termite control measures	15
MODULE 3 Useful insects and pest management	Unit 7: Useful insects: • Honeybees (Apiculture); Mulberry silk worm(sericulture); lac insects (lac culture) Unit 8: Insect pest control methods: • biological, chemical (attractants, pheromones and hormones), Integrated Pest Management (IPM) Unit 9: Role of insects in ecosystem services	15
MODULE 4 Field based Study	<u>Field based study report:</u> • Identification and study of agricultural pests / pest of fruits / vegetables. • Insect collection techniques: light traps, sweep net, Berlese funnel. • Study of insects of college campus dragon fly/ pests of different plants • Visit to ICAR old Goa/ Gov.t of Goa agriculture department/national Malaria research Institute	15

REFERENCE BOOKS:

1) *Aitwal, A.S (1993): Agricultural pests of India and South East Asia. Kalyani publication, New Delhi.*
2) *Awasthi,V.B (2007):Introduction to general and applied entomology ,2nd edition. Scientific publishers India Jodhpur.*
3) *David, B.V. and Ananthakrishnan, T.N (2006): General and applied entomology, 2nd edition Tata McGraw hill, New Delhi.*
4) *Reddy,D.S(2010) Applied entomology,2nd edition New Vishal publications*

REFERENCE BOOKS FOR PRACTICALS:

1. *Fenemore, P.G. and Prakash, A. (1995): Applied Entomology, Wiley Eastern Limited new age international.*

ELECTIVE COURSE: FISH PRESERVATION AND PROCESSING	
COURSE CODE	ZOO-V.E-12
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: gain understanding of the economic benefits of fishes. CO2: They will also be able to understand the nutritional values of the fishes CO3: Perform some protocols of Fish processing and preservation. CO4: Aquaint oneself with the processes at fish processing industry

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fishery Development	1.1 : Status of Development of the fishery and seafood processing industry. 1.2: Empowerment through Aquatic Products: (Background,Nutritionalsecurity,Role ofFisheries Fisheries Sector,Role of Tifac in Fisheries Sector,Objectives,Integrated Fisheries Project(IFP),Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY)	15
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish,Theeffect of Hygiene duringhandling 2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality,Quality assessment of Fresh Fish,Quality Assessment of Fish Products,Physical methods,Assurance of Fresh Fish Quality, Post harvest Changes in Fish,How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes,Methods of Fish.	15
MODULE 3: Value of Fish	3.1:Economic Importance of Fish:Food value,Fish By-Products, surimi, Goan fish para, balchao 3.2: Postmortem changesin Fish,Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition,Lipids,Proteins,N- containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	15

PRACTICAL COMPONENT OF ZOO-V.E-12: FISH PRESERVATION AND PROCESSING (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Estimation of Proteins and Lipids form fish tissue	02
2	Determination of moisture and ash content from the fish	01
3	Preparation of fish Fillet	01
4	Study of Fish Parasites – Ectoparasites (gills); endoparasites (gut)	02
5	Method of fish preservation (salting, pickling)	02
6	Visit to Fish Processing Centre/Fishing Co-operative Society /Fishery Institute/Fishery survey of India, Vasco (FSI)	04

REFERENCE BOOKS :

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India
2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

REFERENCE BOOKS FOR PRACTICALS:

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers
Delhi,India
2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

ELECTIVE COURSE: FISH PRESERVATION AND PROCESSING (AS NON-PRACTICAL BASED COURSE)	
COURSE CODE	ZOO-V.E-12
MARKS	100 [75 -Theory; 25- Fieldbased report]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Fieldbased work: 15 HOURS.
COURSE OBJECTIVES	• To familiarize the students with different methods of fish preservation and processing • To acquaint them with techniques and precautions for hygienic fish handling • The course content is locally relevant and prepares students for entrepreneurship and self employment
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: gain understanding of the economic benefits of fishes. CO2: They will also be able to understand the nutritional values of the fishes CO3: Perform some protocols of Fish processing and preservation. CO4: Aquaint oneself with the processes at fish processing industry

