M.Sc., ZOOLOGY

SYLLABUS
(2024-25 onwards)

Department of Biology
The Gandhigram Rural Institute - Deemed to be University
Gandhigram – 624 302
Dindigul District
Tamil Nadu
India

M.Sc., ZOOLOGY PROGRAMME

SCHEME OF EXAMINATION

FIRST SEMESTER									
	Course code	**Course Title**	**C**	**L**	**P**	**E**	**CFA**	**ESE**	**Total**
CORE COURSES	24ZOOP0101	Structure and Function of Invertebrates	4	4	-	3	40	60	100
	24ZOOP0102	Comparative Anatomy of Vertebrates	4	4	-	3	40	60	100
	24ZOOP0103	Environmental Biology@	4	4	-	3	40	60	100
	24ZOOP0104	Cell and Molecular Biology#	4	4	-	3	40	60	100
	24ZOOP0105	Practical 1: Invertebrates and Vertebrates	2	-	4	3	60	40	100
	24ZOOP0106	Practical 2: Environmental Biology, Cell and Molecular Biology	2	-	3	3	60	40	100
	24GTPP0001	Gandhi in Everyday Life	2	2	-	-	50	-	50
		Total credits	**22**						

SECOND SEMESTER									
	Course code	**Course Title**	**C**	**L**	**P**	**E**	**CFA**	**ESE**	**Total**
CORE COURSES	24ZOOP0207	Bioinstrumentation and Research Methods @	4	4	-	3	40	60	100
	24ZOOP0208	Biochemistry & Animal Physiology@	4	4	-	3	40	60	100
	24ZOOP0209	Entomology	4	4	-	3	40	60	100
	24ZOOP0210	Advanced Biostatistics	4	4	-	3	40	60	100
	24ZOOP0211	Practical 3: Bioinstrumentation, Biochemistry and Animal Physiology & Entomology	2	-	4	3	60	40	100
EG	-	Elective: Generic	3	3	-	3	40	60	100
	24ENGP00C1	Communication and Soft Skills	2	2	-	-	50	-	50
	24ZOOP0212	Summer Internship	1	-	-	-	50	-	50
		Total credits	**24**						

THIRD SEMESTER									
	Course code	**Course Title**	**C**	**L**	**P**	**E**	**CFA**	**ESE**	**Total**
CORE COURSES	24ZOOP0313	Genetics and Genomics	4	4	-	3	40	60	100
	24ZOOP0314	Evolution	4	4	-	3	40	60	100
	24ZOOP0315	Developmental Zoology & Immunology@	3	3	-	3	40	60	100
	24ZOOP0316	Practical 4: Genetics and Genomics, Evolution, Developmental Zoology and Immunology	2	-	4	3	60	40	100
EDC	24ZOOP04EX	Elective: Discipline Centric	3	3	-	3	40	60	100
MC	24ZOOP03MX	Modular course	2	2	-	-	50	-	50
VPP	24EXNP03V1	Village Placement Programme	2	-	-	-	50	-	50
	24ZOOP0317	Field Visit	2	-	-	-	50	-	50
		Total credits	**22**						

FOURTH SEMESTER									
	Course code	**Course Title**	**C**	**L**	**P**	**E**	**CFA**	**ESE**	**Total**
CORE COURSES	24ZOOP0418	Fundamentals of Microbiology	4	4	-	3	40	60	100
	24ZOOP0419	Animal Biotechnology & Genetic Engineering	4	4	-	3	40	60	100
	24ZOOP0420	Economic Zoology	4	4	-	3	40	60	100
	24ZOOP0421	Practical 5: Fundamentals of Microbiology, Animal Biotechnology and Genetic Engineering & Economic Zoology	2	-	4	3	60	40	100
MC	24ZOOP04MY	Modular course	2	2	-	-	50	-	50
	24Z00P0422	Dissertation	6	12	-	-	75	75*+ 50**	200
		Total credits	**22**						
		Overall credits 90							

# Courses may be offered under MOOC/NPTEL based on availability online and the syllabus also modified as per MOOC/NPTEL with equal credits	**@ A portion of the Course may offered under MOOC/NPTEL based on availability online**
*Evaluation by External Examiner	**Evaluation by External and Internal Examiners
C-Credits	ESE-End Semester Assessment
P-Practical Hours	CNCC-Compulsory Non -Credit Course
L-Lecture Hours	MC- Modular course
E-Exam Hours	EDC – Elective Discipline Centric
CFA-In-semester continuous assessment	VPP – Village Placement Programme

List of Elective: Discipline Centric Courses (3 credits)	**List of Modular Courses (2 Credits)**
24ZOOP03E1: Fisheries and Aquaculture	24ZOOP03M1: Advanced Molecular Techniques
24ZOOP03E2: Parasitology	24ZOOP03M2: Bioinformatics
24ZOOP03E3: Animal Cell Culture Technology	24ZOOP04M1: Rural Entrepreneurship
24ZOOP03E4: Wildlife Conservation	24ZOOP04M2: Bionanotechnology

List of Generic Elective Courses (3 Credits)	24ZOOPO4M3: Intellectual Property Rights
24ZOOP02E1: Ornamental Fish Culture	**Value Added Courses (2 Credits)**
24ZOOP02E2: Applied Zoology	24ZOOP0VA1: Sericulture
24ZOOP02E3: Animal Behavior	24ZOOP0VA2: Poultry Farming
	24ZOOP0VA3: Dairy Farming

Name of the Programme	**M.Sc., ZOOLOGY**				
Year of Introduction	2007		Year of Revision		2024
Semester -wise Courses and Credit Distribution	I	II	III	IV	Total
No. of Courses	7	8	8	6	29
No. of Credits	22	24	22	22	90

OBE Elements for Zoology Programme

Programme Educational Objectives (PEO)

PEO 1 : To develop advanced knowledge and understanding relevant to Zoology

PEO 2 : To provide students with a broad understanding of animals and their interactions with the environment

PEO 3 : To enable students to undertake a quantitative and qualitative approach to acquiring, analyzing and interpreting data

PEO 4 : To provide students with the practical skills of conducting experiments in the laboratory and field

PEO 5 : To enhance student's employability particularly for a career in Zoology

Program Outcome (PO)

PO1 : Become knowledgeable in the subject of Zoology and apply the principles of the same to the needs of the Employer / Institution / Enterprise / Society

PO2 : Gain Analytical skills in the field / area of Zoology

PO3 : Understand and appreciate professional ethics, community living and Nation building initiatives

PO4 : Able to identify and classify the major groups of animals, compare and contrast anatomical and physiological characteristics of invertebrates and vertebrates

PO5 : An in-depth understanding and awareness of relevant theories, concepts and principles of zoology

PO6 : Explicate the environmental interrelationships of life on Earth and relate to physical features of the environment to the population and community structure and ecosystem.

PO7 : Assess the implication of pollution and biodiversity of animals in the natural ecosystems, importance and conservation measures

PO8 : Explain the functioning of organisms at the level of cell, tissue, organ and organ systems

PO9 : Familiarize the major evolutionary patterns, adaptation and behaviour of various group of animals

PO10 : Explain the importance of Animal Biotechnology and Genetic engineering.

PROGRAMME SPECIFIC OUTCOME (PSO)

After completion of Zoology Programme, the students are expected to

PSO1 : Apply the knowledge of Zoology in the domain of scientific development

PSO2 : Solve the complex problems in the field of Zoology with an understanding of the societal, legal and cultural impacts

PSO3 : Specialized knowledge and practical training on Zoology to address contemporary problems in academia, industry and needs of society

PSO4 : A research-oriented learning that develops analytical and integrative problem-solving approaches.

PSO5 : Understand the animals and interaction with environment, concepts of organ development and immunology, molecules and organelles of cell, biochemical constituents, economic importance of insects, importance of statistical tools, genetic abnormalities and importance of genetic engineering

Semester	**First**	**Course Code**	**24ZOOP0101**
Course Title	**Structure and Function of Invertebrates**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised	If revised, Percentage of revision effected	50
Category	Core Course		
Scope of the Course (may be more than one)	1. Understand the structure and functions of invertebrate animals 2. Know the different specialized structures of animals belonging to different phyla 3. Learn the evolutionary significance of invertebrate larvae		
Cognitive Levels addressed by the Course	**K1**-Classification and taxonomic procedures of different phyla **K2-** Make the students to understand the important invertebrates and its salient features **K3**-Application ofvarious theories and concepts in invertebrata **K4**-Analyze the structure and functions of special organs in invertebrates **K5**-Invertebrate larvae and their evolutionary significance		
Course Objectives	The Course aims • to know the international nomenclature and classification of different phyla up to classes • to able to know the feeding, locomotion and reproduction of invertebrate animals • to familiarize the morphological and physiological adaptations of invertebrate animals • to understand the phylogeny, larval forms and metamorphosis of insects • to understand the different larval forms of invertebrates and their evolutionary significance.		
Unit	**Content**		**No. of Hours**
I	**Structure and function in invertebrates** Principles of Animal taxonomy- Species concept-International code of zoological nomenclature- Taxonomic procedures-New trends in taxonomy.		11
II	**Organization of coelom** Acoelomates- Pseudocoelomates- Coelomates; Protostomia and Deuterostomia; Locomotion-Flagella and ciliary movement inProtozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata.		14

III	**Nutrition and Digestion** Patterns of feeding and digestion in lowermetazoan- Filter feeding in Polychaeta, Mollusca andEchinodermata. Respiration- Organs of respiration- Gills, lungs andtrachea; Respiratorypigments- Mechanism of respiration.	13
IV	**Excretion** Organs of excretion-coelom, coelomoducts, Nephridia and Malphigian tubules- Mechanisms of excretion- Excretion and osmoregulation. Nervous system- Primitive nervous system in Coelenterata and Echinodermata-Advanced nervous system in Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda)- Trends in neuralevolution.	13
V	**Invertebratelarvae** Larval forms of free-livinginvertebrates - Larval forms ofparasites- Strategies and Evolutionary significance of larvalforms. Minor Phyla-Concept and significance- Organization and general characters.	13
References	Text Books 1. Vasantika Kashyab. 2019. A Text book of Invertebrate Zoology. KNRN Publications, Meerut 2. R.L. Kotpal.2017. Modern text book of Zoology- Invertebrate- Rastogi Publication, Meerut. 3. M.Ekabaranatha Iyar and T.N. Ananthakrishnan (Recent Edition) Manual of Zoology.Vol. I. Part I & II, Visvanathan Publications, Chennai 4. N.C Nair, A. Thangamani, S. Leelavathy, S. Prasanakumar, N. Soundrapandian, T.Murugan L. M. Narayanan and N. Arumugam, 2017, Animal diversity (Invertebrata& Chordata), Saras Publication, Nagercoil. 5. Fatik Baran Mandal 2012. Invertebrata Zoology, PHI, Learning Private Limited, New Delhi – 110001.	
	Reference Books 1. E.L. Jordan and P.S. Verma 2018. Invertebrate Zoology, S. Chand & Company Ltd, New Delhi. 2. R. L. Koptal 2017. Animal Diversity, Rastogi Publication, Meerut. 3. N. Arumugam 2002. Invertebrate Zoology, Saras publication, Nagercoil. 4. Frank A. Brown 2002. Invertebrates, Biotech Books, Delhi.	
	E-Resources 1. http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Understand animal's classification system and their zoological nomenclature. CO2: Describe the salient features of phyla such as Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca and Echinodermata CO3: Understand the functional activities of organisms CO4: Understand the parasitic adaptations of tape worm, flukes and flatworms & realise the diseases caused by these parasites CO5: Realize the role of hormones in metamorphosis of insects, torsion in gastropods, role of water vascular system in echinodermata and economic values of each phylum of invertebrate	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	3
CO2	2	2	3	3	3
CO3	2	2	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Strongly Correlated (S)	3 Marks
Moderately Correlated(M)	2 Marks
Weekly Correlated (W)	1 Mark
No Correlation (N)	0 Mark
Note: No Course can have "0" (Zero) score	

Semester	**First**	Course Code	**24ZOOP0102**
Course Title	**Comparative Anatomy of Vertebrates**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	50
Category	Core		
Scope of the Course	1. Learn the taxonomy and comparative anatomy of chordates 2. Understand the concept of prochordates 3. Know the economic importance of different vertebrates		
Cognitive Levels addressed by the Course	**K1**- Understand the principles of chordata **K2**- Realize adaptive radiation and parental care in vertebrate animals **K3** -Analyze dentition in mammals and their adaptations **K4**- Identification of poisonous and non-poisonous snakes **K5**-Comparative anatomy of different organs and economic importance of Vertebrates		
Course Objectives	The Course aims • to know the principles of taxonomy and nomenclature • to know the classification of chordates up to order level • to understand the salient features of different chordates. • to explain the adaptive radiation and structural peculiarities among vertebrates • to understand the comparative anatomy and economic importance of vertebrates		
Unit	**Content**		**No. of Hours**
I	**Origin and classification of vertebrates** Concept of Protochordata; The nature of vertebrate morphology- Definition, scope and relation to other disciplines- Importance of the study of vertebrate morphology.		13
II	**Vertebrate integumentary system** Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.		13
III	**Circulatory and Respiratory system** General plan of circulation in various groups- Blood- Evolution of heart- Evolution of aortic arches and portal systems. Respiratory system- Characters of respiratory tissue- Internal and external respiration- Comparative account of respiratory organs.		12

IV	**Skeletal system** Form, function, body size and skeletal elements of the body- Comparative account of jaw suspensorium, Vertebral column, Limbs and girdles. Evolution of Urinogenital system in vertebrate series.	12
V	**Sense organs** Simple receptors- Organs of Olfaction and taste- Lateral line system- Electroreception. Nervous system- Comparative anatomy of the brain in relation to its functions. Comparative anatomy of spinal cord- Nerves-Cranial, Peripheral and Autonomous nervous systems.	14
References	Text Books 1. R.K. Saxena and Sumitra Saxena. 2019. Comparative Anatomy of Vertebrates. Viva Books Pvt. Ltd. New Delhi.pp.227-589. 2. B.N. Yadav and D. Kumar.2018. Vertebrate Zoology. Daya Publishing House, New Delhi 3. R.L. Kotpal-2017. Modern text book of Zoology- Vertebrate- Rastogi Publication, Meerut. 4. Fatik Baran Mandal 2012. Chordate Zoology, PHI, Learning Private Limited, New Delhi – 110001. 5. M. Ekabaranatha Iyar and T.N. Ananthakrishnan (Recent Edition) Manual of Zoology. Vol. II. Part I & II, Visvanathan Publications, Chennai	
	Reference Books 1. N.C Nair, S. Leelavathy, N. Soundrapandian, T. Murugan and N. Arumugam, 2017. Animal diversity (Invertebrata& Chordata), Saras Publication, Nagercoil. 2. A. Thangamani, S. Prasanakumar, L. M. Narayanan and N. Arumugam, 2017. Chordate Zoology, Saras Publication, Nagercoil. 3. E.L. Jordan and P.S. Verma2011. Chordate Zoology, S. Chand & Company Ltd, New Delhi. 4. Route and Solanki 2002. Learning Prochordata- Mammalia –Theory andPractice Dominant Pub. & Distributors, New Delhi. 5. Frank. A. Brown. 2002. Chordata, Biotech Books, Delhi.	
	E-Resources 1.http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Understand the principles of taxonomy, nomenclature, binomial and taxonomic keys CO2: Describe the salient features and one example each of prochordata, cephalochordata, hemichordate and urochordata CO3: Identify Reptiles, Aves and Mammals according to their distinctive characters in their phylum and class & order CO4: Describe the structural peculiarities of prototheria, metatheria and eutheria CO5: Understand migration of birds & fishes and their importance and appreciate the parental care exhibited by fishes, amphibians, reptiles, birds &mammals	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	2	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**First**	Course Code	**24ZOOP0103**
Course Title	**ENVIRONMENTAL BIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	10
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concepts of environment 2. Use of natural resources more effectively without harming the environment. 3. Importance of remote sensing, GIS, Environmental education, pollution and its effects, environmental quality monitoring, impact assessment and conservation.		
Cognitive Levels addressed by the Course	**K1-**Inculcate the advanced environmental concepts **K2**- Observation of environmental issues to the present scenario **K3**- Application of recent techniques in pollution reduction. **K4**- Survey and evaluation of natural resources and its management. **K5**- Awareness among the people on environmental issues		
Course Objectives (Maximum:5)	The Course aims • to provide fundamental environmental principles that provides an in-depth understanding of our environment. • to understand how environmental systems interfere with population and wealth of our natural resources. • to understand the importance of remote sensing, GISand environmental education. • to learn the impact of pollution on environment and environmental Acts. • to assess the importance environmental impact assessment and audit, biomonitoring and treatment.		
Unit	**Content**		**No. of Hours**
I	**Environmental Concepts** Scope of Environmental Biology- Ecosystem- Abiotic and Biotic components - Types- Terrestrial- Forest and Grassland - Aquatic- Freshwater and Marine- Food chain and food web, ecological pyramids -Productivity- Primary and secondary- Biogeochemical cycles-Oxygen, carbon, nitrogen, sulphur and phosphorus- Population Ecology. Biogeographical Zones of India		13
II	**Natural Resources and Conservation** Natural Resources-Renewable-Biomass, biogas, solar energy, wind, tidal energy and Non-Renewable- Fossil fuels-coal, oil, natural gas, mineral and nuclear energy-Conservation of natural resources- Biodiversity -Status, types, threats and biodiversity hotspots- Wildlife conservation and management-Special Projects for Endangered species-Project Tiger, Lion, Elephant and Snow Leopard- National parks, sanctuaries and biosphere reserves.		14
III	**Remote Sensing, GIS and Environmental Education** Remote sensing-Components, types and applications-GIS and its application-Environmental Education-Objectives, goals, scope, guiding principles and Centre for Environmental Education.		8
IV	**Pollution and Environmental Acts** Pollution-Types-Air, water, soil and radio-active-sources, biological effects and control -Environmental protections acts - Air and water-Environmental Laws.		11
V	**Environmental Assessment, Monitoring and Treatment** Environmental Impact Assessment- steps and methods - Public participation in environmental decision making– Impact Analysis and Environmental Audit-Environmental Standards-Air and water- Bio indicators and Environmental Monitoring-Bioassay –Application in Environment - Physical, chemical and biological treatment of liquid effluents.		18

References	Text Books 1. P.S. Verma and V.K. Agarwal. 2019. Environmental Biology. S. Chand and Company, New Dehi. 2. P.D. Sharma2017. Ecology and Environment- Rastogi Publication, Meerut. 3. Purohit, Shammi & Agrawal 2012. Environmental Sciences – A New Approach Agrobios (India), Jodhpur. 4. Metcalf and Eddy 2011. Waste water Engineering- Treatment and Reuse. Tata Mc Graw Hill Education Pvt.Ltd, New Delhi. Pp.311-1026. 5. S.K. Agarwal. 2002. Eco – informatics. Vol I, III, IV APH pub. Company, New Delhi. Vol. I:135-165:265- 311; Vol. III: 221 - 259; Vol. IV : 1-140. 6. Kailash Thakur 1997. Environmental protection law and policy in India. Deep and Deep pub. New Delhi. pp. 184-197; 210 – 248.
	Reference Books 1. G. Tyler Miller and Scott E. Spoolman. 2019. Environmental Science. Cengage Learning India Pvt. Ltd. Delhi. 2. P.D. Sharama 2013. Environmental Biology and Toxicology- Rastogi Publication, Meerut. 3. Pushpa Dahiya and Manisha Ahlawat 2013. Environmental Science- A New Approach, Narosa Pub. House, New Delhi.pp.2.1-2.60. 4. V.S. Kulkariani, S.N. Kaw and R.K. Trivedy 2002. Environmental Impact Assessment for wetland protection. Scientific publishers (India). 5. Kaiser Jamil 2001. Bio indicators and biomarkers of Environmental pollution and Risk assessment. Oxford and IBH Pub. Co. Pvt. Ltd, New Delhi. pp.1 – 168. 6. Rajesh Gopinath and N. Balasubramanya. 2018. Environmental Science and Engineering. Cengage Learning India Pvt.Ltd.pp.36-179.
	E-Resources 1. http://nptel.ac.in/courses/122103039/40 2. http://b-ok.xyz/book/671429/bc900f 3. http://b-ok.xyz/book/2463090/f0ce34
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the components of environment, ecosystems, interactions of organisms, and appreciate how elements are cycling in the environment CO2: Identify the natural resources, types of biodiversity and status and importance of national parks, sanctuaries and biosphere reserves CO3: Understand remote sensing, GIS and their applications CO4: Describe the types, biological effects and control of pollution and the importance of environmental acts. CO5: Recognize the need of Environmental impact assessment, environmental audit, monitoring and treatment of effluents.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	1	2	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	2

Semester	**First**	Course Code	**24ZOOP0104**
Course Title	**CELL AND MOLECULAR BIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised **Course**	Revised Course	If revised, Percentage of revision effected	30
Category	Core		
Scope of the Course (may be more than one)	1. Basic understanding on the biology of cell communication 2. Developing skills to understand the cell division and their regulations 3. Creates employability scope in the molecular screening laboratories		
Cognitive Levels addressed by the Course	K-1 Ability to remember cell communication and cell signaling K-2 Comprehensive knowledge on cell cycle and regulation of cell cycle K-3 Capacity to analyze transcription in prokaryotes and eukaryotes K-4 Better understanding of structures of DNA, RNA and Proteins K-5 Make new techniques to study molecular mechanism of antisense molecules K-6 Assessment of functions of DNA, RNA and Proteins		
Course Objectives	**The course aims** • to impart updated information on the principles of cell communication • to give an in-depth knowledge on control of cell cycle • to make the student knowledgeable on concepts and mechanism of DNA replication process • to expose the students on mechanisms of transcription process in prokaryotes and in eukaryotes. • to enhance student's interest to distinguish translation processes in prokaryotes with eukaryotes.		
Units	**Content**		**No. of Hours**
I	**Structure of Cell and cell membranes** Ultrastructure of plant and animal cell; Membrane structure and function; Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structural organization and function of intracellular organelles; Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.		13
II	**Cell communication and cell signaling** Cell signaling; hormones and their receptors, cell surface receptors, membrane-associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures. bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.		13
III	**Cell cycle and cell growth** Cell cycle - types of cell division - mitosis and meiosis. Control and regulation of cell cycle - cell volume - size - internal / external checkpoints in G1 - G2 - S and M. Positive regulators - cyclin A - B - D and E - Cdks and cyclin-Cdk complex. Negative regulators - Rb protein - E2 Factors - p53 - and p21. Extracellular control system - survival factors and growth factors. Programmed cell death - apoptosis - aging and its theories.		12
IV	**Transcription** Basic factors of RNA Synthesis - RNA ploymerases – I, II and III - Transcription Mechanisms in prokaryotes and eukaryotes – chain Initiation, elongation and termination. Significance of pribnow box, TATA box, CAAT box and enhancers in transcription initiation. Rho dependent and Rho independent termination of transcription. Classes of RNA Molecules – Messenger, ribosomal and transfer RNA. Post –transcriptional modification - RNA splicing – role of lysozyme – Spliceosomes, Group I and Group II introns Self-splicing. Capping and tailing of 5' and 3' termini of Eukaryotic mRNA molecules.		13

V	**Translation** Genetic code – Definition, deciphering of codons – Universality of the code – Wobble hypothesis and codon degeneracy - codon dictionary. Mechanism of protein synthesis -importance of Initiation (IF), elongation (EF) and releasing factors (RF) - post-translational modifications – protein splicing and folding – role of molecular chaperones. Regulation of gene expression in prokaryotes –Operon concept – inducible and repressible operons Eg. lac, trp, ara, and his operons; Feedback inhibition and Allosteric enzymes. Molecular Pharming. Genome Editing tools: ZFNs, TALENs and CRISPR-Cas9.	13
References	Text Books 1. Sundara Rajan, S. 2003. Introduction to Cell Biology. Vikas Publishing House Pvt. Ltd., New Delhi. 2. Nair, P.K.G. and Prabhakar Achari, K. 1999. A Text Book of Cell Biology. Konark Publishers Pvt. Ltd., Delhi. 3. David Freifelder, 2020. Molecular Biology. 4th Reprint., Narosa Publishing House, New Delhi, India. 4. Lansing M. Prescott, John P. Harley and Donald A. Klein 2020. Microbiology (11thEd.). Mc Graw Hill companies.	
	Reference Books 1. Geoffrey M. Cooper. 2019. The Cell – A Molecular Approach, 8th Edition, Oxford University Press 2. Lizabeth A. Allison., Fundamental Molecular Biology, 2nd Edition, 2012 John Wiley & Sons, Inc. 3. David P. Clark, Molecular Biology, 3 rd Edition, 2019 Elsevier Inc. 4. Robert F. Weaver, Molecular Biology, 5th Edition 2012 by The McGraw-Hill Companies, Inc. 5. Bruce Alberts, Molecular Biology of Cell, 6th Edition,2015, Garland Science, Taylor & Francis Group, LLC 6. Michael M. Cox, Molecular Biology Principles and Practice, 2012 by W. H. Freeman and Company. 7. James D. Watson, Molecular biology of the gene, 7th Edition,2014, Cold Spring Harbor Laboratory. * (NPTEL) - National Programme on Technology Enhanced Learning.	
	E-Resources 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio/ 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Outline the fundamental concepts of cell communication CO2: Discuss the positive and negative regulations CO3: Explain the mechanisms of DNA replication & repair mechanisms CO4: Evaluate the differences of transcription process in prokaryotes with eukaryotes CO5: Compare the mechanisms of translation in prokaryotes with that in eukaryotes	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**First**	Course Code	**24ZOOP0105**
Course Title	**Practical 1: Invertebrates and Vertebrates**		
No. of Credits	2	No. of contact hours per week	4

New Course/ Revised **Course**	Revised Course	If revised, Percentage of revision effected	20
Category	Core		
Scope of the Course (may be more than one)	1. Observe the taxonomic characteristics of animals belonging to different phylum. 2. Identification and knowing the salient features of helminth parasites. 3. Visit to seashore and observation of economically important crustaceans, molluscs, echinoderms and fishes.		
Cognitive Levels addressed by the Course `	**K1** - To understand the microscopic animals of different phyla **K2** - To learn the poriferans and coelenterates **K3** - To identify the different nematodes **K4** - Analyze the characteristics of insects of different orders **K5** - Assess the salient features and mode of life of different vertebrates		
Course Objectives	The Course aims • to identify the important microscopic animals of different phyla. • to identify and know the different types of Helminthes • to observe crustaceans, molluscs, echinoderms and fishes through field visit to sea shore and fish farms. • to study the morphometrics of fish and prawns • to identify special features and the mode of life of vertebrates.		

Practicals	**Content**	**No. of Hours**
1.	Identification and study of protozoans–Amoeba, Euglena, Volvox, Chlamydomonas, Trypanosoma and Paramecium.	4
2.	Identification and study of Poriferans – Chalina	4
3.	Identification and study of Coelenterates – Hydra, Jellyfish and Corals.	4
4.	Identification and study of Platyhelminthes – Liver fluke and Tapeworm.	4
5.	Observation of Nematodes -Round worm, Pin worm, Whip worm, Microfilaria and Hookworm.	4
6.	Mounting of earthworm body setae	4
7.	Mounting of cockroach mouthparts	4
8.	Study of morphometrics of fish.	4
9.	Mounting of prawn appendages	4
10.	Visit to seashore and observation of crustaceans, molluscs, echinoderms and fishes.	8
11.	Visit to fish farms, aquarium and museum.	8
12.	CFA	4
13.	Record Work	8

References

1. S.S. Lal. 2018. Practical Zoology- Invertebrate. Rastogi Publication, Meerut.
2. S.S. Lal. 2018. Practical Zoology- Vertebrate. Rastogi Publication, Meerut.
3. Jeya surya, Dulsy Fathima, R.P. Meyyan Pillai, S. Prasanakumar, N. Arumugam, L.M. Narayanan, V. Kumaresan and, A. Marikuttikan 2017, Practical Zoology (Animal Physiology Vol.III), Saras Publication, Nagercoil.
4. Jeyasurya, N. Arumugam, N.C Nair, S. Leelavathy, N. Soundrapandian, and L. M. Narayanan 2017, Practical Zoology (Vol. 1& II), Saras Publication, Nagercoil.

Course Outcomes	On completion of the course, students should be able to
	CO1: Identify the important microscopic animals of different phyla. CO2: Know the types of worms CO3: Identify earthworms, Nereis, leech, insects of different orders and Arachnids CO4: Observation of crustaceans, molluscs, echinoderms; gaining nowledge through field visit to sea shore and fish farms. CO5: Identify teleosts, elasmobranchs, amphibians, reptiles, aves& mammals.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**First**	Course Code	**24ZOOP0106**
Course Title	**Practical. 2: ENVIRONMENTAL BIOLOGY, CELL AND MOLECULAR BIOLOGY**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	25
Category	Core		
Scope of the Course (may be more than one)	1. Opportunity to understand the basic concepts of experiments in Environmental Biologyand Cell &Molecular Biology 2. Exposure of students to approaches and techniques of Environmental Biologyand Cell &Molecular Biology Providing skills to handle the experiments in Environmental Biology and Cell &Molecular Biology		
Cognitive Levels addressed by the Course	**K1-**Emphasis on the importance of physicochemical parameters in the environment **K2**- Understand the different parameters of the environment **K3**- Analyze the importance of remote sensing, GIS and Environmental Education **K4**- Assess the different techniques in Cell &Molecular Biology **K5**-Know the molecular techniques of isolation, separation and amplification of DNA		
Course Objectives	The Course aims • to estimate total dissolved solids, dissolved oxygen, carbon dioxide, total alkalinity, chloride, hardness in different water samples • to know the importance of BOD and COD in polluted water samples • to understand how to study the population of plants. • to understand how to design bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae. • to know the applications of remote sensing and GIS		

Practicals	**Content**	**No. of Hours**
1.	Estimation of Total Solids and Dissolved solids	3
2.	Estimation of Dissolved oxygen	3
3.	Estimation of Carbon dioxide	3
4.	Estimation of BOD & COD in different water samples (Demonstration).	6
5.	Estimation of Chloride.	3
6.	Squash preparation of onion root tip and observation of mitotic stages	3

7.	Preparation of human buccal mucosal epithelium and determination of Barr bodies	3 3
8.	Isolation of genomic DNA from bacterial cell	6
9.	Separation of DNA by Agarose gel electrophoresis	6
10.	Quantitative estimation of DNA by DPA method	3
11.	Amplification of DNA by PCR	6
12.	Reagent Preparation	6
13.	CFA	3
14.	Record Work	7
	Reference Books 1. P.K. Gupta 2012. Methods in Environmental Analysis Water, Soil and Air. Agrobios (India), Jodhpur. 2. APHA. 2012. Standard Methods for the examination of water and waste water (20th Edition). American Public Health Association, Washington. D.C. 3. Rina Majumdar. 2018. Laboratory Manual of Cell Biology. Prestige Books publishers. 4. P.V.G.K. Sarma. 2021. Molecular Biology A Practical Manual. MJP Publishers (First edition). 5. S.K.Gakhar. 2019. Molecular Biology:A Laboratory Manual. Dreamtech Press.	
	On completion of the course, students should be able to	
	CO1: Understand how to estimate Total Dissolved solids, Dissolved oxygen, Carbon dioxide, Total alkalinity, Chloride, hardness, BOD and COD in different water samples CO2: Understand how to study on population of plants. CO3: Understand the Bioassay studies on industrial effluents/ pesticides Using fish, aquatic insects and larvae. CO4: Understand the applications of remote sensing and GIS in environment. CO5: Know the molecular techniques of isolation, separation and amplification of DNA	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	1	1	1	1	1
CO4	3	3	3	3	3
CO5	3	3	3	3	3

24GTPP0001GANDHI IN EVERYDAY LIFE Credit: 2
(Offered by Department of Gandhian Thought and Peace Science, GRI-DU, Gandhigram)

Semester	**Second**	Course Code	**24ZOOP0207**
Course Title	**BIOINSTRUMENTATION AND RESEARCH METHODS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	5
Category	Core		
Scope of the Course (maybe more than one)	1. Facilitate the students to understand the instrumentation techniques 2. Learning the fundamental and working principles of instruments 3. Understand the concept of research methodology.		
Cognitive Levels addressed by the Course	**K1**- Enrich the knowledge in the field of bioinstrumentation **K2**- Gaining factual ideas in bioinstrumentation and research methods **K3**- Application of recent instrumentation techniques in research **K4**- Focus on the working principles of instruments in the field of Biology **K5**- Developing competence and writing skills in thesis and publications **K6**- Promote and establish the research activities in the field of Zoology		
Course Objectives (Maximum:5)	The Course aims • To understand the principles and applications of ordinary and electron microscopes • To learn the techniques in isolation and separation of cell organelles, micro and macromolecules. • To imbibe the principle and applications of Electrophoresis, colorimetry and calorimeter • To understand the research methods, thesis writing and presentation • To learn the article publication, ethics and IPR.		
Unit	**Content**		**No. of Hours**
I	**Microscopy, pH and Buffer** Microscopy- Principle and Applications- Light, phase contrast, Confocal and Fluorescence – Electron Microscopy -SEM and TEM - pH basic principles – pH electrodes- Principles, application and preparation of common buffers- Citrate, acetate, tris and phosphate		11
II	**Centrifugation and Chromatography** Homogenization- Manual, mechanical and sonication- Centrifugation techniques- Basic principles, Different types of Centrifuges, Analytical and preparative ultracentrifugation methods – Chromatography- Paper, thin layer, Ion-exchange, column- separation of amino acids and sugars- Gas liquid chromatography, HPLC. Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes-		13
III	**Electrophoresis, Colorimetry and Calorimeter** Electrophoresis- General Principles Horizontal & Vertical gel electrophoresis and immune electrophoresis -Electrophoresis of proteins and nucleic acids- Spectroscopic techniques- UV-Visible and FT-IR – Flame photometer, Bomb calorimeter, AAS, Mass Spectra, NMR – Principle and applications. Radioisotophic techniques.		13
IV	**Research, Thesis writing and Presentation** Research- Definition, objectives, types and importance- Research methods in Biological Sciences- Research process- Literature and reference collection – sources- Role of Libraries in research-e-journals and e-books- Scientific databases- Indexing data bases, Citation data bases: Web of Science, Scopus, Google Scholar-Research report writing- Parts of Thesis and Dissertation- Presentation in seminars and conferences		13
V	**Article Publication, Ethics and Intellectual Property Rights** Writing scientific paper- Organization of scientific paper- Publication in research journals-Standards of Research journals- Peer review-Types- Impact factor- citation index, h-index, i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Ethics in research-Plants and animals-Intellectual Property Rights- Origin and history of Indian Patent system- Basis of patentability- Patent application procedure in India.		14

References	Text Books 1. Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai. p.39-98;113-153;185-375. 2. C.R. Kothari and Gaurav Garg.2019. Research Methodology- Methods and Techniques. New Age International Publishers, New Delhi.pp.1-25. 3. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publishing House, New Delhi. 4. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani 5. G.R. Chatwal and S.K. Anand. 2014. Instrumental Methods of Chemical Analysis. Himalaya Publishing House
	Reference Books 1. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai. 2. G.H. Mitchell 2017. Gel Electrophoresis: Types, Applications and Research. Nova Science Publishers Inc 3. B.K. Sharma 2014 Instrumental Method of Chemical Analysis. Krishna Prakashan Media(P) Ltd. 4. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi. 5.Keith Wilson and John Walker 2002 Practical biochemistry – Principles and techniques. Fifth Edn. Cambridge Univ. Press.
	E-Resources 1. http://nptel.ac.in/syllabus.php?subject Id= 102107028. 2. http://b-ok.xyz/book/674611/288bc3 3. http://www.researchgate.net/publication/317181728- Lecture Notes on Laboratory Instrumentation and Techniques. 4. iiscs.wssu.edu/drupal/node/4673 5. http://www.studocu.com/en/search/research methodology?languages=language_en&type =document *(NPTEL) -National Programme on Technology Enhanced Learning.
Course Outcomes	On completion of the course, students should be able to
	CO1: Enabling the students to understand the principles and applications of different types of microscopes, pH meter and buffers. CO2: Providing excellence in isolation and separation techniques. CO3: Enhance the application and separation techniques of various micro and macromolecules CO4: Explain the basic information on research methods CO5: Create awareness on the importance of article publication and IPR.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

Semester	**Second**	Course Code	**24ZOOP0208**
Course Title	**BIOCHEMISTRY AND ANIMAL PHYSIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	15
Category	Core		
Scope of the Course (may be more than one)	1. Inculcate the structure and function of proteins, carbohydrates and lipids. 2. Gain knowledge on the physiology of human respiratory, circulatory and digestive systems 3. Know the types of sensory receptors and mechanism of action of endocrine glands.		