ZOO-V.E- 12 : FISH PRESERVATION AND PROCESSING		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Fishery Development	1.2 : Status of Development of the fishery and seafood processing industry. 1.2: Empowerment through Aquatic Products: (Background,Nutritionalsecurity,Role ofFisheries Fisheries Sector,Role of Tifac in Fisheries Sector,Objectives,Integrated Fisheries Project(IFP),Indian national centre for ocean information services (INCOIS), Catch per unit effort (CPUE), Maximum sustainable yield (MSY	15
MODULE 2: Fish Handling and preservation	2.1: Recent Scenario: Quality Changes and Shelf life of Chilled Fish,Theeffect of Hygiene duringhandling 2.2: Fish Handling Methods: Organoleptic test, Assessment of Fish Quality,Quality assessment of Fresh Fish,Quality Assessment of Fish Products,Physical methods,Assurance of Fresh Fish Quality, Post harvest Changes in Fish,How does a Fish Lose its Quality, fish as vectors of zoonotic diseases 2.3: Fish Preservation: Reasons for Spoilage of Fishes,Methods of Fish.	15
MODULE 3: Value of Fish	3.1:Economic Importance of Fish:Food value,Fish By-Products, surimi, Goan fish para, balchao 3.2: Postmortem changesin Fish,Bacteriological Changes, Lipid Oxidation and Hydrolysis, Chemical Composition,Lipids,Proteins,N- containing Extractives,Vitamins and Minerals, 3.3: Aquatic Resources and their utilization, value added product: chitin	15
MODULE 4 Field based Study	<u>Field Based study:</u> Visit to Fish Processing Centre/ Fishing Co-operative Society / Fishery Institute/Fishery survey of India, Vasco (FSI) to study the following: 1) Quality control of fishes 2) Fish parasites (ecto and endo) 3) Fish filleting, 4) Fish preservation (salting/ pickling)	15

REFERENCE BOOKS :

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India

REFERENCE BOOKS FOR PRACTICALS:

1) Braj Kishore Singh (2008) Applied Fisheries and Aquaculture Swastik Publishers and Distributers Delhi,India

2) Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut, India.

PARVATIBAI CHOWGULE COLLEGE OF ARTS AND SCIENCE
(Autonomous)
PROGRAMME BSC ZOOLOGY

COURSE CURRICULUM OF SEMESTER 6

SEMESTER	COURSE CODE	COURSES	CREDITS	CONTACT HOURS
SEMESTER VI	ZOO-VI.C-8	Wildlife Biology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
		Wildlife Biology	Theory = 04	Theory = 60
	ZOO-VI.E-13/	Health and Nutrition	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	*ZOO-VI-GE-1	Health and Nutrition	Theory = 04	Theory = 60
	ZOO-VI.E-14	Ecology and Ethology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-15	Laboratory Techniques in Pathology	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	ZOO-VI.E-16/	Bio Entrepreneurship	Theory = 03 Practicals =01	Theory = 45 Practicals =30
	*ZOO-VI-SE-2	Bio Entrepreneurship	Theory = 04	Theory = 60

SEMESTER VI

CORE COURSE: WILDLIFE BIOLOGY	
COURSE CODE	**ZOO-VI-C-8**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Apply the techniques used in assessment and monitoring of wildlife. CO2: Understand the basics of wildlife status, conservation, assessment and management. CO3: Know about the diversity, extent, range of wildlife population dynamics. CO4: Know the rules, regulations and factors governing wildlife

ZOO-VI-C-8: WILDLIFE BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Wildlife	UNIT 1: Introduction to wildlife • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. UNIT 2: Evaluation and management of wildlife • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	15
MODULE 2: Population Estimation And Protected Areas	UNIT 3: Population estimation • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. UNIT 4: Protected areas • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	15
MODULE 3: Management Of Wildlife	UNIT 5: Management of habitats • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, UNIT 6: Management planning of wildlife in protected areas • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). UNIT 8: Management ofcritical population • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	15

PRACTICAL COMPONENT OF WILDLIFE BIOLOGY ZOO-VI-C-8: (DURATION: 30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1)	Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds	02
2)	Acquainting oneself with basic equipment needed in wildlife studies; use, care and maintenance (compass, binoculars, spotting scope, range finders, Global Positioning System, various types of cameras and lenses)	02
3)	Familiarization and study of species specific evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers, feathers, etc. – case study	02
4)	Demonstration of various field techniques for flora and fauna: PCQ, Ten tree method, Circular, Square and rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment	03
5)	Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip)	03

REFERENCE BOOKS:

1. *Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.*
2. *Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.*
3. *Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.*
4. *Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences*
5. *Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.*

CORE COURSE: WILDLIFE BIOLOGY (AS NON-PRACTICAL BASED COURSE)	
COURSE CODE	**ZOO-VI-C-8**
MARKS	100 [75 -Theory; 25- Field based]
CREDITS	04
CONTACT HOURS	Theory: 45 HOURS [03 Lectures Per Week] Field based work: 15 HOURS.
COURSE OBJECTIVES	This course is designed to enable students to understand the basics of wildlife status, conservation, assessment and management.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Apply the techniques used in assessment and monitoring of wildlife. CO2: Understand the basics of wildlife status, conservation, assessment and management. CO3: Know about the diversity, extent, range of wildlife population dynamics. CO4: Know the rules, regulations and factors governing wildlife

ZOO-VI-C-8: WILDLIFE BIOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Introduction To Wildlife	UNIT 1: Introduction to wildlife • Values of wildlife - Conservation ethics, Importance of conservation, Causes of depletion, World conservation strategies. UNIT 2: Evaluation and management of wildlife • Habitat analyses, Physical parameters: Topography, Geology, Soil and water. • Biological Parameters: food, cover, forage, browse and ground cover estimation. • Standard evaluation procedures: remote sensing and GIS.	15
MODULE 2: Population Estimation And Protected Areas	UNIT 3: Population estimation • Population density, natality, mortality, fertility schedules and sex ratio computation. • Analysis of scat and dropping of ungulates and carnivores. • Trichotaxonomy, pug marks and census method based on indirect evidences. UNIT 4: Protected areas • Protected Area network (PAN): National parks and wildlife sanctuaries. • Biogeographical features of important features of protected areas in India (any 3). • Tiger conservation - tiger reserves in India, challenges and management of tiger reserves.	15
MODULE 3: Management Of Wildlife	UNIT 5: Management of habitats • Setting back succession, grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds. • Cover construction, preservation of general genetic diversity, restoration of degraded habitats, UNIT 6: Management planning of wildlife in protected areas • Habitat carrying capacity, visitors carrying capacity, eco tourism / wild life tourism, concept of climax persistence, ecology of perturbance. • Role of national / state statutory bodies on governing wildlife (NBWL, IUCN, CITES, state wildlife boards and forest department). UNIT 8: Management ofcritical population • Radio- telemetry, care of injured and diseased animal, quarantine, common diseases of wild animals, capture and translocation of wildlife. • Captive management – a brief idea.	15

MODULE 4: Field based Study	Field based study report on: • Study of butterflies and their host plants on the campus / molluscs/ ants/ spiders / birds • Any two biodiversity monitoring by various field techniques for flora and fauna: • Trail / transect-quadrate monitoring for abundance and diversity estimation of mammals and birds (direct and indirect evidences) (on campus or fieldtrip) • Identification of animals through pug marks, hoofmarks, scats, pellet groups, nest, antlers, feathers, etc. • Local case study report of wild life conflict Use of compass, binoculars, spotting scope, range finders, Global Positioning System on field.	15

REFERENCE BOOKS:

1. *Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.*
2. *Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence. Cambridge University.*
3. *Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.*
4. *Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences*
5. *Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.*

ELECTIVE COURSE: HEALTH AND NUTRITION	
COURSE CODE	**ZOO-VI-E-13 /**
MARKS	100 [75 –Theory ; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC/WEEK) PRACTICALS: 30 HOURS (01 PRACTICAL /WEEK)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Know about nutrients and their function CO2: Read and interprete food labels. CO3: Correlate role of lifestyle and food habits in causing diseases. CO4: Prepare Diet Plans for different age group individuals.