Cognitive Levels addressed by the Course	**K1**- Understand the principles of biochemistry and animal physiology **K2**- Learn the importance of protein, carbohydrate, lipids and enzymes in day-to-day life **K3**- Evaluate the anatomy and physiology of different organ systems. **K4**- Assess the mechanism of osmoregulation in different animals. **K5**- Compare the modes of excretion in vertebrate and invertebrate animals.	
Course Objectives (Maximum:5)	The Course aims • to study the classification, structure and properties of different biomolecules and enzymes. • to understand the various physiological mechanisms and functioning in the animal kingdom. • to enable the students to understand the physiological aspects of life. • to apply the knowledge in day-to-day life. • to know the anatomy of different organ system and their specific functions.	
Unit	**Content**	**No. of Hours**
I	**Carbohydrate and lipids** Classification, structure and functions - Monosaccharides, Disaccharides, Polysaccharides - Homo and hetero polysaccharides. Lipids - Classification, structure and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids.	11
II	**Amino acids, Proteins and Enzymes** Amino acids - Structure, classification and properties. Protein-Classification– Based on source, shape, composition and solubility- Structure of protein – primary, secondary, Tertiary and quaternary .Enzymes - Classification – Based on substrate acted upon by the enzyme, type of reaction catalyzed, substrate acted upon and type of reaction catalyzed, substance that is synthesized, chemical composition of the enzyme substance hydrolyzed and the group involved and over–all chemical reaction taken into consideration – Major classes of enzymes – Mechanism of enzyme action – Enzyme-substrate complex formation- Fisher's template, Induced Fit theory, substrate strain theory-Factors affecting enzyme activity-Effect of pH, temperature, time, light, radiation, enzyme concentration, substrate concentration and Michael's – Menten equation- Enzyme specificity and enzyme inhibition.	12
III	**Nutrition, Respiration and Circulation** Nutrition - classification – Nutritive requirements of animals –Feeding mechanisms – Digestion – Digestive enzymes – absorption and assimilation of carbohydrates, proteins and lipid. Respiration – Respiratory Pigments – Blood – gas transport – Respiratory quotient. Circulation - Blood constituents – Functions of blood – blood grouping - Types of Hearts – Neurogenic and myogenic hearts – regulation of heart beat and blood pressure. ECG – its principle and significance-cardiac cycle.	16
IV	**Osmoregulation and Excretion** Osmoregulation – Basic principles – Mechanism – Osmoregulation of freshwater, marine and terrestrial environment. Excretion –Nitrogenous wastes – Ammonia, Urea and uric acid – Ornithine cycle (urea cycle). Excretion- vertebrate nephron – Anatomy of mammalian kidney and urine formation-micturition- electrolyte balance and acid-base balance.	12
V	**Muscle, Nerve and Endocrine Glands** General organization, classification and function of muscles and nerves– synapse and neuromuscular junction. Thermoregulation- Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization. Stress and adaptation. Endocrine glands–pituitary, thyroid & parathyroid, pancreas, ovary & testis. Basic mechanism of hormone action- hormones and diseases.	13

References	Text Books 1. S. Rajan and R.Selvichristy. Biochemistry.2020. CBS Publishers & Distributors Pvt. Ltd.New Delhi.pp.1-60;144-160. 2. Keshaw Trehan. 2019. Biochemistry. New Age International Publishers.pp.55-88;291-311. 3. S. Prasanakumar, A. Meena, R.P. Meyyan Pillai, Dulsy Fathima, L.M. Narayanan, and K Nallasingam.2017. Animal Physiology and Biochemistry, Saras Publication, Nagercoil. 4. G.S. Sandhu 2002. Text book of biochemistry 18thEdn. Campus books International, New Delhi pp. 24-208. 5. R. Nagabhushanam Reprinted 1991. Text Book of Animal Physiology Second Edition. M.S. Kodarker R. Sarojini Oxford and IBH Publishing company Private Limited, New Delhi. 6. William S. Hoar 1987. General and comparative Physiology Third Edition print Hall International INC, Englewood cliffs, N.S. USA
	Reference Books 1. T.A. Brown.2018. Biochemistry.Viva Books,New Delhi. pp.36-150. 2. K. V. Sastry& Priyanka, Mathur. 2018. Animal Physiology and Biochemistry, Rastogi Publication, Meerut. 3. U.Satyanarayana and U.Chakrapani. 2017. Fundamentals of Biochemistry.Books and Allied (P) Ltd. Kolkotta.pp.4-31. 4. Mohan P. Arora. 1989. Animal Physiology Himalaya Publishing House, New Delhi. 5. Eckert and Randall Second Edition, Animal Physiology – Mechanisms and Adaptations W.B. Sounders Company, Philadelphia 6. C. Ladd Prosser (Third Edition), Comparative Animal Physiology. 1973. W.N. Sounders Company, Philadelphia.
	E-Resources 1. https://onlinecourse.nptel.ac.in/noc18bt14/preview. 2. https://b-ok.org/book/2595944/cab169 3. https://b-ok.org/book/989964/a5ob8a *(NPTEL) -National Programme on Technology Enhanced Learning.
Course Outcomes	On completion of the course, students should be able to
	CO1: Learn the Classification, structure and properties of protein, carbohydrate, Lipids and enzymes CO2: Learn animal foods & nutritive types, feeding mechanisms in different animals and process and role of enzymes in digestion, absorption& assimilation CO3: Recognize the presence of different types of respiratory pigments & their functions CO4: Identify organs involved in respiration, circulation and excretion among mammals CO5: Able to understand the structure and functions of receptors, nerve, muscle and endocrine glands.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Second**	Course Code	**24ZOOP0209**
Course Title	**ENTOMOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	40
Category	Core		
Scope of the Course	1. Understand the concept of Entomology and general organization of insects. 2. Learn the role of insects in forensic investigation and transmission of diseases.		

(may be more than one)	3. Know the beneficial and destructive insects and importance of insect pest control.	
Cognitive Levels addressed by the Course	**K1**- Understand the elementary classification and general organization of insects. **K2**- Learn the medically important and forensic insects. **K3**- Evaluate the economic importance of beneficial and destructive insects. **K4**- Realize the insect pest of economically important plants. **K5**- Analyze the different methods of pest control and need for transgenic plants.	
Course Objectives	The Course aims • to understand the insects by studying their general organisation, structure, life cycle and importance. • to know the life cycle and control of medically important and forensic insects • to understand the destructive plant pests of rice, legumes, sugarcane, fruits, groundnut and coconut • to know the economic importance of beneficial insects • to explicate the various types of insect control methods and Integrated Pest Management.	
Unit	**Content**	**No. of Hours**
I	**Introduction to Entomology** Elementary classification of class insecta-General organization and structure-types of mouth parts, sense organs, appendages and wings. Metamorphosis-types and hormonal control of metamorphosis. Pheromones-types and functions. Reasons for the dominance ofinsects and insects reaching pest status.	13
II	**Medical and Forensic Entomology** Medical entomology – Bionomics, life cycle and control of Arthropods of medical importance-mosquitoes, sand fly, fleas and lice. Insects of forensic importance- Corpse feeders – Maggots – life cycle -Role of insects in crime investigation.	13
III	**Destructive insects** Insect pests - definition - Categories of pests - Types of damage to plants by insects - causes of pest outbreak - Economic threshold level. Biology of the insect pests of paddy (*Cnaphalocrocis medinalis, Nilaparvata lugens*), cotton (*Heliothis armigera*, *Pectinophora gossypiella*), sugarcane (*Chilo infuscatellus*, *Pyrilla perpusilla*), vegetables (*Leucinodes orbonalis*, *Earias vitella*), coconut (*Oryctes rhinoceros*, *Rhynchophorus ferrugineus*) and stored grains (*Callosobruchus maculatus, Sitophilus oryzae*).	13
IV	**Pest Control** Insect pest control methods- Natural, cultural, applied, legal and biological control– merits and demerits- *Bacillus thuringiensis* and its mode of action on insect. Integrated Pest Management (IPM) and its importance. Development and uses of pest resistant plant varieties.	13
V	**Insect Toxicology** Principles and scope- Chemical classification of insecticides chemistry and mode of action of the insecticides- Inorganic compounds: Arsenic and fluorine compounds. Organic compounds: Organochloride, organophosphorus and carbamates; Botanical insecticides - ill effects of insecticides.	12
References	Text Books 1. P.K. Sehgal. 2018. Entomology -An Illustrated Textbook, New India Publishing Company, New Delhi.pp.243-276. 2. M.S.Nalina Sundari and R.Santhi.2017.Entomology.MJP Publishers, Chennai.pp.133-238;241-257;291-338. 3. K.K. Nayar, T.N. Ananthakrishnan& B.V. David .1996. General& applied entomology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 4. Larry P, Pedigo. 1996. Entomology and Pest management. Prentice Hall of India Ltd., New Delhi. 5. Ashok Kumar & Prem Mohan Nigam. 1991. Economic & Applied Entomology Emkay Publications, Delhi.	

	Reference Books 1. H.F. Van Enden. 1989. Pest Control 2nd edition. Cambridge University Press, Cambridge. 2. Lalit kumar Jha 1987. Applied Agricultural Entomology. New Central Book Agency, Calcutta. 3. A.D. Imms. 1965. A General Text Book of Entomology, 9th edition. ELBS edition, Great Brittan. 4. V.B. Wigglesworth. 1965. The Principles of Insects Physiology, ELBS edition, Great Britain.
	E-Resources 1. http://b-ok.org/book/509727/f99f7e 2. http://projects.ncsu.edu/cals/course/ent425/library/tutorials
Course Outcomes	On completion of the course, students should be able to
	CO1: Realize the parts of insects and their functions. CO2: Know the medical importance of insects CO3: Understand the agricultural importance of insects CO4: Understand the classification and economically importance of insects CO5: Understand the insect control, merits, demerits and importance of integrated pest management system

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

24ZOOP0209 ADVANCED BIOSTATISTICS Credits -4
(Offered by Department of Applied Research, GRI-DU, Gandhigram)

Semester	**Second**	Course Code	**24ZOOP0210**
Course Title	**ADVANCED BIOSTATISTICS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Core		
Scope of the Course (may be more than one)	1. Understand the importance of statistics in biology 2. Realize the role of biostatistics to interpret the experiments in biology 3. Motivate the students to understand the different aspects of biostatistics to understand hypothesis testing and Tests of significance.		
Cognitive Levels Addressed by the Course	**K1-** Understanding basic concepts in Bio-Statistics **K2-** Comprehending statistical measures in the biological data analysis **K3-** Ability to interpret the statistical inference		
Course Objectives (Maximum:5)	The Course aims • To be familiar with statistics and its applications in biology • To solve problems quantitatively using appropriate statistical measures • To create and interpret visual representations of quantitative information • To understand and critically assess data collection and its representation • To enhance the understanding of various rates, ratios and odds ratio.		

Unit	Content	No. of Hours
I	**Basics of Biostatistics:** Definition and Applications of Biostatistics. Descriptive and Inferential Statistics. Level of Measurement. Descriptive Statistics: Measures of central tendency and dispersion. Frequency distribution and graphical representation of data.	12
II	**Multivariate Analysis:** Correlation – Concept – Types – Simple Correlation - Karl Pearson and Spearman rank - Multiple Correlation (Three variables). Regression – Concept – Types – Simple linear and Multiple Linear (Three variables) regression.	13
III	**Sampling Distribution and Hypothesis Testing:** Sampling distribution – Student t distribution, F distribution, $\chi 2$ distribution – Applications and properties - Basic concepts and types of hypotheses – Standard error - Type I and II error – Level of significance – Confidence Interval – Testing procedure.	13
IV	**Parametric Test:** Large sample tests - Tests for single mean and difference between two means, confidence intervals for mean(s), Test for single proportion and difference between two proportions. Small sample tests - Test for single mean and difference between two means, paired t – test, $\chi 2$ test, F – test. ANOVA: one-way and two-way classification.	13
V	**Non-Parametric Test:** One sample test - Run test, Sign test and Wilcoxon-Signed Rank tests (single and paired samples). Two independent sample tests - Median test, Wilcoxon, Mann-Whitney U test. Kruskal-Wallis test, Friedman's Rank test.	13
References	Text Books 1. Veer Bala Rastogi2017. Biostatistics, Medtech publication, (3rd revised Edition),. 2. Qazi Shoeb Ahmad and Viseme Ismail 2008.Biostatistics, University Science Press, New Delhi, (1st Edition), 3. Sampath Kumar V.S.1997.Bio-Statistics, ManomaniamSundaranar University Publication, Tirunelveli, 4. Verma B.L, Shukla G.D and Srivastava.R.N.1993.Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 5. W.G. Cochran. 1985.Sampling Techniques, Wiley Eastern Ltd, New Delhi.	
	Reference Books 1. Rangaswamy, 2020. A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi. 2. Gupta. S.P.2017.Statistical Methods, New Delhi: Sultan Chand, 3. Hogg. R.T. and A.T. Craig. A.T.2012.Introduction to Mathematical Statistics, (7thEd) 4. Rohatgi, V. K. and A. K. md. Ehsanes Saleh.2009. An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi. 5. Gupta. C.B. 2004. An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed),	
	E-Resources 1. https://www.biostat.washington.edu/about/biostatististics 2. Modules/BS/BS704_http://sphweb.bumc.bu.edu/otlt/MPH-Biostatistics Basics 3. https://www.edx.org/course/biostatistics-0	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Get acquainted with basic concepts of statistics and its relevance to the core subject. CO2: Visualization of biological data using diagrams, charts and graphs. CO3: Analyze the different sample characteristics using descriptive statistics. CO4: Observe and interpret the relationship between various biological parameters. CO5: Calculate and interpret regression estimates made on biological data.	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	2
CO2	3	2	3	1	3
CO3	3	3	1	3	3
CO4	3	3	1	3	2
CO5	3	3	1	2	3

Semester	**Second**	Course Code	**24ZOOP0211**
Course Title	**Practical 3: BIOINSTRUMENTATION, BIOCHEMISTRY AND ANIMAL PHYSIOLOGY& ENTOMOLOGY**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	25
Category	Core		
Scope of the Course (may be more than one)	1. Know the various bioinstrumentation techniques 2. Learn the estimation of proteins, carbohydrates and cholesterol 3. Understand the methods of collection and preservation of insects		
Cognitive Levels addressed by the Course	K1- Critically understand the applications of various bio-instruments K2: Acquire hand on experience in various chromatography techniques K3: Learn the importance of estimation of protein, carbohydrate, and cholesterol K4- Gain knowledge on opercular activity in fish K5- Understand the techniques of insect collection and preservation		
Course Objectives (Maximum:5)	The Course aims • Provide skilful handling of various bioinstruments • Know the importance of separation of compounds by chromatography • to understand the importance of estimating protein, total carbohydrates and amylase • to know the techniques of insect collection and preservation • to inculcate the opercular movements in fish		

Unit	**Content**	**No. of Hours**
1.	Preparation of buffers and determination of pH	3
2.	Separation of amino acids and sugars using paper chromatography (2D)	3
3.	Separation of amino acids and sugars using thin layer chromatography	3
4.	Differential centrifugation of samples	3
5.	Estimation of sodium, potassium, calcium and magnesium using Flame photometer	3
6.	Estimation of protein	3
7.	Estimation of total soluble carbohydrates	3
8.	Estimation of total cholesterol	3
9.	Quantitative estimation of amylase activity	3
10.	Identification of ABO blood groups	3
11.	Estimation of glucose level in urine	3
12.	Opercular activity of fish in relation to temperature	3
13.	Qualitative tests for identification of ammonia, urea and uric acid (Nitrogenous excretory products)	3
14.	Insect collection and preservation for systematic studies	3
15.	Observation of insect pests of Paddy (*Cnaphalocrocis medinalis, Nilaparvata lugens*), Sugarcane (*Chilo infuscatellus, Pyrilla perpusilla*) and Stored products (*Callosobruchus maculatus, Sitophilus oryzae*)	3
16.	CFA	3
17.	Chemicals preparation for each practical	6
18.	Record Work	10

References	Reference Books 1. J. Sinha, A.K. Chatterjee and P. Chattopadhyay. 2017. Advanced Practical Zoology. Books and Allied(P) Ltd. Kolkotta 2. S. Rajan and R.Selvi Christy.2015. Experimental Procedures in Life Sciences. Anjana Book House, Chennai 3. Lal SS. 2017. Practical Zoology: Invertebrate. Rastogi Publications. 4. Rina Majumdar. 2018. Laboratory Manual of Cell Biology. Prestige Books publishers. 5. Ernest Brown Babcock.2022. Genetic Laboratory Manual, published by Legare street press.
Course Outcomes	On completion of the course, students should be able to
	CO1: Know the various bio-instrumentation techniques CO2: Understand the importance of estimating protein, total carbohydrates and cholesterol. CO3: Understand the ABO blood groups and qualitative analysis of glucose in urine. CO4: Learn the basic techniques of insect collection and preservation CO5: Able to know the identification of insects for systematic studies

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

24ENGP00C1 COMMUNICATION AND SOFT SKILLS Credits -2
(Offered by School of English and Foreign Languages, GRI-DU, Gandhigram)

24ZOOP0211 SUMMER INTERNSHIP Credits – 2

Semester	**Third**	Course Code	**24ZOOP0313**
Course Title	**GENETICS AND GENOMICS**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	40
Category	Core		
Scope of the Course (may be more than one)	1. Understand the various aspects of genetics and genomics 2. Realize the importance of studying genetics in various health disorders 3.Motivate the students to understand the different aspects of genetics and genomics to prepare for National level competitive examinations		
Cognitive Levels addressed by the Course	K1- Understand the basics and advancement of classical and modern genetics K2- Realize knowledge of the organization of genes and chromosomes K3- Understand the role of genetics in solving the issues in biological sciences K4- Expand the knowledge of genetics and genomics to utilize in national-level competitive exams K5- Realize the importance of genetics and genomics in the medical field		
Course Objectives (Maximum: 5)	**The Course aims** • To evaluate the Mendelian principles • To demonstrate the importance of extrachromosomal inheritance and human genetics • To analyse the various aspects of modern genetics • To create broad knowledge of Genomics in relation to biological research • To explain the details of Proteomics in relation to biological research		

Unit	Content	No. of Hours
I	**Mendelian genetics** Mendelian principles: Dominance, segregation, independent assortment: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Linkage and crossing over, mechanism of crossing over, sex limited and sex influenced characters. Multiple alleles, pseudo-allele, complementation tests. Sex determination and Sex-linked inheritance. Concept of the gene; Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, Eugenics - human betterment.	13
II	**Extra chromosomal inheritance and human genetics** Extra chromosomal inheritance: inheritance of mitochondrial and chloroplast genes, maternal inheritance. Cytoplasmic inheritance; Predetermination - Virus-like inclusions and infective particles, milk factor, kappa particles, plastid inheritance. Structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, ploidy and their genetic implications. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.	13
III	**Mutation and Modern genetics** Nature of Mutations, types of mutations, methods of detection of mutation: Ames test, CIB method and attached method, Molecular mechanism of spontaneous mutation. Mutagenic effects of food additives and drugs. DNA damage and repair. Homeotic mutants in *Arabidopsis* and *Antirrhinum*. Transposable elements and their types. Induced mutations, site-directed mutagenesis.	14
IV	**Genomics** Introduction to Genomics, Transcriptomics, Proteomics, Metabolomics and single-cell genomics. Genome sequencing, Whole genome shotgun sequencing, Physical mapping of genomes, Clone-by-clone sequencing, new generation sequencing technologies, Bioinformatics tools to analyse genomes, Examples of sequenced genomes (*Saccharomyces*, *Drosophila* and *Arabidopsis*)	12
V	**Proteomics** Protein isolation and identification methods SDS -PAGE, Isoelectric focusing, 2D gel electrophoresis, Peptide sequencing, Mass Spectrometry methods used in proteomics, Peptide databases, Immunological methods to study protein functions, Protein-protein and Protein-DNA interactions, Comparative proteomics, subcellular proteomics, quantitative proteomics.	12
References	**Text Books**: 1. Verma, P.S. and Agarwal, V.K. 2004. Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S.Chand & Company Ltd. New Delhi. 2. Gupta and Jains, 1991. The Cell and Biotechnology, 1st Edition, Agro Botanical Publication, New Delhi. 3. Benjamin A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England. 4. Lesk AM. 2017. Introduction to Genomics. Oxford University press. Oxford, UK. 5. Twyman R. 2013. Principles of Proteomics. Garland Science, Taylor & Francis Group, LLC, New York, USA. **Reference Books** 1. Eldon J. Gardner. 2004. Principles of Genetics 8th edition, John Wiley and Sons, New York. 2. Molecular Genetics of Bacteria, 4th Edition.2013. Larry Snyder, Joseph E.Peters, Tina M. Henkin, Wendy Champness. ASM press. 3. Lewin's Genes XII. 2017.Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick .Jones and Bartlett Publishers, Inc. 4. Hilde de Reuse, Stefan Bereswill. 2009. Microbial Pathogenomics. Karger Medical and Scientific Publishers, Switzerland.	

	5. Proteomics- From peptide sequence toFunction.2002. SR Pennington and MJ Dunn. **Web resources** http://xgu.zool.iastate.edu http://www-cse.ucsd.edu/groups/bioinformatics/GRIMM/ http://www.cs.unm.edu/~moret/GRAPPA/	
Course Outcomes	On completion of the course, students should be able to do CO1: Explain the structure and function of cell and its organelles CO2: Understand the mechanism of Cell signaling CO3: Compare knowledge on Cell division and cell cycle CO4: Analyse the concept of proteomics, genomics and metabolomics. CO5: Determine the various bioinformatic tools used to analyze the genomes.	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2
CO2	3	2	3	2	3
CO3	1	1	1	1	1
CO4	3	2	2	3	2
CO5	2	2	3	3	2

Semester	Third	Course Code	**24ZOOP0314**
Course Title	**EVOLUTION**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	30
Category	Core		
Scope of the Course (may be more than one)	1. Understand the basic principle and theories of evolution 2. Make the students to learn the basis of molecular evolution and origin of new genes 3. Inculcate new knowledge on the mechanism of speciation and evolution of human races		
Cognitive Levels addressed by the Course	**K1-** Remember the principles of Lamarckism, Darwinism and Biogenetic law **K2 -**Analyze the concepts of molecular divergence **K3**-Understand the population genetics and Hardy-Weinberg equilibrium **K4**-Compare the adaptive radiation of Darwin's finches **K5** -Evaluate the causes of human evolution and predict the future of man		
Course Objectives (Maximum:5)	The Course aims • To understand the concept of evolution. • To understand the role of genes in evolution • To learn the concept of species and speciation • To gain knowledge on variations and mutations in evolution • To know the aspects of human evolution and human races.		
Unit	**Content**		**No. of Hours**
I	**Evolutionary Theories** Lamarckism, Neo-Lamarckism, Darwinism and Neo-Darwinism, Mutation Theory, Biogenetic Law. Genetic variability, Natural selection, Genetic drift, Founder Principles. Behavioral Evolution- Altruism and evolution – Group selection and kin selection.		13
II	**Molecular Evolution** Molecular divergence - Molecular tools in phylogeny, classification and identification - Protein and nucleotide sequence analysis - Origin of new genes and proteins - Gene duplication and divergence		13
III	**Variations** Types of Variation, Cytological basis of variations, Chromosomal aberrations-		12

	Population genetics - populations, Gene pool, Gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift.	
IV	**Speciation** Isolation – Isolating mechanisms. Concept of Species, Migration and Gene flow, Darwin finches, Speciation, adaptive radiation, adaptive divergence, radiation evolution. Monophyly and Polyphyly	13
V	**Human Evolution** Evolution of Man, Origin of Man, Special features of primates, Compelling causes of evolution of Man, Evolutionary trends, Cultural evolution, Civilization, human races, future of man.	13
References	Text Books 1. Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. & Patel, N.H. 2007. Evolution. CSHL Press. 2. Futuyama, D. 2005. Evolution. Sinauer Associates, INC. 3. Futuyama, D. 1997. Evolutionary Biology. 3rd ed. Sinauer Associates, INC 4. Stearns, S. C. &Hoeskstra, R. F. 2005. Evolution. Blackwell Science Ltd. 5. Jha, A.P. Genes and Evolution. John Publication, New Delhi	
	Reference Books 1. Hartl, D. L. 2005. Principles of Population Genetics. 4th ed. Sinauer Associates. 2. Ridley, M. 1996. Evolution. 2 nd ed. Blackwell Science Ltd. 3. Savage, J. M. 1969. Evolution. 2 nd ed. NY, Holt 4. Dobzhansky, Th. Genetic and Origin of Species. Columbia University Press. 5. King, M. Species Evolution –The role of chromosomal change The Cambridge University Press, Cambridge	
	E-Resources 1. https://www.yourgenome.org 2. https://ncert.nic.in	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Gain knowledge on evolutionary theories and mechanism of natural selection CO2: Understand the molecular evolution and gene families. CO3: Realize the types of speciation and isolating mechanisms CO4: Learn the origin of life and human evolution. CO5: Know the Hardy-Weinberg equilibrium and population genetics	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	2	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester	**Third**	Course Code	**24ZOOP0315**
Course Title	**DEVELOPMENTAL ZOOLOGY AND IMMUNOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	25
Category	Core		
Scope of the Course (may be more than one)	1. Enable the students to know about the process of gametogenesis, structure of spermatozoa & ova and mechanism of fertilization 2. Reveal the process of organogenesis and development of brain, heart and ear 3. Help the students to understand the basis of immunity and functions of immune system		

Cognitive Levels addressed by the Course	**K1**- Make the students to understand the various concepts in developmental biology and immunology **K2** - Apply basic concept of gastrulation and morphogenesis **K3**- Analyze the types of regeneration, mechanism and causes of aging **K4**- Evaluate the types of immunoglobins **K5** - Create interest among the students on the mechanism of immune response and types of immunity	
Course Objectives (Maximum:5)	The Course aims • to make the students to understand the various concepts of development. • to enable the students to understand the basic principles of growth and development • to understand the application of developmental biology • to understand the nature and components of defence mechanism of human body • to identify major components of the immune system at organ, cellular and molecular levels	
Unit	**Content**	**No. of Hours**
I	**Gametogenesis and Fertilization** Origin of primordial germ cells-Spermatogenesis and Oogenesis – structure of spermatozoa and egg– Types of eggs- Fertilization (external and internal)– Parthenogenesis–– Planes and patterns of cleavage; laws of cleavage- -– Blastulation- types of blastula.	14
II	**Gastrulation, Organ development, Regeneration and Aging** Gastrulation–Morphogenetic movements & Fate map- nuclear transplantation experiments in amphibians- Organizer – concept – Induction process – Organogenesis of heart, brain, eye, ear& gonads in chick. Regeneration-types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and senescence: Biology of senescence- cause of aging- mechanism involved in apoptosis. and teratogenesis.	16
III	**Reproductive disorder and techniques** Assisted Reproductive Technology (ART) – Male infertility –Semen analysis- Sperm abnormalities – Superovulation – IVF, ICSI, GIFT. Reproductive Endocrine Disorders in Male and Female- Hypogonadism, ED (Erectile Dysfunction), Gynecomastia, POS (polycystic ovarian syndrome), Hirsutism, Perimenopause.	14
IV	**Immunity** Branches and recent developments of Immunology – Adaptive Immunity- Components-Humoral & cell-mediated- Cells in adaptive immunity- Antigen presenting cells, B-lymphocytes, T-lymphocytes, cytotoxic T-lymphocytes, NK cells- Steps in Adaptive immunity- Innate immunity – General features- Cells in Innate immunity- Phagocytic cells, cells that release inflammatory mediators- Anatomic, physiologic, endocytic and phagocytic barriers (Source: NPTEL) - Cells of Innate Immune Response – Structure and function of Lymphoid organs- Primary- Thymus, bone marrow- Secondary – Lymph nodes, spleen, MALT, CALT, GALT, tonsils.	10
V	**Antigen, Immunogenicity and Immunoglobins** Antigen- Classification Exogenous, endogenous, autoantigens,tumor antigens, allogenic, xenogenic, idiotypic- Immunogenicity – Chemical characteristics- Foreignness ,molecular size, chemical complexity, antigen processing and presentation- Biological characteristics-Genotype of the host, Immunogen dose and route of administration- Antigenicity, Haptens, Epitopes and types, Adjuvent types, mitogens, Types, properties and functions-Immunoglobins – Types, structure and properties of immunoglobin -Antigen determinants of immunoglobulins- isotypes, allotypes and idiotypes. Monoclonal antibodies: definition, production and applications- Auto-immune diseases- Immunodeficiency diseases.	10

References	Text Books 1. K.V. Sastry and Vineeta Shukla. 2018. Developmental Biology, Rastogi Publication, Meerut 2. N. Arumugam, 2017. Developmental Zoology, Saras Publication, Nagarcoil 3. Shyamasree Ghosh. 2017. Immunology and Immunotechnology, Books and Allied (P)Ltd, Kolkata. 4. AjoyPaul.2016. Text book of Immunology, Books and Allied (P)Ltd, Kolkata. 5. Ramesh Mathur & Meenakshi Mehta. 2002. Embryology, Anmol Publication Pvt.Ltd.NewDelhi. 6. Frederick R Bailey. 2018. Text-Book of Embryology, Forgotten Books.
	Reference Books 1. S.S.Lal and SanjeevKumar.2015. Immunology–Rastogi Publication, Meerut. 2. C.Vaman Rao.2017. Immunology. Narosa Publishing House Pvt. Ltd. New Delhi. pp.2.1-7.1. 3. P.R.Yadav.2001.AText Book of Embryology, Campus Books International, New Delhi. 4. T. Subramanian.2002. Developmental Biology. Narosa Publishing House, New Delhi. 5. C.V. Rao.2002.An Introduction to Immunology. Narosa Publishing House, New Delhi. 6. Balinsky B.I. 2012 An Introduction to Embryology (5 Ed.), Cengage Learning India
	E-Resources 1. http://nptel.ac.in/syllabus/syllabus. Php?subject Id= 102103038 2. http://b-ok.xyz/book/463534/11604b 3.http://www.studocu.com/en/document/ university-of-leads/animal developmental- biology/lecture-notes/animal-developmental-biology- lecture-notes-lecture-1/60800/view. 4.http://www.studocu.com/en/document/ hogeschool-van-arnhem-en-nijjmegan/immunologie/summaries/samenvatting-boek-immunology-immunologie-am/810272/view.
Course Outcomes	On completion of the course, students should be able to
	CO1: Realize the egg interaction, sperm entry and know the physiological factors in fertilization process. CO2: Understand the mechanism of blastulation process CO3: Realize the development of organs CO4: Appreciate the contribution of great immunologists and to know the types of lymphoid organs, lymph nodes and their functions CO5: Understand the types, functions of Immunoglobins and Antigen- antibody reactions

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Third**	Course Code	**24ZOOP0316**
Course Title	**Practical 4: GENETICS AND GENOMICS, EVOLUTION, DEVELOPMENTAL ZOOLOGY AND IMMUNOLOGY**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	-
Category	Core		
Scope of the Course (may be more	1. Enable the students to know the basis of inheritance and genome organization 2. Able to concept of evolution 3. Learn the development of frog and chick		

than one)		
Cognitive Levels addressed by the Course	**K1**- Exposure to the instruments in biological sciences **K2-** Imbibe the techniques involved in bioinstrumentation **K3**- Demonstrate knowledge and understanding on the basic concept ofevolution K4- Analyse the developmental stages in frog and chick K5- Assess the mammalian sperm and ova	
Course Objectives (Maximum:5)	The Course aims • to separate amino acids and sugars using chromatography and electrophoresis • to study the homologous and analogous structures in animals • to observe the leaf and stick insects by cryptic colouration • to observe the development of frog and chick embryo • to reveal the structure of sperm and ova in man	
Practicals	**Content**	**No. of Hours**
1.	Observation of simple Mendelian traits in Man	3
2.	Identification of colour blindness using colour charts	3
3.	Construction of Pedigree	3
4.	Study of biochemical and genetic disorders through slides or models or charts etc	3
5.	Mounting of polytene chromosomes from the salivary glands of *Drosophila / Chironomus larvae*	6
6.	Study of homology and analogy from suitable specimens.	3
7.	Observation of leaf insects and stick insects to study adaptation by cryptic colouration and natural selection	3
8.	Observation of Monarch and Viceroy butterflies to study Batesian mimicry. Problems on Hardy-Weinberg Law	3
9.	Observation of developmental stages of frog with the help of permanent slides-	3
10.	Egg, Cleavage, Blastula and Gastrula	3
11.	Development of chick embryo with the help of permanent slides – 24 hrs, 48 hrs, 72 hrs and 96 hrs.	3
12.	Observation and study of mammalian sperm and ova with the help of permanent slides	3
13.	Preparation of Reagents	10
14.	CFA	3
15.	Record Work	12
References	1. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed.Addison Wesley Longman Pvt. Ltd, Indian Branch, Delhi, India. 2. J.Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi. 3. Varsha Baweja and Monica Misra . 2021. Practical Manual of Developmental Biology (First edition). 4. Karthik Kaliaperumal und Senbagam Duraisamy Senthilkumar Balakrishnan. 2017. Practical Immunology A Laboratory Manual, 1st Edition, LAP LAMBERT Academic Publishing.	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Separate amino acids and sugars using paper and thin layer chromatography CO2: Estimate proteins, sodium, potassium, calcium and magnesium using spectrophotometer and flame photometer. CO3: Know the biological applications of SEM, FT-IR, AAS and NMR CO4: Gain knowledge on evolutionary process like adaptation, coloration and mimicry CO5: Know the developmental biology of frog and chick.	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	**Fourth**	Course Code	**24ZOOP0418**
Course Title	**FUNDAMENTALS OF MICROBIOLOGY**		
No. of credits	**4**	No. of contact hours per week	**4**
New Course / Revised Course	Revised Course	If revised, percentage of Revision effected **(Minimum 20%)**	20
Category	Core		
Scope of the Course (May be more than one)	1. Basic understanding on the morphology and functions of the structures with the prokaryotes and eukaryotes 2. Skill development microbiological cultural techniques 3. Creates employability scope in the microbiological laboratories / hospitals / industries		
Cognitive Levels addressed by the course	K-1 Ability to remember historical and recent developments in microbiology K-2 Grasp the comprehensive knowledge on Systematic bacteriology K-3 Use microbiological tools for better understanding of microbial structures and their functions K-4 Capacity to analyze factors influencing microbial growth K-5 Make new techniques to study microbial activity in nature K-6 Assessment of disease-causing microorganisms		
Course Objectives	The course aims to: • enhance the student's knowledge in historical aspects and microscopic techniques • acquire an overall knowledge on the morphology and functions of the structures with the prokaryotes and eukaryotes. • develop knowledge in microbial control techniques • make the students knowledgeable on the various culture techniques used in the microbiological lab • give an overview on the diseases caused by various microorganisms		