ZOO-VI-E-13: HEALTH AND NUTRITION		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry (Overview) • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties(overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties	**15**
MODULE 2: NUTRIENTS AND DIETARY PATTERN FOR HUMANS	UNIT 3: Functions of food components of food-nutrients • Biochemical role and dietary sources of macro and micronutrients (carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine). • Changes of nutrient value during cooking of the following food groups: cereals, pulses and vegetables. Nutrient loss - dry, moist, frying and microwave cooking. UNIT 4: Nutrition and dietetics • Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition.	**15**

MODULE 3: DIET RELATED DISEASES	UNIT 5:Health and diseases • Major nutritional deficiency diseases- protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. • Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. • Social health problems: smoking, alcoholism, drug dependence and Acquired Immune Deficiency Syndrome (AIDS); • Common ailments- irritable bowel disease (IBD), constipation: causes and dietary management UNIT 6: Food hygiene • Potable water- sources and methods of purification at consumer level • Food and water borne infections: bacterial infection: cholera, typhoid, dysentery; viral infection: hepatitis, poliomyelitis, protozoan infection: Amoebiasis, Giardiasis; Parasitic infection: Taeniasis and Ascariasis their causative agent, symptoms, transmission and prevention. • Brief account of food spoilage: Causes and preventive measures	**15**

PRACTICAL COMPONENT OF 'HEALTH AND NUTRITION ZOO-VI-E-13: DURATION (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric	03
2.	Estimation of lactose in milk	02
3.	Titrametic estimation of: • Ascorbic acid estimation in food • Calcium in food	02
4.	Observation of any two grain pests	01
5.	Project based: • Identify nutrient rich sources of foods, their seasonal availability and price • Study of nutrition labeling on selected foods	04

GENERIC ELECTIVE COURSE: HEALTH AND NUTRITION (For students of other discipline)	
COURSE CODE	***ZOO-VI-GE-1**
MARKS	Theory 100 marks
CREDITS	04 [Theory]
CONTACT HOURS	Theory(4 Lec/week)
COURSE OBJECTIVES	This course is an introduction to the nutrients, their functions and role in maintaining good health of humans.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Know about nutrients and their function CO2: Read and interprete food labels. CO3: Correlate role of lifestyle and food habits in causing diseases. CO4: Prepare Diet Plans for different age group individuals.

***ZOO-VI-GE-1:HEALTH AND NUTRITION (As Generic elective to students of other discipline)**		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: BASIC CONCEPT OF FOOD AND NUTRITION	UNIT 1: Overview of health and nutrition • Definition of health and nutrition • Scope of nutrition, food as a source of nutrients • Nutrients and energy, principles of meal planning • Adequate, optimum and balanced diet • Malnutrition and health. UNIT 2: Nutritional Biochemistry (Overview) • Carbohydrates, lipids, proteins - definition, classification, structure and properties • Significance of acid value, iodine value and saponification value of lipids • Essential and non-essential amino acids • Enzymes- definition, classification, properties (overview). • Coenzymes, vitamins (fat soluble and water soluble), structure and properties • Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties UNIT 3: Activities related to module 1(5hrs).	**15**
MODULE 2: ROLE OF NUTRIENTS AND CHANGES IN NUTRIENT VALUES	UNIT 4: Functions of food components of food-nutrients • Overview of the Vitamins and minerals - dietary sources of macro and micronutrients. UNIT 5: Changes in nutrient values • Changes of nutrient value during cooking of the following food groups: cereals, pulses, vegetables and meats. • Methods of cooking and Nutrient loss - dry, moist, frying and microwave cooking. Canning of food. UNIT 6: Activities related to module 2(5hrs).	**15**
MODULE 3: DIETARY PATTERN FOR HUMANS	UNIT 7: Nutrition and dietetics Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition. UNIT 8: Food based dietary guidelines, enhancing the nutritional quality of the diet, nutritional labeling. UNIT 9: Activities related to Module3 (Comparison of different nutrient labels of various food products). (5hrs).	**15**

MODULE 4: HEALTH AND DISEASES	UNIT 8: Major nutritional deficiency diseases- Protein energy malnutrition, Vitamin deficiency, iron deficiency anaemia, iodine deficiency disorders, their causes, symptoms, treatment, prevention and government programmes, if any. UNIT 9: Life style related diseases- obesity, hypertension, hyperurecimia, diabetes mellitus, polycystic ovarian disease (PCOD) - their causes and prevention through dietary/lifestyle modifications. UNIT 10: Food hygiene: Potable water- sources and methods of purification at consumer level. Brief account of food spoilage: Causes and preventive measures UNIT 11: Activities related to Module 4(5hrs).	**15**

REFERENCE BOOKS:

1) *Mudambi, SR and Rajagopal, MV. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; New Age International Publishers.*
2) *Srilakshmi B. (2002). Nutrition Science; New Age International (P) Ltd.*
3) *Srilakshmi B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.*
4) *Swaminathan M. (2009). Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.*
5) *Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.*
6) *Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.*
7) *Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.*