Unit	Content	No. of Hours
I	**History and classification of Microorganisms** Historical and recent developments -Scope of microbiology- Spontaneous generation and germ theory of disease - Major contribution of scientists– – Leeuwenhoek, Edward Jenner, and Alexander Fleming, Joseph Lister, Robert Koch and Louis Pasteur. Modern Microbiology - Landmark achievements in 20th century. Microscopy: Simple, Compound, Dark field and Fluorescence microscope.	13
II	**Prokaryotic and Eukaryotic Cell (Source NPTEL course)** Ultra structure of Prokaryotic and Eukaryotic cell- The Prokaryotic Cell: Size, shape and arrangement of bacterial cells; structure of cell wall, and structures external (glycocalyx, flagella, pili, etc.,) and internal (plasma membrane, cytoplasm, inclusion bodies, etc.,) to the cell wall. The Eukaryotic Cell: Cilia, flagella, cytoskeleton, cytomembrane systems, mitochondria and chloroplast Comparison of Prokaryotic and Eukaryotic cell.	13
III	**Microbiological Techniques I** Microbial control – Physical methods - Heat, (Low & High temperatures), Filtration,	12

	high pressure, Osmotic pressure, Radiation, and Desiccation. Chemical methods – chemical agents, types and mode of action- Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value)	
IV	**Microbiological Techniques II (Source NPTEL course)** Cultural techniques: pure culture techniques, types of media - media preparation - preservation of cultures - aerobic and anaerobic culture techniques - growth of bacteria: batch and synchronous culture - factors influencing growth - growth curve-Microbial nutrient -macro nutrients, micro nutrients, growth factors and sources of nutrients- Methods to study microbial morphology - wet mount and hanging drop method. Staining techniques - Gram's, acid fast, spore and capsule staining.	13
V	**Microbiology of Diseases** Infections: types of infection, sources of infection, reservoirs and vectors of infection. Normal microflora of the human body. Classification of medically important microorganisms; Diseases of Man - Bacterial: Staphylococcus, Streptococcus, Neisseria, Clostridium and Mycobacterium. Fungal: Dermatophytes, opportunistic fungal pathogens. Viral: Pox viruses; Hepatitis viruses and Human Immunodeficiency viruses (HIV).	13
References	**Text Books**: 1. Jeffery C. Pommerville. 2016. Alcamo's Fundamentals of Microbiology (Third Edition). Jones and Bartlett Learning. LLC, Burlington, MA 01803. 2. Tortora, G.J, Funke B.R. and Case, C.L.2010. Microbiology: An introduction 10th Ed, Benjamin Cummings, N.Y. 3. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2009. Prescott's principle of Microbiology, Mc Graw Hill, New York. 4. Dubey, R.C and Maheswari, D.K. 2005. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 5. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company. **Reference Books**: 1. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 2. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi. 3. Hans G. Schlegel. 2012(Reprint). General Microbiology. VII Ed. Cambridge University Press. UK. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 5. John L. Ingrahm and Catherine Ingrahm. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA. 6. Lansing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. V Ed. WCB/McGraw Hill Company. 7. Brock, T. D., Smith, D. W and Madigene, M. T. 1997. Biology of Microorganisms: Milestones in Microbiology. Prentice-Hall International Inc. London. 8. Talaro, K and Talaro, A. 1996. Foundations in Microbiology, 2en Ed., Wm. C. Brown publishers, Toronto. 9. Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press. **Web resources**: https://www.cliffsnotes.com › biology › microbiology https://www.livescience.com https://www.nature.com › ... › microbiology techniques	

Course Outcomes	On completion of the course, students should be able to: CO1: Discuss important milestones and accomplishments to appreciate the historical aspects CO2: Identify key organelles and their functions in both eukaryotes and prokaryotes CO3: Describe the overall classification and diversity of microorganisms CO4: Demonstrate microbial control measures and various culture techniques in microbiology. CO5: Explain the diseases caused by various microorganisms

Mapping of COs with PSOs

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Fourth**	Course Code	**24ZOOP0419**
Course Title	**ANIMAL BIOTECHNOLOGY AND GENETIC ENGINEERING**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	25
Category	Core		
Scope of the Course (may be more than one)	1. Understand the history, scope and applications of animal cell culture 2. Inculcate the development of biosensors for disease management and environmental protection 3. Learn the applications of biopharming and animal transgenesis		
Cognitive Levels addressed by the Course	**K1 -** Create interest in genetic engineering of animals **K2 -** Know the importance of biotransformation and production of useful products **K3 -** Develop awareness on the need for bioenergy and biosensors **K4 -** Analyse the concept of gene cloning and transgenic animals **K5 -** Assess the significance of gene therapy in prevention of diseases		
Course Objectives (Maximum:5)	**The course aims** • to impart knowledge on the concepts & scope in biotechnology • to provide an in-depth study on biotransformation techniques and biosensors • to enhance interest in alternate energy resources. • to understand genetic engineering concepts & techniques for animal welfare. • to know the transgenic organisms and to acquire knowledge on GMOs.		
Unit	**Content**		**No. of Hours**
I	**Concepts and Scope in Animal Biotechnology** Historical development – Animal tissue cultures techniques – primary culture, cell strains and cell lines – culture medias – Small scale and large-scale culture techniques – Animal bioreactors. Germplasm and cryopreservation. Immobilization of cells / enzymes – Adsorption, entrapping, ionic bonding, cross linking, encapsulation and microencapsulation. Application of immobilized cells & enzymes.		13
II	**Biotransformation and Biosensors *(Source NPTEL course)*** Biotransformation and production of useful compounds – Glycerol, butanol, acetone, alkene oxide, Poly hydroxy butyrate and valerate (PHBV), Xanthangum and		

	Microbial Leaching. Biosensors – definition and outline design- biosensors for personal diabetes management, noninvasive blood-gas monitoring, blood-glucose sensors. Noninvasive biosensors in clinical analysis	13
III	**Biotechnological application in animal improvements** Embryo biotechniques, in vivo and in vitro embryo production and preservation, sexing, micromanipulation and cloning, transgenic animal and biopharming. Mapping of genome and genome sequencing. Marker assisted selection. Gene banking. Nutritional biotechnology including bioconversion of lignocellulose, genetic manipulation of microbes to improve feed utilization and health.	13
IV	**Genetic Engineering (Source: NPTL Course)** Cloning vectors-plasmids, cosmids, phagemids, Lambda bacteriophage, M13, BAC, YAC, MAC and expression vectors. Restriction enzymes, DNA modifying enzymes. Transformation techniques-calcium chloride method-electroporation and biolistic methods. Construction of genomic and cDNA libraries and screening by colony and plaque hybridization. Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants.	13
V	**Animal transgenesis and Rules and regulation in biotechnology** GMOS –Transgenic animals –development of Transgenic animals – Mechanism of transferring genes into specific animal tissues and cell lines. Production of transgenic animals (cattle, mice, sheep, goat, pig and fish) and chimeras. Application of transgenic animals: Production of useful proteins and other products in transgenic animals (production of regulatory proteins, blood products, vaccines, hormones, and other therapeutic proteins). Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges and future of gene therapy. Rules and regulation in biotechnology – biosafety, bioethics, hazards of environmental engineering and intellectual property rights (IPR) and protection (IIP).	12
References	Text Books 1. R.C. Dubey.2019. A Textbook of Biotechnology. S. Chand and Company. New Delhi 2. S.B. Primrose, R.M. Twyman, and R.W. Old. 2012. Principles of Gene Manipulations; 6thEdn. Blackwell Science. 3. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Ed, Anmol Publications Pvt. Ltd., New Delhi. 4. Kumar H.D, 1991. A text book on Biotechnology 2nd Ed, East-west Press Private Ltd., New Delhi. Pg.1-250; 411-472; 534-555. 5. Glick, B.R. and Pasternak, J.J. 1994. Molecular Biotechnology, ASM Press, Washington DC.	
	Reference Books 1. Dubey R.C., 2014.Advanced Biotechnology 1st Edition. S.Chand&Company Ltd., New Delhi. 2. Robert F. Weaver, 2012Molecular Biology; McGraw Hill 3. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7thEdn. 4. T. A. Brown 2006 Gene Cloning and DNA analysis- An Introduction;, 5th Edition, Wiley Blackwell Publishing 5. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.	
	E-Resources 1.https://www.edx.org/learn/biotechnology 2.https://biog.feedspot.com/genetics-blogs/ 3.learn.genetics.utah.edu/ 4.http://bmc biotechnol.biomedcentral.com	

Course Outcomes	On completion of the course, students should be able to
	CO1: Discuss on the history and concepts of animal biotechnology CO2: Explain on biotransformation methods and working systems of biosensors CO3: Compare alternate energy sources and generation of bioenergy products from biomass CO4: Outline on concepts and techniques of Genetic Engineering CO5: Assess applications of GMOs and on Ethical issues

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	2
CO2	3	2	1	2	2
CO3	3	2	1	2	2
CO4	3	2	1	2	2
CO5	3	2	1	2	2

Semester	Fourth	Course Code	**24ZOOP0420**
Course Title	**ECONOMIC ZOOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Core		
Scope of the Course (may be more than one)	1. Provide theoretical knowledge on aquaculture, apiculture, sericulture and lac culture 2. Gain knowledge on the economic importance of honey, silk and lac 3. Assist in learning the breeding of live stocks, poultry and rearing of earthworms		
Cognitive Levels addressed by the Course	**K1**- Understand the aquaculture status, economics of fish farming and fishery products **K2**- Analyze the life cycle and management of honeybees, silkworms and lac insects **K3**- Apply knowledge on types of breeds, management and disease prevention in cattle, goat, sheep and poultry **K4**- Evaluate the economics of fish farming, apiculture, sericulture and lac culture **K5**- Create interest on vermiculture and vermicomposting		
Course Objectives (Maximum:5)	The Course aims • To understand the National and International status of aquaculture, economics of fish and prawn farming, fishery by-products and fishery contribution. • To understand the importance of apiculture and lac culture. • To understand the importance of rearing silkworm and sericulture. • To know the economic importance of livestock and poultry. • To know the vermicomposting and vermiproducts.		
Unit	**Content**		**No. of Hours**
I	**Aquaculture Potential** Status and scope of aquaculture — Economics of aquaculture – Fish culture-Catla, Tilapia and Rohu. Prawn culture-*Penaeus monodon* (Marine shrimp) and *Macrobrachium rosenbergii* (freshwater). Fishery Byproducts – Fishery contribution to economic development – Fish trade & Marketing.		10
II	**Apiculture and Lac Culture** Apiculture- Honey bee- Types- Colonial organization and Division of Labour-Queen, worker Drone- Honey comb-Life cycle- Bee hive- Maintenance and Management-Honey extraction techniques- Economic Importance of Honey- Food & Medicinal value, Bee wax, Royal Jelly & bee venom- Lac culture- Distribution-Life cycle Host plants- harvesting andcultivation of Lac- Economic importance.		14
III	**Sericulture** Species of silkworm- Mulberry silk moth- Life cycle- Collection of eggs-		

	Incubation of eggs- Rearing of Larvae- Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons - Spinning cocoons- Quality & Marketing- Post-cocoon processing- Shifting, Reeling and spinning- Diseases of silkworm and uses.	14
IV	**Economic Importance of Livestocks and poultry** Important livestock-Cattle, Goat, Sheep – Breeds, Management, Livestock diseases and Economics. Poultry- Types and breeds-Management of growers, layers, broilers – Feed formulations for chicks, growers and broilers-Nutritive value of egg and meat, disease and economics of poultry.	16
V	**Vermiculture:** Introduction to vermiculture- types of earthworm-rearing of earthworms-Vermicomposting technology-methods-earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration. Potentials and constraints for vermiculture in India. Marketing the products of vermiculture.	10
References	Text Books 1. G.S.Shukla and V.B.Upadhyay.2017.EconomicZoology-RastogiPublication,Meerut. 2. S.Sarkar, G.Kundu and K.K.Chaki. 2016.Introduction to Econmic Zoology. New Central Book Agency(P) Ltd.Kolkotta.pp.33-151;205-220;404-515. 3. Jeyasurya,N.C.Nair,N.SoundaraPandian,A.Thangamani,L.M.Narayanan,N.Arumugam,S. LeelavathiandT.Murugan.2017.Economic Zoology.Saras Publication, Nagercoil. 4. Q.J.Shammiand S.Bhatnagar.2002. AppliedFisheries.Agrobios(India) 5. R.P.Parihar.1996. A textbook of Fish Biology and Fisheries central Pub. House, Allahabad. 6. Arvind Kumar. 2005. Verms &Vermitechnology, APH Pub. Corporation, NewDelhi.	
	Reference Books 1. V.G. Jhingran. 1997.Fish and Fisheries of India. Hindustan Publishing corporation (India)Delhi. 2. Sagarika Chaudhuri.2017.Economic Zoology.New Central BookAgency(P)Ltd.Kolkotta.PP.9-267;323-334;641-677. 3. ManjuYadav.2008.EconomicZoology.DiscoveryPub.House,New Delhi. 4. N.Arumugam,T.Murugan,J.JohnsonandP.RamPrabhu.2017.AppliedZoology--SarasPublication, Nagercoil. 5. G.C. Banerjee. 2010.A Text book of Animal Husbandry 9thEdn. Oxford & IBH Pub. NewDelhi.. 6. T.V.Sathe.2004.VermicultureandOrganicFarmingDayaPub.Home,Delhi.	
	E-Resources 1. gurukpo.com/applied zoology-ethology-biostatics 2. http://ia800306.us.archive.org/O/items/economic zoology. 3. 3. Ooosbogoog/economic zoology Ooosbogoog. Pdf	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Learn the status, economics, byproducts and of aquaculture CO2: Understand the importance of apiculture and lac culture CO3: Recognize the importance of sericulture CO4: Learn the importance of Livestock and poultry CO5: Understand the importance of vermiculture	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Fourth**	Course Code	**24ZOOP0421**
Course Title	**Practical 5: FUNDAMENTALS OF MICROBIOLOGY, ANIMAL BIOTECHNOLOGY AND GENETIC ENGINEERING & ECONOMIC ZOOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	60
Category	Core		
Scope of the Course (may be more than one)	1. Learn the basic microbiological laboratory techniques 2. Understand the important techniques of cell culture, cryopreservation of semen and DNA isolation 3. Observe economically important honey bees, silkworm and fishes		
Cognitive Levels addressed by the Course	K1 - Observe the types of culture media and staining methods K2 - Know the measurement of microorganisms by micrometry K3 - Remember the preparation of cell culture media and sterilization methods K4 - Realize the cryopreservation of semen K5 - Understand the economic importance of rearing bees, silkworm and vermiculture.		
Course Objectives (Maximum:5)	The Course aims • to enhance the student's knowledge and impress upon them the important aspects of microorganisms • to provide practical knowledge and skill in the isolation and handling of microorganisms • to understand the preparation of animal cell culture media • to know the importance of cryopreservation techniques • to gain skill in farming animals for improving rural economy.		

Practical	**Content**	**No. of Hours**
1.	a) Microscopic Examination of Living Organisms – Demonstration of Motility (Hanging drop method).	3
	b) Measurement of Microorganisms using Micrometry.	3
2.	Staining Techniques – Grams staining, capsular staining, endospore staining and acid fast staining	
3.	Preparation of Culture Media and isolation of microorganisms from soil by serial dilution	3
4.	Pure culture techniques and preservation and maintenance of microorganisms.	3
5.	Enumeration of microorganisms from Air using Air sampler	3
6.	Standard Qualitative Analysis of Water by MPN test	3
7.	Preparation of cell culture media.	3
8.	Field visit to semen bank to observe cryopreservation of semen of livestock animals.	3
9.	Isolation of genomic DNA from goat liver	3
10.	Observation and identification of economically important Honey bees, Silkworm, Catla, Tilapia and livestocks	3
11.	Field visit to Aquaculture/ Sericulture industry	6
12.	Field visit to Vermiculture industry	6
13.	Preparation of media	6
14.	CFA	6

15.	Record	10
References	1. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (I Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India. 2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 3. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 –5) (2001 – 2003). 4. Amit Guptal. 2019. Immunology and Animal Biotechnology-a laboratory manual. LAP LAMBERT Academic Publishing. 5. Purushothaman T and Irfana Mol. 2022. Essentials of Immunology, Animal & Pharmaceutical Biotechnology. Notion Press; 1st edition.	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Demonstrate the standard methods for the isolation, identification and culturing of microorganisms. CO2: Explain the maintenance of pure culture of microorganisms CO3: Gain practical skills in the preparation of media for animal cell culture CO4: Know the biological importance of cryopreservation techniques CO5: Gather hands on training in economic zoology by field visit to aquaculture, sericulture and vermiculture industry	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2	2	2
CO3	3	3	2	2	2
CO4	3	3	2	2	2
CO5	3	3	2	2	2

24GTPP00H1 – HUMAN VALUES AND PROFESSOINAL ETHICS
MODULAR COURSE FOR P.G. PROGRAMMES
(Offered by Department of Gandhian Thought and Peace Science, GRI-DU, Gandhigram)

ELECTIVE COURSES - DISCIPLINE CENTRIC

Semester	**Third**	Course Code	**24ZOOP03E1**
Course Title	**FISHERIES AND AQUACULTURE**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Elective -Discipline Centric		
Scope of the Course (may be more than one)	1. Inculcate the importance of inland fisheries and aquaculture in India 2. Provide theoretical knowledge on cultivable fishes 3. Gain knowledge on pond construction, management of fish farms and nutritional requirement of fishes		
Cognitive Levels addressed by the Course	**K1** - Realize the status of fisheries and aquaculture **K2**- Remember the pond construction techniques and management **K3**- Analyze the economic importance of cultivable fishes **K4**- Evaluate the nutritional requirements of fishes and types of feeds **K5**- Create interest in fish farming, hatching techniques, transportation and disease management		
Course Objectives	The Course aims • To understand the fisheries potential and kinds aquaculture practices in India		