ELECTIVE COURSE: ECOLOGY AND ETHOLOGY	
COURSE CODE	ZOO-V.E-14
MARKS	100 [75 – Theory; 25 – Practicals]
CREDITS	04 [03 – Theory; 01 – Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LECTURE/WEEK) PRACTICALS : 30 HOURS (01 PRACTICAL/WEEK)
COURSE OBJECTIVES	• To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components • To study impact of anthropogenic activities on ecosystem and study behaviour of organisms under natural conditions
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: gain better understanding of concepts of ecology. CO2: Acquainted with the basics of animal behaviours CO3: Know strategies of biodiversity conservation, CO4: Understand mechanisms of sustainable development.

ZOO-V.E- 11 : ECOLOGY AND ETHOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1 : Basic Ecology	1.1 :Introduction to Ecology : What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology 1.2 : Ecosystem Ecology:kinds of ecosystem,Gaia hypothesis, energy flow within the Ecosystem, food chains, ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead. 1.3: Population Ecology: survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator –prey relationships,symbiosis	
MODULE 2 : Conservation Ecology and Basic Ethology	2.1: Community Ecology:characters of a community, classification of a community,community periodism, community stratification,community succession 2.3:Introduction to Ethology: the history of ethology, types of behavior – instinct and learning,economic and social aspect of behaviour, ethologists and their work – Lorenz, Tinbergen, Goodall, M.K. Chandrashekar, animal behaviour :an evolutionary approach 2.4: Concept of Ethology:stimuluous –response concept,reflexes, innate releasing mechanisms,fixed action pattern,ethogram releaser,motivation or drive with respect to hunger and sexual behaviour	
MODULE 3 : Advanced Ethology	3.1 : Approaches to studying behaviour, methods associated with neurophysiological approach,psychological and ethological approach. 3.2: Pheromones :introduction,types of pheromones,the primer pheromones,the imprinting pheromones 3.3:Hormones: effect of hormones on sexual behaviour,maternal behaviour,territorial marking, learning and memory 3.4:Patterns of behavior :feeding, aggressive and reproductive behavior, biological clocks 3.5:Communication behavior :introduction,communication signals,	

PRACTICAL COMPONENT OF ZOO–V.E-14: ECOLOGY AND ETHOLOGY (DURATION -02 HRS /WEEK)		
SR.NO.	**PRACTICAL**	**NO. OF PRACTICALS**
1	Field Based practicals: • Determination of population density in a natural/ hypothetical community by Quadrats method in intertidal zone. • Report on a visit to National Parks/ Biodiversity Parks/ Wild life sanctuary • Observation of random subjects for understanding human behaviour.	05
2	Study of an aquatic/mangrove ecosystem: Mmeasurement of the area,temperature, turbidity,determination of pH,and dissolved oxygen content (Winkler's method),and free CO_2	03
3	Ethology: • To study the habituation to light stimulus in earthworm/crabs/snails/ spider web • To demonstrate photactic and geotactic responses of the animal provided earthworm/crabs	02
4	Study of Life Tables and plotting of surviourship curves of different types from the hypothetical/real data provided.	02

REFERENCE BOOKS :

1. *Arora, Mohan. P. (2004) : Ecology , Himalaya Publishing House*
2. *Aubrey Manning and stamp Dawkins (1997) : An Introduction to Animal behaviour (fourth edition), Cambridge University Press.*
3. *Dash M. C. (2001) : Fundamental of Ecology , Tata Mc Graw – Hill publishing Company Limited New Delhi*
4. *Felicity Huntingford (1984) : The study of Animal behaviour , Chapman and Hall.*
5. *Hoshang S. Gundevia and Hare Govind Singh (2006) : A Text Book of Animal Behaviour, S. Chand & Company LTD. New Delhi-110055.*
6. *Juneja Kavita (2002) : Ecology , Anmol Publications PVT. LTD. New Delhi-110002 (India)*
7. *Mathur Reena (1994) : Animal Behaviour, Rastogi and Company, Meerut-250002 India.*
8. *Rana, S. V. S.(2003) : Essentials of Ecology and Environmental Science ,Prentice- Hall of India Private Limited , New Delhi-110001*
9. *Ranga, M. M.(2002) : Animal Behaviour Second Enlarged Edition , Agrobios (India)*
10. *Robert A. Wallace (1938) : Animal Behaviour Its Development, Ecology and Evolution , Goodyear Publishing Company, Inc. Santa Monica, California.*
11. *Sharma P.D.(2014-15) : Ecology and Environment, Rastogi Publications. Meerut (12th revised edition) -25002.*
12. *W.H. Thorpe (1979) : The Origins and rise of Ethology, Praeger Publishers.*