(Maximum:5)	• To learn the pond construction and management. • To know the culture technique of important fishes • To learn the nutritional requirements of fishes and culture technique of live feeds • To study the importance of induced breeding, methods of fish transportation and fish diseases	
Unit	**Content**	**No. of Hours**
I	**Scope of aquaculture and culture practices** Scope of fisheries and Aquaculture-Present status and prospects of Fisheries and Aquaculture- Aquaculture research organizations- CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA Fishery resources of India – Inland fishery resources and Coastal aquaculture resources– Types of aquaculture practices –Fresh water aquaculture-Monoculture, monosex culture, polyculture, sewage – fed fish culture- Integrated fish culture -Agriculture-cum-fish culture and Animal-Husbandry cum fish culture-Mariculture- pen culture, cage culture and raft culture.	10
II	**Pond Construction and Management** Pond construction– Farm site selection – Topography, soil type, water supply – Designing – construction of fish ponds – Bunds, slope – Berm — Bund formation – Inlet and outlet – Types of ponds – Hatching, Nursery, Rearing and stocking- Pond management –Pre-stocking- Eradication of weeds and predatory fishes - Manual and mechanical, chemical, biological- Addition of lime, fertilizers-Inorganic and organic- Stocking Management- stocking criteria, species combination- stocking density and rate - post- stocking management – harvesting and Marketing.	10
III	**Cultivable Fishes,Prawns and Shrimps** Selection criteria of cultivable fishes- Indian Major Carps – Catla, Rohu, Mrigal – Exotic carps – Silver carp, Grass carp, Common carp – Minor carps – Calbasu, Bata, White carp, Fringe lipped carp – Cat fishes – Singhi, Magur, Pangash – Murrel culture – Snake head murrel, Giant snake head –. Prawn and Shrimp culture – Culture Methods-Extensive, Intensive, Semi- intensive.	9
IV	**Nutrition and Feed Development** Types of feeds –Natural, artificial and Live feeds (Daphnia &Artemia) and their culture techniques Nutritional requirements – protein, carbohydrate, lipids, minerals, vitamins-weight budgeting. Feeding Methods –-Feed formulation (square method)-proximate analysis-feed quality analysis-Qualities of good feed.	9
V	**Reproduction, Transportation and Diseases** Bundh breeding, Induced breeding in fishes – Advantages and disadvantages-Factors influencing induced breeding - Hypophyzation–Hatchery technology for major carps and fresh water prawn -Types-Traditional method using hatching hapa, earthen pot hatchery, glass jar hatchery, eco hatchery– Methods of packing and transportation – open and closed system – Transport of spawn and fry, fingerlings and brood fish-General rules and measures of safe transport. Diseases management – bacterial, fungal, protozoan and viral diseases.	10
References	**Text Books** 1. KamleshwarPandy and J.P. Shukla, 2017. Fish and Fisheries, Rastogi Publication, Meerut. 2. A.K.Pandey and Kalyani Pandey.2014. Elements of Aquaculture and Fishery Biology. Axis Books Pvt. Ltd. New Delhi. 3. Y.S.Chandrasekhar.2014. Fish Nutrition in Aquaculture. Swastik Publications,New Delhi 4. N.M.Chakrabarty, P.P.Chakraborty and S.C.Mondal. 2010. Biology, Breeding and Farming of Important Food Fishes.Narendra Pub. House, Delhi. 5. S.C.Agarwal. 2007. A Handbook of Fish Farming. Narendra Pub. House, Delhi. 6. Q. J. Shammi and S. Bhatnagar. 2002. Applied Fisheries. Agrobios (India)	
	Reference Books 1. Ramachandran Nair.2017. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publishers & Distributors Pvt Ltd.pp.282-302 2. P.C. Thomas, Suresh Ch. Rath and Kanta Das Mohapatra. 2003. Breeding and seed	

	production of Fin Fish and shell fish. Daya pub. House, New Delhi. 3. C.B.L. Srivastava. 1999. A text book of Fishery Science and Indian Fisheries. Kitab Mahal, Allahabad. 4. V.G.Jhingram. 1997. Fish and Fisheries of India, Hindustan Publishing Corporation (India), Delhi. 5. K.P. Biswas. 1992. Prevention and control of fish and prawn diseases. Narendra pub.House, Delhi. pp. 43-69.
	E-Resources 1.http://www.studocu.com/en/document/james-cook-university/introduction- to- aquaculture/lecture-notes/lecture-notes-lecture-all-full-notes/672525/view 2. http://b-ok.xyz/book/614845/az7f54.
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the fishery and aquaculture resources and types of aquaculture practices CO2: Appreciate the importance of pond construction and management. CO3: Familiarize the culture techniques of carps,cat fishes and murrels CO4: Realize the nutrition and feed development techniques. CO5: Recognize the importance of induced breeding, methods of transportation and management of fish diseases.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

Semester	**Third**	Course Code	**24ZOOP03E2**
Course Title	**PARASITOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	-
Category	Elective -Discipline Centric		
Scope of the Course (may be more than one)	1. Learn the types of disease-causing parasites and their adaptations 2. Understand the lifecycle and diseases of protozoan, platyhelminthes and nematode parasites 3. Gain knowledge on treatment methods of parasitic diseases		
Cognitive Levels addressed by the Course	**K1**- Observe the parasite-host relationship **K2**- Analyze the bionomics, lifecycle and control of protozoan parasites **K3**- Know the bionomics, lifecycle and control of platyhelminth parasites **K4**- Apply knowledge on the mode of transmission of parasitic diseases **K5**- Develop interests in the personal hygiene and prevention of parasiticdiseases		
Course Objectives (Maximum:5)	The course aims • to understand the concept of parasitology and human welfare • to learn the life cycle and control of protozoan parasites • to gain knowledge on the lifecycle and control of platyhelminth parasites • to know the medical importance of nematode parasites • to study the transmission and prevention of parasitic diseases		

Unit	Content	No. of Hours
I	**Introduction to Parasites** Introduction to parasites of man, scope and definition of parasites/parasitology- Animal Association- Types of Parasites and Hosts- Mode of transmission of parasite- Host specificity and parasitic adaptation.	10
II	**Protozoan Parasites** Protozoan parasites: Bionomics, life cycle and control –*Trypanosoma, Leishmania, Giardia, Trichomonas, Opalina, Entamoeba, Plasmodium* and *Balantidium*.	10
III	**Platyhelminthes Parasites** Platyhelminthes parasites: Bionomics, life cycle and control – tape worm (*Taenia solium*), liver fluke (*Fasciola hepatica*), blood fluke (Schistosoma), *Echinococcus granulosus, Hymenolepisdiminuta, Diphyllobothrium latum*.	10
IV	**Nematode Parasites** Nematode parasites of Animals: Bionomics, life cycle and control – *Ascaris lumbricoides, Trichuris trichuria, Trichinella spiralis, Ancylostomadeuodenale, Enterobius vermicularis, Wuchereriabancrofti, Loa loa, Dracunculus medinensis.*	9
V	**Arthropod Parasites** Arthropod parasites: Bionomics, life cycle and control –*Phthirus pubis, Cimex species*, Reduvids, black fly, *Glossina*, *Pulexirritans*, *Tabanus*and *Sarcoptes scabiei*.	9
References	Text Books 1. H.S. Singh.2018. Parasitology, Rastogi Publication, Meerut. 2. G.Rathanasamy. 2017 Text book of Medical Entomology and Parasitology. Viswanathan& Co., Publications, Chennai. 3. J. Park and Park. 2013. Social and preventive medicine 22th Edition. 4. Thomas C. Cheng. 2006. General Parasitology, Academic Press, USA 5. C.K. Jayaram Paniker. 1997. Text book of Medical Parasitology. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.	
	Reference Books 1. M.Rahmatullah. 2013. Modern Parasitology, Axis Books Pvt. Ltd. NewDelhi 2. K.N.Sachdev.1983. Medical Parasitology, Jaypee Brothers Medical Pub. New Delhi. 3. Sonlstry, E.J.L. 1965. Text book of Veterinary Clinical Parasitology. F.A. Davis Co.Philadelphia. 4. Asa C. Chandler. 1952 Introduction to Parasitology 8thedition. John Wiley & Sons,Inc. New York. 5. Larry S. Roberts & John Janovy Jr. Foundations of Parasitology 5thedition.	
	E-Resources 1. https://www.ncbi.nlm.nih.gov/books/NBk8262/ 2. https://www.ncbi.nlm.nih.gov/books/NBK8043/	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Understand the parasitology and its interference with human welfare CO2: Realize the importance of protozoan parasites CO3: Learn the parasitic adaptation of platyhelminthes CO4: Understand the life cycle of nematode parasites CO5: Recognize the importance of arthropod parasites	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester	**Third**	Course Code	**24ZOOP03E3**
Course Title	**ANIMAL CELL CULTURE TECHNOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	-
Category	Elective -Discipline Centric		
Scope of the Course (may be more than one)	1. Know the history and advantages of animal cell culture 2. Understand the types of cell culture techniques and basic requirements of animal cell culture 3. Learn the applications of animal cell culture in the prevention of diseases		
Cognitive Levels addressed by the Course	**K1**- Realize the structural organization of animal cells **K2**- Remember the safety, bioethics and good laboratory practices **K3-** Learn the basic in vitro cell culture techniques **K4**- Analyze the viability of cell lines and uses of cell cultured based vaccines **K5-** Evaluate the applications of cell culture in the treatment of cancer and other diseases.		
Course Objectives (Maximum:5)	The course aims • To understand the basic knowledge of animal cell culture. • To learn the types of animal cell culture • To know the equipment, materials and biosafety needed for animal cell culture • To study the establishment of cell lines and assessment of cell viability • To gain knowledge on the uses of animal cell culture in the diagnosis and treatment of diseases.		
Unit	**Content**		**No. of Hours**
I	**Introduction to Animal Cell culture** History- Good Laboratory Practices (GLP)- sterilization methods- types of animal cell culture- biology of cultured cells - advantages and disadvantages of cell culture.		10
II	**Laboratory designing and components** Equipment for cell culture, aseptic technology, safety, bioethics and validation, culture vessels, and substrates – media preparation and its types.		8
III	**Basics *in vitro* techniques** Primary and established cell lines- measurement of cell growth. Disaggregation of primary culture, measurement of viability and cytotoxicity- apoptosis – characteristic features and molecular mechanisms.		10
IV	**Cell culture types:** Epithelial cells –Breast, cervix, liver, colon; Mesenchymal cells –bone and cartilage; neurodermal cells –neurons and glial cells, gonads. Stem cell cultures embryonic and adult stem cells and their applications. Cell cultured based vaccines.		10
V	**Applications of Animal Cell Culture:** Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, IVF Technology, toxicology studies.		10
References	**Text Books** 1.Wahied Khawar Balwan. 2018. Animal Physiology and Biochemistry.Paradise Press, New Delhi.		

	2. Pinkert, C.A. 2012. Transgenic animal technology: a laboratory handbook (2nd ed.): Academic Press. 3. Castilho, L., Moraes, A., Augusto, E., Butler, M. 2008. Animal cell technology: from biopharmaceuticals to gene therapy, (1sted.): Taylor & Francis. 4. Ian Freshney, R.2010. Culture of animal cells: A manual of basic technique and specialized applications, (6th ed.): Wiley-Blackwell. 5. John, R & Masters, W. 2000. Animal cell culture: A practical approach, (3rd ed.): OUP Oxford Publishers. 6. Wilson Aruni, A &Ramadass, P. 2011. Animal tissue culture: MJP Publishers. 7. Davis, J. M. 2011. Animal Cell Culture. John Willy and Sons Ltd. USA.
	Reference Books 1. Freshney R. I. 2005. Culture of Animal Cells. John Willy and Sons Ltd. USA. 2. Butler, M. 2004. Animal Cell Culture and Technology. Taylor and Francis. New York, USA. 3. Verma, A. S. and Singh, A. 2014. Animal Biotechnology. Academic Press, Elsevier, USA. 4. Cartwright, E. J. 2009. Transgenesis Techniques. Humana Press. London, UK. 5. McArthur, R. A. and Borsini, F. 2008. Animal and Translational Models for CNS Drug Discovery. Elsevier. London, UK.
	E-Resources 1. https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978-0- 7503-1347-6ch1 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/
Course Outcomes	On completion of the course, students should be able to
	CO1: Know the basic concept and principles of animal cell culture CO2: Learn the good laboratory management practices in cell culture CO3: Understand the equipments, materials and media needed for cell culture CO4: Differentiate the primary and secondary cell culture CO5: Remember the advantages and applications of animal cell culture

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	3	3	3

Semester	**Third**	Course Code	**24ZOOP03E4**
Course Title	**WILDLIFE CONSERVATION**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Elective -Discipline Centric		
Scope of the Course(may be more than one)	1. Inculcate the importance of wild life conservation 2. Provide theoretical knowledge on wildlife in India and their current management techniques. 3. Gain knowledge on wildlife census and the tools used for wildlife tracking.		
Cognitive Levels addressed by the Course	K1 - Realize the past and present conservation strategies K2 - Remember the nationals parks, sanctuaries and biosphere reserves in India. K3 - Analyze the threats to wildlife and need for special management programme. K4 - Evaluate the major threats to biodiversity and restoration of biodiversity. K5 – Develop interest among students in wildlife conservation, wildlife census and use of remote sensing in wild animals tracking.		

Course Objectives	The Course aims • List the different Wildlife Protection Act and its importance • Summarize different wildlife sanctuaries and their importance in India. • Scrutinize the special management program for wild animals in India • Describe the wildlife conservation approaches and limitations • Wildlife census technique and tracking of wild animals.	
Unit	**Content**	**No. of Hours**
I	**Introduction to wildlife** Biogeographic classification of India. Wildlife management in India - concept - importance - and perspectives. Wildlife ecology and biodiversity - habitat - climate and food availability - Indian forests - characteristics - composition and distribution with reference to major types of vegetation.	9
II	**Wildlife habitat** Characteristics of fauna and adaptation with special reference to tropical forest. Protected area concept - national parks - sanctuaries and biosphere reserves - cores and buffers - nodes and corridors. Community reserve and conservation reserves - management of wildlife distribution status. Habitat utilization pattern - threats to survival of Nilgiri thar, slender loris, musk deer, great Indian bustard and olive ridley turtle.	10
III	**Wildlife in India** Live capturing and marking techniques of birds and mammals. Zoological parks and sanctuaries in India. Threats to wildlife - Wildlife Protection Act (1972) and its amendments. Wildlife wealth of India - threatened wildlife and its depletion in India. Wildlife conservation approaches and limitations - special management program of wild animals in India - project tiger, operation rhino and project elephant.	9
IV	**Wildlife and Biodiversity Conservation** IUCN threat categories - Red Data Book - threats to biodiversity - major causes - extinctions and vulnerability of species to extinction. Strategies for biodiversity conservation - principles of biodiversity conservation - In-situ and Ex-situ conservation strategies - theory of reserve design. Restoration of biodiversity - acceleration of ecological succession - reintroduction of biota.	10
V	**Wildlife tools, techniques and practices** Radio isotopes - radio collaring – GPS – GIS & Remote sensing. Q GIS – Map Info. Wildlife census techniques - objectives - direct and indirect methods. Pug-marking and line transect method - technique - merits and limitations. Bird census methods - call count and point count.	10
References	**Text Books** 1. Bist BS, Joshi R and Pathak K. 2022. A Textbook of Wildlife Conservation and Protected Area Management. Heritage Publishers and Distributors Pvt Ltd. 2. Sodhi NS and Ehrlich PR. 2011. Conservation Biology For All. Oxford University Press. 3. Thomas EA and Harold EB. 2015. Forest Measurements (V Ed.). Waveland Press, Inc. 4. Silvy NJ. 2012. The Wildlife Techniques Manual Management -Vol II. (VII Ed.) The Johns Hopkins University Press, Baltimore. 5. Ranjitsinh MK. 2017. A Life with Wildlife – From Princely India to the Present. HarperCollins.	
	Reference Books 1. Hunter Jr ML and Gibbs J. 2007. Fundamentals of Conservation Biology. Wiley Blackwell Publ. 2. Eric GB and William LR. 2002. Wildlife Ecology and Management (V Ed.). Pearson Publ. 3. Raymond FD. 1964. Wildlife Biology. John Wiley, New York. 4. Silvy NJ. 2012. The Wildlife Techniques Manual Research – Vol I. (VII Ed.). The Johns Hopkins University Press, Baltimore. 5. Agarwala V P, 1980. Forests in India. Oxford and IBH Publishing Co., New Delhi.	

	E-Resources 1.https://wii.gov.in/ 2. https://india.gov.in/wildlife-protection-act-1972-3
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the importance of the wildlife protection Act and management CO2: Evaluate the richness of the species diversity in the different sanctuaries in India. CO3: Analyse the different habitat and species diversity CO4: Assess the present status and recommend the strategy to improve the habitat. CO5: Describe the methods to create awareness about wildlife conservation.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	3	3	3	3
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

ELECTIVE COURSES-GENERIC

Semester	**Second**	Course Code	**24ZOOP02G1**
Course Title	**ORNAMENTAL FISH CULTURE**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	10
Category	Elective Course -Generic		
Scope of the Course (may be more than one)	1. Inculcate the present status and importance of ornamental fish culture 2. Learn the important freshwater ornamental fishes and their characteristics 3. Understand the breeding, management and economics of ornamental fishes		
Cognitive Levels addressed by the Course	**K1-** Create interest among the students on ornamental fish farming **K2**- Know the maintenance of aquarium in home **K3**- Learn the popular freshwater ornamental fishes **K4**- Analyze the methods of breeding, hatching and feeding of ornamentalfishes **K5**- Evaluate the economic importance of ornamental fish farming		
Course Objectives (Maximum:5)	The Course aims • To know the status of ornamental fish culture and design of setting up of fish tank • To familiarize the popular varieties of ornamental fishes and their characteristics • To understand the importance of food and feeding of ornamental fishes • To know the techniques of breeding of aquarium fishes • To understand the economics commercial farming of ornamental fishes		
Unit	**Content**		**No. of Hours**
I	**Overview** Present status of ornamental fish culture in India -Importance of ornamental fish culture. Design and setting up of fish tank**:** Types, construction, accessories and maintenance of home aquarium-Aquarium plants and their uses.		9
II	**Freshwater Ornamental Fish culture** Criteria for the selection of Ornamental fishes -Popular fresh water ornamental fishes and their characteristics – Live bearers – guppy, molly, platy and swordtail – Egg layers- Gold fish, fighter, gourami, angelfish, koi carp, zebrafish.		9
III	**Food and Feeding** Natural &Artificial feeds-Feed formulation and preparation of pelleted feed – Live feed organisms: Daphnia, tubifex& Artemia - Quantity and time of feeding.		9

IV	**Breeding and Disease Management of Aquarium Fishes** Mode of reproduction: Identification of sexes, selection of breeding pair - Breeding of egg layers-gold fish, fighter, angel fish and barbs and live bearers-guppy, molly, platy and swordtail – Care of the fry- Diseases-Parasitic,bacterial, viral, protozoan and fungal.	11
V	**Commercial Farming** Construction and Management of commercial ornamental fish farm: types; Economics of Commercial farming	10
References	**Text Books** 1. K.V.Jayashree, C.S.Thara Devi and N.Arumugam. 2015. Home Aquarium and Ornamental Fish Culture. SaraS Publication,Nagercoil.pp.17-126;421-438. 2. Amita Saxena.2003. Aquarium Management Daya pub. House, New Delhi pp. 87 – 192. 3. C.B.L. Srivastava. 2002. Aquarium fish keeping Kitab Mahal, Allahabad pp. 87-91. 4. Cliff W. Emmens. 1987. A complete guide to Tropical fish, T.F.H. Publishing. pp. 73-97.	
	Reference Books 1. Sagarika Chaudhuri.2017. Economic Zoology. New Central Book Agency(P)Ltd.Kolkotta.pp.554-607.	
	E-Resources 1. http://b-ok.xyz/book/1240495/OeeO8e 2. http://b-ok.xyz/book/2872234/Oa56ed	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Realize the present status and importance of ornamental fish culture CO2: Understand the popular varieties of fresh water ornamental fishes and their characteristics CO3: Realize the need of artificial and live food organisms CO4: Familiarize the breeding techniques of ornamental fishes CO5: Understand the economics of commercial farming	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Second**	Course Code	**24ZOOP02G2**
Course Title	**APPLIED ZOOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	-
Category	Elective Course -Generic		
Scope of the Course (may be more than one)	1.Learn the importance of beneficial and harmful insects 2. Know the potential of aquaculture in economy growth 3. Understand the transmission of diseases by animals and maintenance of livestock for rural entrepreneurs.		
Cognitive Levels addressed by the Course	**K1**- Enable the students to know the scientific ways of farming animals **K2**- Develop interest among students to become self-entrepreneur by animal farming **K3**- Analyze the importance of beneficial insects in producing useful products of human welfare		

	K4- Evaluate the economic importance of livestock, poultry and goat farming **K5**- Understand the theoretical knowledge on maintenance of honey bees, silkworm and earthworms	
Course Objectives	The Course aims • To understand the aquaculture potential, cultivable fish and prawn, culture methods,types of fish ponds and pond construction and management • To understand the beneficial and harmful effects of insects and economic importance of rodents, snakes, bats. • To understand Infectious and communicable diseases • To know important livestock, diseases, parasites, dairy and poultry industries • To understand the importance of apiculture, sericulture and vermiculture	
Unit	**Content**	**No. of Hours**
I	**Aquaculture** Aquaculture potential of India- Cultivable fishes of India- Indian major carps, Exotic carps, cat fishes and murrels- Culture methods- pond construction and Management- Type of fish ponds – Prawn culture and Management.	12
II	**Agricultural Zoology** Beneficial insects: spiders, mantis, ladybird beetle, damsel fly- Harmful insects: migratory locust, rhinocerous beetle, aphids, mosquitoes and cockroach- Economic importance of rodents, snakes, bats.	9
III	**Medical Zoology** Infectious / Communicable diseases: Small pox, hepatitis, AIDS, influenza, tuberculosis, plaque, cholera, amoebiasis, malaria, dengue, chikungunya, trypanosomiasis and Elephantiasis.	9
IV	**Veterinary Zoology** Important Livestock- Cattle, goat, sheep & rabbit Live- Stock diseases- tetanus, anthrax, ranikhet- Live- Stock parasites- helminthes, flies, ticks, lice and mites- Dairy and Poultry industries.	9
V	**Apiculture, Sericulture and Vermiculture** Apiculture- Honey bees- bee hive, management of bee hive, swarming, diseases and honey. Sericulture- Silk moth, Silk farming- Processing Cocoons for raw silk- Other farms of silk- Tussar silk, Muga silk and Erisilk- Diseases- Vermiculture- Important Species of Earthworms.	9
References	**Text Books** 1. Tarit Kumar Banerjee.2017. Applied Zoology.New Central BookAgency(P) Ltd. 2. Pradip. V. Jabde. 2005. Text book of Applied Zoology. 3. Parihar, R.P. 1996 A Text book of Fish Biology and Indian Fisheries. Central pub. House, Allahabad. 3. Banerjee, G.C. 2010. A Text book of Animal Husbandry Oxford & IBH Pub New Delhi. 4. Ashok Kumar and Prem Mohan Nigam. 1991. Economic & Applied Entomology. Emkay Publications, New Delhi. 5. Shukla, G.S and V.B. Upandhyay. 2017. Economic Zoology 5th Rev. Edn. Rastogi Publications, Meerut.	
	Reference Books 1. Gupta, S.K and P.C.Gupta. 2006. General and Applied Ichthyology (Fishand Fisheries). S.Chand & Company, New Delhi. 2. Q.J. Shamni and S. Bhatnagar. 2002. Applied Fisheries, Agrobios (India) 3. Kotpal, R. L.2000. Modern Text book of Zoology. Rastogi publications. 4. Ashok Kumar. 2009. Text book of Animal Diseases Sonali publication.	

	E-Resources 1. b-ok.org/book/610091/eb7967 2. b-ok.org/book/2141454/b57379
Course Outcomes	On completion of the course, students should be able to
	CO1:Understand the types of cultivable fish and prawn, culture methods and types of fish ponds CO2: Recognize the importance beneficial and harmful effects of insects CO3: Understand the importance Infectious and communicable diseases CO4: Learn the important livestock, diseases, parasites CO5: Understand the importance of apiculture, sericulture and vermiculture.

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	2	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Second**	Course Code	**24ZOOP02G3**
Course Title	**ANIMAL BEHAVIOUR**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised,Percentage of revision effected	-
Category	Elective Course -Generic		
Scope of the Course (may be more than one)	1. Classify the different types of behavior 2. Discuss the different parameters used to evaluate the behaviour 3. Explain the social behaviour and its role in anti-predators		
Cognitive Levels addressed by the Course	K1- Develop knowledge on concept of animal behaviour. K2- Know the modes of animal communication. K3- Learn the mechanism of behavioural physiology. K4- Analyze the mechanism of decision making and emotion. K5- Evaluate the relevance of biological clock for human welfare.		
Course Objectives	The Course aims • To know the history and development of ethology. • To understand the modes of animal communication. • To analyze the physiology of behaviour in changing environments. • To know the instinct of learning and mechanism of decision making. • To understand the function of biological clocks.		

Unit	**Content**	**No. of Hours**
I	**History of Animal Behaviour** Founders of ethology - history and development - learned vs innate behaviour - instincts conditioning - habituation and reinforcement. Measuring behaviour - states and events. Measures of behaviour - sampling methods and constructing ethograms.	10
II	**Animal Communication** Modes of communication - advantages and disadvantages - functions of communication - types of signals. Finding food - foraging strategies - generalists vs specialists - marginal value theorem and patch residence time. Finding shelter - habitat selection - territoriality - dispersal and migration.	10
III	**Behavioral Physiology** Coordination and Orientation, Homeostasis and Behavior, Physiology and Behavior in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.	10

IV	**Mental activities** Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of honey bees, Evolutionary optimality, Mechanism of Decision making. Mentality of Animals: Languages and mental representation, non-verbal communication in human, mental images, Intelligence, tool use and culture, Animal awareness and Emotion.	9
V	**Biological Clock** Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chrono pharmacology, chrono medicine, chronotherapy.	9
References	**Text Books** 1. Alcock J. 2005. Animal Behaviour: An Evolutionary Approach. (VIII Ed.). Sinauer Associates Inc. 2. Davies NB, Krebs JR and West SA. 2012. An Introduction to Behavioural Ecology. (IV Ed.). Wiley-Blackwell Publ. 3. Cloudsley - Thompson. JL. 1961. Animal Behaviour. McMillan Publ. 4. Tinbergen N. 2014. Social Behavior in Animals with Special Reference to vertebrates. Martino Fine Books. 5. Shukla JP. 2021. Fundamentals of Animal behavior. Atlantic Publ.	
	Reference Books 1. Manning A and Dawkins MS. 2016. An Introduction to Animal Behaviour. (VI Ed.). Cambridge University Press. 2. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp. 3. Vinod Kumar, 2002. Biological Rhythms. Narosa Publishing House, Delhi. 4. Simmons P and Young D. 2010. Nerve cells and Animal Behaviour. Cambridge University Press. 5. Morgan CL. 2019. Animal behavior. Alpha Edition.	
	E-Resources 1. https://www.stlzoo.org/about/blog/2018/06/11/eyes-dont-have-it-using- technology observe-animal-behavior 2. https://www.sciencedirect.com/science/article/abs/pii/S0003347200916063	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Recall and record genetic basis and evolutionary history of behaviour. CO2: Analyse and identify innate, learned and cognitive behaviour and differentiate between various mating systems. CO3: Classify movement and migration behaviours and explain environmental influence upon behaviour. CO4: Illustrate the different sampling methods for different behaviour in population. CO5: Design and develop the procedure for sampling the data and analysis.	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

MODULAR COURSES

Semester	**Third**	Course Code	**24ZOOPO3M1**
Course Title	**ADVANCED MOLECULAR TECHNIQUES**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected(Minimum 20%)	20
Category	Modular Course		
Scope of the Course (may be more than one)	1. Inculcate the principle and applications of chromatographic and spectrophotometric techniques 2. Learn the separation of proteins by electrophoresis 3. Understand the amino acid sequencing and blotting techniques		
Cognitive Levels addressed by the Course	**K1 -**Realize the scope and applications of different molecular techniques **K2 -** Compare the native PAGE and SDS PAGE analysis **K3 -** Gain knowledge of DNA microarray techniques **K4 –** Realize the importance of PCR amplification in disease diagnosis **K5 –** Understand the mapping of genome in forensic studies		
Course Objectives (Maximum:5)	**The course aims** • to give knowledge on working principle and applications of electrophoresis techniques • to develop interest to acquire latest information on molecular sequencing and its applications • to make knowledge on PCR techniques and its applications • to impart in-depth knowledge on chromatographic and spectrophometric techniques and their uses • to create interest on the importance of genome sequencing and physical mapping analysis		
Unit	**Content**		**No. of Hours**
I	**Chromatographic and Spectrophotometric techniques** Principle and applications of Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC). Principle and applications of Atomic Absorbance Spectra (AAS), Infra –red (IR) Spectra and LC-MS technique.		9
II	**Electrophoresis:** Principle and application of paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE) and Immuno-electrophoresis.		9
III	**Molecular Sequencing** Amino acid sequencing and analysis -MALDI-TOF, DNA sequencing – Enzymatic & chemical methods and new generation sequencing – 16S & 18S rRNA sequencing. Blotting techniques – Southern, northern, western and Dot blots. Microarray techniques – oligonucleotide array and cDNA array and its applications.		10
IV	**PCR techniques** Principle and applications- types of PCR - enzymology- primer types-methods. PCR amplification for Detection of mutation, monitoring cancer therapy, detect bacterial & viral infections, sex determination of prenatal cells, linkage analysis in sperm cells and studies on molecular evolution.		10
V	**Molecular mapping of genome** Physical mapping and map -based cloning – choice of mapping population & simple sequence repeat loci – southern and fluorescence in situ hybridization for genome analysis - chromosome microdissection and microcloning - molecular markers in genome analysis (RFLP, RAPD, and AFLP analysis) – molecular markers linked disease resistance genes – application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, varietal analysis, animal trafficking and poaching - germplasm maintenance and taxonomy. Molecular mapping of genome.		10
References	**Text Books** 1. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.		

	2. James.D.Watson, Michael Gilman, Jan Wit Koeski and Mark Zuller, 2001. Recombinant DNA. IInd Ed. Scientific American Book, New York. 3. B. Lewin 2000. Genes VII Oxford University Press. 4. E.J. Gardener*et al.*,. 1991. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York.
	Reference Books 1. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani. 2. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi. 3. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press. 4. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore 5. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.
	E-Resources 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html
Course Outcomes	On completion of the course, students should be able to
	CO1: Outline the working principle and applications of electrophoresistechniques CO2: Explain molecular sequencing techniques CO3: Discuss PCR techniques and their applications CO4: Uses of chromatographic and spectrophotometric techniques CO5: Demonstrate methods involved for genome sequencing and physical mapping

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1	2	2
CO2	2	2	1	2	2
CO3	2	2	1	2	2
CO4	2	2	1	2	2
CO5	2	2	1	2	2

Semester	**Third**	Course Code	**24ZOOP03M2**
Course Title	**BIOINFORMATICS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	
Category	Modular Course		
Scope of the Course (may be more than one)	1. Understand the basics of bioinformatics 2. Learn the analysis of sequence by computational methods 3. Know the importance of protein and nucleic acid databases		
Cognitive Levels addressed by the Course	**K1 -**Analyze the various tools used in bioinformatics **K2 -** Realize the use of computer in biological applications **K3 -** Gain knowledge on detecting DNA polymorphisms **K4 -** Realize the importance of molecular docking analysis **K5 -** Understand the significance of protein databases		

Course Objectives (Maximum:5)	The course aims • to study on Bioinformatics, microbial genomics and proteomics • to understand genome analysis, sequence analysis and protein analysis • to explain the tools used in Bioinformatics • to impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations • to know computational biology	
Unit	**Content**	**No. of Hours**
I	**Whole genome analysis** Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing.	9
II	**Sequence analysis** Computational methods, homology algorithms (BLAST) for proteins and nucleic acids. PROSITE, PEAM and Profile Scan.	10
III	**Databases Analysis** Use of internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB).	9
IV	**DNA microarray and general Analysis** DNA microarray printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for global patterns of gene expressions using fluorescent labeled DNA or end labeled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.	10
V	**Protein analysis and Proteomics** Sequence analysis of individual protein spots by mass spectroscopy. Protein microarray. Advantages and disadvantages of DNA and protein microarrays. Introduction to docking.	10
References	**Text Books** 1. Read, TD., Nelson, KE., Fraser, CH. 2004. Microbial Genomics. Humana Press Inc., USA. 2. Rashidi, H.H. and Buchler, L.K. 2002 Bioinformatics Basics:Applications in Biological Science and Medicines, CRC Press, London 3. Stephen P. Hont and Rick Liveey (OUP) 2000. Functional Genomics, A practical approach.	
	Reference Books 1. Perysju, Jr. and Peruski 1997. The Internet and the New Biology: Tools for Genomic and molecular Research. 2. Mark Schena (OUP). DNA Microarrays, A practical approach	
	E-Resources 1. https://www.bioinformatics.org 2. bioinformaticsonline.com 3. www.ii.uib.no/~inge/list.html	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Evaluate whole genome analysis methods CO2: Apply the computational tools used for sequence analysis tools CO3: Demonstrate the use of internet in data analysis CO4: Acquire knowledge on DNA microarray techniques CO5: Familiar with the different methods of protein analysis	

Mapping of COs with PSOs

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	3	3	2
CO3	3	2	3	3	3
CO4	3	2	3	3	2
CO5	3	3	3	3	2

Semester	**Fourth**	Course Code	**24ZOOP04M1**
Course Title	**RURAL ENTERPRENEURSHIP**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Modular Course		
Scope of the Course (may be more than one)	1. Understand the importance of biogas technology 2. Learn the effective way of utilization of vermicompost 3. Field observation of mushroom farms, spirulina industries and fish farms		
Cognitive Levels addressed by the Course	**K1 -**Create awareness on utilization of bioresources for rural economy **K2 -** Remember the scope and applications of biogas and vermiculture technology **K3 -** Gain knowledge on mushroom cultivation **K4 -** Assess the techniques for spirulina cultivation **K5 -**Analyze the importance of biotechnology in enhancing rural economy		
Course Objectives (Maximum:5)	**The course aims** • to create interest on the fundamentals of biogas technology • to expose the technologies related to composting • to impart information on scope of mushroom culture technology • to impart knowledge on *Spirulina* cultivation technology • to know Ornamental fish culture technology		
Unit	**Content**		**No. of Hours**
I	**Biogas technology** Introduction and history – anaerobic digestion – microbes involved – factors influencing methane production – Stages of methane generation – Wastes used in methanogenesis – various bioreactors used for methane generation – Advantages and disadvantages.Visit to biogas production units with field demonstration.		10
II	**Composting technology** Historical background – waste availability – factors influencing – methods-biomaturity- enrichment of compost and crop productivity. Vermiculture technologies-species of earthworm– life cycle – methods – different types of waste suitable for vermicomposting. Utilization of vermicompost for crop production. Visit to vermicompost industries with field demonstration.		10
III	**Mushroom technology** Bioconversion of organic wastes into protein - Oyster mushroom technology, paddy mushroom technology, milky mushroom and button mushroom technology, post-harvest technology. Mushroom farming and prospects. Visit to mushroom farms with field demonstration.		10
IV	***Spirulina* cultivation technology** Biology of *Spirulina* - cultivation methods, post-harvest technology and single cell protein formulation. Visit to *Spirulina* industries with field demonstration.		9
V	**Ornamental Fish culture** National and International status -Importance – Selection of Ornamental fishes –Commercially important fresh water and Marine ornamental fishes -Setting and Maintenance of aquarium tanks-Kinds of feedsand feeding methods – breeding techniques – gold fish, angel fish, fighter, guppy, molly, platy, zebrafish and sword tail – Economics.		9
References	**TextBooks** 1. Tripati, G. 2003. Vermiresources technology, 1st Ed., Discovery Publication House, New Delhi. 2. Anita Saxena, 2003. Aquarium management. Daya Pub. House, New Delhi. 3. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd.,New		

	Delhi. 4. Kumar, H.D., 1991. A Textbook on Biotechnology, II Edition, East-west Press Pvt. Ltd., New Delhi. 5. Chawla O.P. 1986. Advances in Biogas Technology, ICAR, New Delhi.
	Reference Books 1. Srivastava, C.B.L, 2002. Aquarium fish keeping. Kitab Mahal, Allhabad. 2. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 3. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific, Singapore. 5. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi 6. Bahl, N. 1988. Handbook on mushrooms. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
	E-Resources 1. https://www.eesi.org 2. https://agritech.tnau.ac.in/org_farm/orgfarm_composting.html 3. https://www.rpcau.ac.in 4. https://www.techno-preneur.net 5. https://www.ncdc.in/
Course Outcomes	On completion of the course, students should be able to
	CO1: Evaluate the different aspects of biogas production technology CO2: Discuss the different types of composting technologies and how to establish a composting unit CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: Summarize Spirulina cultivation by low-cost method CO5: Understand the culture technique of different ornamental fish and establish an aquarium farm

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	1	3
CO2	3	3	1	1	3
CO3	3	3	1	1	3
CO4	3	3	1	1	3
CO5	3	3	1	1	3