ELECTIVE COURSE: LABORATORY TECHNIQUES IN PATHOLOGY	
COURSE CODE	ZOO-VI.E-15
MARKS	100 [75 –Theory; 25- Practical]
CREDITS	04 [03 –Theory; 01- Practical]
CONTACT HOURS	THEORY : 45 HOURS (03 LEC / WEEK) PRACTICAL: 30 HOURS (01 PRACTICAL / WEEK)
COURSE OBJECTIVES	This course is an introduction to the various techniques used in pathological diagnosis.
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: Perform basic techniques of cell/tissue processing CO2: Be Familiar with procedures of tests done for disease detection CO3: Process various body fluids and tissues for disease detection. CO4: Understand the clinical implication of the pathological tests.

ZOO-VI.E-15: LABORATORY TECHNIQUES IN PATHOLOGY		
MODULE	**TOPICS**	**CONTACT HOURS**
MODULE 1: Blood Analysis	UNIT 1: Introduction to medical lab techniques and its importance UNIT 2: : Analyses of human Blood: • Ways of obtaining blood samples, precautions and complications. • Methods of estimation and clinical significance of: hemoglobin, Packed Cell Volume (PCV), RBC count, WBC count, Complete Blood Count (CBC), platelets, Erythrocyte Sedimentary Rate (ESR), Differential Leucocyte Count (DLC).	15
MODULE 2: Evaluation Of Excretory Material And Gametes	UNIT 3:.Urine Analyses • Physical characteristics, preservation of urine sample • Gross examination, chemical examination, abnormal constituents and its clinical implications. • Microscopy of urinary sediments UNIT 4: Stool Analyses • Stool tests for protozoan parasites and helminth eggs. • Clinical significance. UNIT 5: Semen analyses: • Constituents of semen • Gross and microscopic, cytochemical examination, clinical implications.	15
MODULE 3: Liver Function Cytology Imaging	UNIT 6: Clinical status of liver function - • Function of liver. • Tests of excretion by liver, evaluation of synthesis in liver, evaluation of enzyme activity. UNIT 7: Clinical cytological studies • Fine Needle Aspiration Cytology (FNAC), Ultrasound guided FNAC, aspiration of intra thoracic masses, • Techniques of preparing cell smears, staining techniques UNIT 8: Medical imaging • X-Ray, PET, CT Scan, MRI, Dexa Scan, Ultrasound, Doppler's Test (using photographs/reports etc).	15

PRACTICAL COMPONENT OF: LABORATORY TECHNIQUES IN PATHOLOGY ZOO-VI.E-15 - (30 HOURS – 02hrs/WEEK)		
SR. NO	**PRACTICAL**	**NO. OF PRACTICALS**
1.	Preparation of blood smears and staining techniques (Leishman's staining, Giemsa staining, Field's staining).	02
2.	Use of different types of anticoagulants, obtaining serum from blood, preparation of cell suspension (blood cells).	01
3.	RBC Count, WBC Count, Differential WBC Count	03
4.	Urine analysis – normal and abnormal constituents	02
5.	Blood sugar estimation using glucometer	01
6.	Estimation of hemoglobin (Sahli's method)	01
7.	Estimation of PCV	01
8.	Estimation of ESR (Wintrobe's / Westergreen method)	01

REFERENCE BOOKS:

1. *Sood R (1999). Medical laboratory techniques, Jaypee publishers, New Delhi.*
2. *Park, K. (2007), Preventive and Social Medicine, B.B. Publishers*
3. *Godkar P.B. and Godkar D.P (2007). Textbook of Medical Laboratory Technology, II Edition, Bhalani Publishing House.*
4. *Cheesbrough M (2002)., A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
5. *Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd. New Delhi.*

ELECTIVE COURSE: BIOENTREPRENEURSHIP	
COURSE CODE	Elective: ZOO-VI.E- 16
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS (03 hrs/week) 15 hrs of intervention by teacher.
COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarise them with the basic skills required for a start-up
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: understand concept of business Proposals CO2: familiar with the methodologies and regulations required to start an enterprise CO3: Identify opportunities available in life science for start-ups. CO4: Generate Ideas and initiate a Business Plan.