Semester	**Fourth**	Course Code	**24ZOOP04M2**
Course Title	**BIONANOTECHNOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	-
Category	Modular Course		
Scope of the Course (may be more than one)	1. Inculcate the principle and scope of bionanotechnology 2. Know the types, synthesis methods and characterization of nanoparticles 3. Enable to know to the biological applications of nanoparticles		
Cognitive Levels addressed by the Course	**K1**- Create basic knowledge on nanotechnology **K2-** Know the methods of synthesis of nanoparticles **K3**- Remember the different characterization techniques of nanoparticle **K4**- Evaluate the structural and biological properties of nanomaterials **K5-** Assess the applications of nanoparticles in different fields		
Course Objectives	The Course aims • to acquire broad knowledge on basic concepts, areas, importance, scope, current scenario and		

	prospects of nanotechnology • to understand the synthesis of nanoparticles using different methods. • to know the different equipments used for characterization of nanoparticles and their importance. • to understand the types and properties of nanoparticles. • to know the applications of nanotechnology in various fields.	
Unit	**Content**	**No. of Hours**
I	**Introduction** Origin and concepts- Basics and basis-Emerging areas of nanotechnology Importance of Nanoscience and Nanotechnology- Milestones in Nanotechnology-Scope and Current Scenario and future prospects of Nanotechnology.	9
II	**Synthesis of Nanoparticles** Physical methods-mechanical-High energy Ball Milling, Melt Mixing-Evaporation-physical vapour deposition, Ionized cluster beam deposition, Lazar vaporization and pyrolysis- Sputter deposition- Chemical – Colloidal, microemulsion, sol-gel, hydrothermal, sonochemical and microwave and biological -Using microorganisms, plant extracts, proteins and DNA.	10
III	**Characterization of Nanoparticles** Equipments used for characterization and their uses- Ultra violet – Visible Spectroscopy, Scanning Electron Microscope, Scanning Probe Microscope, Transmission Electron Microscope,Energy Dispersive X – Ray Spectroscopy, Fourier Transform Infrared Spectroscopy,X-Ray Diffraction,Dynamic Light Scattering,Vibrating Sample Magnetizer, Zeta Potential.	10
IV	**Types of nanomaterials** Types and their properties- Clusters- Types of clusters -Micro, small, large -Types of magnetic materials – Properties – Structural and mechanical.	9
V	**Application of Nanotechnology** Application-Energy, textiles, domestic appliances, cosmetics,medicine-imaging, drug delivery, cancer diagnosis and therapy, tissue repair- nanobiosensor-Types- electrical, electrochemical, nanowire, viral, nano shell and nanotubes-Agriculture and food – Livestock – Aquaculture – Environment.	10
References	**Text Books** 1.Rishabh Anand. 2017.Essentials of Nanotechnology. First Edition. MEDTECH -A Division of Scientific International,New Delhi 2. Sulabha K.Kulkarni. 2014. Nanotechnology – Principles and Practices. Third Edition. Capital Publishing Company,Kolkotta. 3. S.Shanmugam. 2011. Nanotechnology. MJP Publishers, Chennai 4. Subbiah Balaji. 2010. Nanobiotechnology. MJP Publishers, Chennai 5. P.K.Sharma. Prospects of Nanotechnology. Vista International Publishing House, Delhi.	
	Reference Books 1. D.P.Kothari, V.Velmurugan and Rajit Ram Singh.2018.Nanotechnology and Nanoelectronics. Narosa Publishing House Pvt Ltd. New Delhi 2. Yashwanth Kumar.2017. An Introduction to Nanobiotechnology. Book Enclave Publishers and Exporters, Jaipur	
	E-Resources 1. https://onlinelibrary,wiley.com 2. https://www.Sciencedirect.com 3. https://www.Cambridge.org 4. https://www.nanowork.com 5. https://core.ac.uk	

Course Outcomes	On completion of the course, students should be able to
	CO1: Acquire the basics of nanobiotechnology and appreciate the importance, current scenario and future prospects of nanotechnology CO2: Acquire knowledge on the methods of synthesis of nanoparticles and their Advantages CO3: Realize the importance of different equipments used for the characterization of nanoparticles CO4: Understand the types and properties of nanoparticles CO5: Learn the applications of nanotechnology in different fields

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester	**Fourth**	Course Code	24ZOOPO4M3
Course Title	**INTELLECTUAL PROPERTY RIGHTS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	-
Category	Modular Course		
Scope of the Course (may be more than one)	1. Know the basic concepts and need for intellectual property 2. Understand about copyrights, trademarks and registration of IPRs 3. Learn the criteria of patentability and patentability of biological inventions		
Cognitive Levels addressed by the Course	**K1 -**Realize the importance of IPR **K2 -**Analyze the practical aspects of copyright registration **K3 -**Analyze the patentability of biological materials **K4 -** Assess the protection of biological resources through patenting **K5 -** Evaluate the legal protection of biological inventions		
Course Objectives (Maximum:5)	**The Course aims** • to evaluate knowledge on Intellectual property Rights • to understand the Copyright and Trademarks and Registration of IPRs • to evaluate the process of Patents & Patentability • to analyse the details of various process of IPR in Life Sciences		
Unit	**Content**		**No. of Hours**
I	**Introduction to IPRs** Basic concepts and need for Intellectual property- Patents, Copyrights, Geographical Indications, Nature of Intellectual Property, Industrial Property, technological Research. Introduction to Intellectual property – Invention and Creativity – Importance – Protection of IPR		10
II	**Copyright and Trademarks and Registration of IPRs** Copy right – definition, protection, related rights, distinction between related rights and copyrights. Nature of copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings. Trade mark – definition, rights, kind of signs, types of trademarks, protection and registration.		10
III	**Patents** Introduction to Patents – Patentability criteria - Novelty, Non-obviousness		

	and industrial applicability - The Patent Act, 1970 – Inventions not patentable – Patent specifications: Provisional and complete - Types of patent applications – compulsory licensing – Patent application Forms and fees –Patent search- Types.	9
IV	**Patentability** Patents - elements of patentability- Novelty- Non -obviousness (Inventive Steps). Industrial Application - Non-patentable subject matter - Registration procedure, rights and duties of patentee, assignment and license, restoration of lapsed patents, surrender and revocation of patents, infringement, remedies &penalties.	10
V	**IPR in Life Sciences** Patentability of Biotechnology Inventions - Protection of Genetic Resources - Patenting of seeds-moral issues in patenting biotechnological inventions – case studies on biotechnology patents. Legal protection of biotechnological inventions. Patenting of basmati rice in USA, case study of Glyphosate tolerance, betaine production and revocation of neem and turmeric patents.	9
References	Text Books 1. Deborah E. Bouchoux.2012. Intellectual:The Law of Trademarks, Copyrights, Patents and Trade secrets, Cengage Learning. Third Edition, 2. Prabuddha Ganguli.2011. Intellectual Property Rights: Unleashing the knowledgeEconomy. McGraw Hill Education, 3. Edited by Derek Bosworth and Elizabeth Webster.2013. The Management of Intellectual Property. Edward Elgar Publishing Ltd. 4. Baine. 2007. Biotechnology from A to Z, Agrobios, New Delhi. 5. Barum. 2006. Biotechnology, Thompson Publishers, New Delhi. 6. Chawla, H.S. 2007. Introduction to Plant Biotechnology. Oxford and IBH publishing Co (P) Ltd.New Delhi.	
	Reference Books 1. Prabuddha Ganguli. 2017. Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education 2. R. Radhakrishnan and S. Balasubramanian.2008. Intellectual Property Rights:Text and Cases. Excel books 3. B.L. Wadehra.2016. Law relating to Intellectual Property, 2011. Universal Law Publishing – An imprint of LexisNexis, 5th Edition 4. Verma, S.K and Mohit Verma. 2010. Textbook of Plant Physiology,Biochemistry and Biotechnology. S.Chand and Co. New Delhi. 5. P.Narayanan. 2010.Law of Copyright and Industrial Designs; Eastern law House, Delhi, 6. T. M Murray and M.J. Mehlman, (2000). Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons	
	E-Resources 1. Subramanian, N., & Sundararaman, M. 2018. Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf 2.World Intellectual Property Organization. 2004. WIPO Intellectual propertyHandbook.Retrieved from https://www.wipo.int/edocs/pubdocs/en/intpropert y/4 89/wipo_pub _489.pdf	
Course Outcomes	On completion of the course, students should be able to	
	CO1: Gain knowledge on Intellectual property Rights CO2: Understand the Copyright, Trademarks and Registration of IPRs CO3: Evaluate the process of Patents CO4 Recognize the importance of Patentability CO5: Analyze the details of various process of IPR in Life Sciences	

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1
CO2	1	1	3	3	2
CO3	1	2	1	3	1
CO4	2	1	2	3	2
CO5	1	3	1	3	1

HUMAN VALUES AND PROFESSIONAL ETHICS Credits:2
(Offered by the Department of Gandhian Thought and Peace Science, GRI-DU,Gandhigram)

VALUE ADDED COURSES

Semester	**Second**	Course Code	**24ZOOP0VA1**
Course Title	**SERICULTURE**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Value Added Course		
Scope of the Course(may be more than one)	1. Classify the different types of silk fibers 2. Discuss the cultivation of mulberry and management of pests 3. Explain the processing of silk and recovery of byproducts		
Cognitive Levels addressed by the Course	K1- Develop knowledge on sericulture. K2- Know the procedure of silkworm rearing. K3- Learn the mechanism of reeling silk and harvesting of silk. K4- Analyze the methods of disinfecting the sericulture houses. K5- Evaluate the economic importance of silkworm.		
Course Objectives	The Course aims • To know the history and development of sericulture. • To understand the propagation of mulberry leaves. • To analyze the life cycle of silkworm. • To know the commercial production of silk. • To understand the harvesting methods of silk.		

Unit	**Content**	**No. of Hours**
I	**History and Development** History, development, status, characteristics and advantages of sericulture in India. Introduction to textile fibers; types- natural and synthetic fibers; sources of silk fiber- Tasar, Muga, Eri,Anaphe, Gonometa, Fagara, spider and mussel; properties and importance of silk fiber.	10
II	**Moriculture** Host plants; Moriculture- distribution, morphology, propagation- seedling, cutting, grafting, layering and micropropagation methods, maintenance- irrigation, manuring and pruning, pests and diseases of mulberry.	10
III	**Life cycle of silkworm** *Bombyx mori*- morphology, anatomy, life cycle, geographical locations, larval moults, voltinism, indigenous and commercial races. Diapause. Egg-storage and transportation.	9
IV	**Silk Processing** *Bombyx mori*- morphology, anatomy, life cycle, geographical locations, larval moults, voltinism, indigenous and commercial races. Diapause. Egg-storage and transportation. Rearing houses and equipment. Rearing operations- disinfection, brushing, feeding and spacing. Moulting and spinning. Harvest. Rearing methods-	10

	chawki, lasso, showa, shelf-rearing, floor-rearing and shoot rearing. Diseases of *Bombyx mori*- protozoan, bacterial, viral and fungal. Pests of silkworm- Uzi fly, desmestids, mites, ants, nematodes, aves and mammals.	
V	**Commercial processing of Cocoon** Physical and commercial characteristics of cocoons. Cocoon harvesting-Cocoon sorting, stifling, deflossing, riddling, cooking, brushing, reeling and re-reeling. Weaving.and marketing. By-products of sericulture industry.	9
References	**Text Books** 1. G. Ganga and J. Sulochana Chetty. 2019. An introduction to sericulture, 2nd edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 2. M. Johnson and M. Kesary. 2019. Sericulture, Saras publication, Tamil Nadu. 3. Singh, Amardev & Ravinder Kumar. 2013. Sericulture handbook Vol 1, Biotech. 4. M. Madan Mohan Rao. An Introduction to Sericulture, 2nd edition, BS Publications. 5. K.K. Nayar, T.N. Ananthakrishnan& B.V. David.1996. General& Applied Entomology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.	
	Reference Books 1. P.K. Sehgal. 2018. Entomology -An Illustrated Textbook, New India Publishing Company, New Delhi.pp.243- 276. 2. Ashok Kumar & Prem Mohan Nigam. 1991 Economic & Applied Entomology Emkay Publications, Delhi. 3. Lalit kumar Jha.1987. Applied Agricultural Entomology. New Central Book Agency, Calcutta. 4. A.D. Imms. 1965. A General Text Book of Entomology, 9th edition. ELBS Edition, Great Brittan. 5. M.S.NalinaSundari and R.Santhi.2017.Entomology.MJP Publishers, Chennai.pp.133-238;241-257;291-338.	
	E-Resources 1. https://agritech.tnau.ac.in/sericulture/ 2. https://csb.gov.in/	
Course Outcomes	On completion of the course, students should be able to	
	CO1: To understand the various practices in sericulture. To know the needs for sericulture and the status of India in global market. CO2: Able to apply the techniques and practices needed for sericulture. CO3: To know the difficulties in sericulture and be able to propose plans against it. CO4: Illustrate the processing of cocoon and silk. CO5: Inculcate the economic importance of sericulture.	

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	Second	Course Code	**24ZOOP0VA2**
Course Title	**POULTRY FARMING**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Value Added Course		
Scope of the Course (may be more than one)	1. Classify the methods of poultry farming 2. Discuss the management of chicks 3. Explain the feed management and methods of feeding		
Cognitive Levels addressed by the	K1- Develop knowledge on poultry farming. K2- Know the management of growers and broilers.		

Course	K3- Learn the principles of feeding chicks. K4- Analyze the poultry diseases and vaccination programme. K5- Evaluate the sexing of chicks and egg testing.	
Course Objectives	The Course aims • To know the general principles of poultry housing. • To understand the management of chicks. • To analyse the nutritive requirements of chicks and feeding methods. • To know the commercial production of eggs. • To understand the handling of chicks and methods of hatching.	
Unit	**Content**	**No. of Hours**
I	**Introduction to Poultry** General introduction to poultry farming - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming.	9
II	**Rearing of Chicks** Management of chicks - growers and layers - Management of Broilers - Preparation of project report for banking and insurance.	10
III	**Poultry Feed** Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.	10
IV	**Care and Management** Selection, care and handling of hatching eggs - Egg testing. Methods of hatching- Brooding and rearing - Sexing of chicks - Farm and Water Hygiene - Recycling of poultry waste.	10
V	**Poultry Diseases** Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.	9
References	**Text Books** 1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi 2. 2. Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition.Biotech Books, New Delhi. 3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow. 4. S.Sarkar, G.Kundu and K.K.Chaki. 2016.Introduction to Economic Zoology. New Central Book Agency(P) Ltd. Kolkotta. pp.33-151;205-220;404-515. 5. Jeyasurya,N.C. Nair,N.SoundaraPandian,A.Thangamani,L.M.Narayanan, N. Arumugam, S. LeelavathiandT.Murugan-2017-Economic Zoology. Saras Publication, Nagercoil.	
	Reference Books 1. G.S.Shukla and V.B.Upadhyay-2017-Economic Zoology-Rastogi Publication, Meerut. 2. Sagarika Chaudhuri. 2017. Economic Zoology. New Central Book Agency (P) Ltd, Kolkotta.641-677. 3. N.Arumugam,T.Murugan,J.JohnsonandP.RamPrabhu,Applied Zoology-2017- Saras Publication, Nagercoil. 4. ArvindKumar.Verms &Vermitechnology, APH PubCorporation, New Delhi, 2005 5. T.V.Sathe. Vermiculture and Organic Farming Daya Pub. Home, Delhi.2004.	
	E-Resources 1.https://swayam.gov.in/nd2_nou19_ag09/preview 2. http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf	
Course Outcomes	On completion of the course, students should be able to	
	CO1: To understand the various practices in Poultry farming. To know the needs for Poultry farming and the status of India in global market. CO2: To be able to apply the techniques and practices needed or Poultry farming. CO3: To know the difficulties in Poultry farming and be able to propose plans against it.	

	CO4: Illustrate the prevention of poultry diseases and vaccination programmes. CO5: Inculcate the methods of recycling poultry wastes.

Mapping of Cos with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester	**Second**	Course Code	**24ZOOP0VA3**
Course Title	**DAIRY FARMING**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Value Added Course		
Scope of the Course (may be more than one)	1. Classify the types of dairy breeds 2. Discuss the management of cattle 3. Explain the feed management and methods of feeding		
Cognitive Levels addressed by the Course	K1- Develop knowledge on dairy farming. K2- Know the housing and management of cattle. K3- Learn the principles of feeding dairy cattle. K4- Analyze the diseases and vaccination programme. K5- Evaluate the composition of milk and milk products.		
Course Objectives	The Course aims To know the general management of cattle. To understand the model dairy houses. To analyse the nutritive requirements of cattle. To know the composition of milk and milk products. To understand the diseases of cattle and their management.		

Unit	**Content**	**No. of Hours**
I	**Introduction to Dairy Farming** General Anatomy - Importance of dairy- Breeds of cattle-Indigenous and exotic - Selection of cattle - Breeding-artificial insemination- Management	9
II	**Dairy Housing** Construction of Model Dairy House - Types - Different Managemental Parameters - Winter and Summer Management.	9
III	**Feed Management** Feedstuffs available for cattle - Roughages -Concentrates - Energy rich concentrates - Protein rich concentrates - Mineral Supplements - Vitamin Supplements - Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant animals - Feeding pregnant heifer.	10
IV	**Milk and Milk Products** Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Income and employment.	10
V	**Cattle Diseases** Contagious disease - Common Bacterial, Protozoan, Viral and Helminth Diseases - Vaccination - Biosecurity.	10
References	**Text Books** 1. The Veterinary Books for Dairy Farmers by Roger W. Blowey. 2. Hand Book of Dairy Farming by Board Eiri. 3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990	

	4. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai. 5. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.
	Reference Books 1. James. N. Marner, 1975. Principles of dairy processing, Wiley eastern limited, New Delhi. 2. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.
	E-Resources https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Tata,+S.N.,+ed%22
Course Outcomes	On completion of the course, students should be able to
	CO1: To understand the various practices in dairy farming. To know the needs for Dairy farming and the status of India in global market. CO2: To be able to apply the techniques and practices needed for dairy farming. CO3: To know the difficulties in dairy farming and be able to propose plans against it. CO4: Illustrate the prevention of poultry diseases and vaccination programmes. CO5: Inculcate the methods of recycling poultry wastes.

Mapping of COs with PSOs

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3