ZOO-VI.E- 16: BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	15
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sectors	15
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 7: Intellectual Property Rights and trademark of biological resources Unit 8: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	15
MODULE 4: Practice based component	**Practice based component:** 1. Lateral thinking and testing entrepreneurial 2. Activities : 1. Brainstorming in Group / market investigation to initiate business ideas for biologists. 2. Preparing Business proposal sketch. 3. Financial Planning. 4. Identifying investors. 5. Developing marketing strategies. 6. Interactions with successful entrepreneur, Banker/ Angel Investors/ Visit to a bio-startup. 7. Formulating and presenting Business model 8. Preparation of final Business execution plan. 9. Submission of the learning process and outcome as Portfolio.	15

ELECTIVE COURSE: BIOENTREPRENEURSHIP	
COURSE CODE	Skill Enhancement Course(SEC): ZOO-SE-2
MARKS	100 [25 -Theory; 75- Practice Based]
CREDITS	04
CONTACT HOURS	Theory: 15 HOURS [01 Lectures Per Week] Practice based: 45 HOURS (03 hrs/week) 15 hrs of intervention by teacher.
COURSE OBJECTIVES	• To help students recognize the opportunities of enterprises in the field of life sciences • To encourage students to think independently and explore new vistas • To familiarize them with the basic skills required for a start-up
COURSE OUTCOME:	Upon successful completion of the course, students will be able to: CO1: understand concept of business Proposals CO2: familiar with the methodologies and regulations required to start an enterprise CO3: Identify opportunities available in life science for start-ups. CO4: Generate Ideas and initiate a Business Plan.

ZOO-VI-SE-2 : BIOENTREPRENEURSHIP		
UNIT	**TOPICS**	**CONTACT HOURS**
MODULE 1: Entrepreneurship Development	Unit 1: Introduction to entrepreneurship: • entrepreneurial competencies and goal setting, bio entrepreneurship, building a bio-enterprise : balance management, capital, technology Unit 2: Introduction to innovation: • identifying business opportunities Unit 3: Raising funds: public and private	05
MODULE 2: Business plan And Guidelines and regulations for entrepreneurship in life sciences	Unit 4: Business model canvas Unit 5: Guidelines and regulations: • Certification and licensing, acts, regulations and guidelines, marketing and export process, accessing university technology, research and development agencies in India Unit 6:Role of micro, medium and small scale industry sector Unit 7: Innovations in research: writing project proposals to various funding bodies such as MHRD, UGC, DST, DBT, etc.	05
MODULE 3: Start -up, quality, safety and procedural compliances in a bio enterprise	Unit 8: Intellectual Property Rights and trademark of biological resources Unit 9: quality, safety and procedural compliances • Bio safety and its implementations • Quality control in entrepreneurship • WHO Guidelines for setting up of a contract research organization. • Starting a research laboratory in India – guidelines and permits required	05
MODULE 4: Practice based component	**Practice based component:** 3. Lateral thinking and testing entrepreneurial 4. Activities : 1. Brainstorming in Group / market investigation to initiate business ideas for biologists. 2. Preparing Business proposal sketch. 3. Financial Planning. 4. Identifying investors. 5. Developing marketing strategies. 6. Interactions with successful entrepreneur, Banker/ Angel Investors/ Visit to a bio-startup. 7. Formulating and presenting Business model 8. Preparation of final Business execution plan. 9. Submission of the learning process and outcome as Portfolio.	45

REFERENCES:

1. *Garg, M.C. (2015) Entrepreneurial development. Guset User.*
2. *Kolchinsky, P. (2004) The entrepreneurs guide to a biotech startup. 4th edition. www.evelexa.com*
3. *Simon, S. 2009. Start with why: How great leaders inspire everyone to take action. Penguin Group (USA) Inc .*
4. *Welch, J. and Byrne, J.A. 2003. Straight from the gut. Business plus publishers.*

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