

M.Sc., ZOOLOGY

SYLLABUS (with effect from July 2021)

**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	21ZOOP0101	Animal Diversity I – Invertebrata	4	4	-	3	40	60	100
	21ZOOP0102	Animal Diversity II – Chordata	4	4	-	3	40	60	100
	21ZOOP0103	Environmental Biology@	4	4	-	3	40	60	100
	21ZOOP0104	Molecular Biology#	4	4	-	3	40	60	100
	21ZOOP0105	Animal Diversity I & II –Practicals	2	-	4	3	60	40	100
	21ZOOP0106	Environmental Biology – Practicals	2	-	3	3	60	40	100
	21GTPP0001	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	21ZOOP0207	Biochemistry & Animal Physiology@	4	4	-	3	40	60	100
	21ZOOP0208	Entomology	4	4	-	3	40	60	100
	21ZOOP0209	Cell Biology & Genetics	4	4	-	3	40	60	100
	21ZOOP0210	Biostatistics	4	4	-	3	40	60	100
	21ZOOP0211	Biochemistry & Animal Physiology –Practicals	2	-	4	3	60	40	100
GE	-	Elective : Generic	3	3	-	3	40	60	100
	21ENGP00C1	Communication and Soft Skills	2	2	-	-	50	-	50
	21ZOOP0212	Summer Internship	1	-	-	-	50	-	50
		Total credits	24						

THIRD SEMESTER									
	Course code	Course Title	C	L	P	E	CFA	ESE	Total
CORE COURSES	21ZOOP0313	Bioinstrumentation and Research Methods @	4	4	-	3	40	60	100
	21ZOOP0314	Evolution	4	4	-	3	40	60	100
	21ZOOP0315	Developmental Zoology & Immunology@	3	3	-	3	40	60	100
	21ZOOP0316	Instrumentation Techniques – Practicals	2	-	4	3	60	40	100
EDC	21ZOOP04EX	Elective : Discipline Centric	3	3	-	3	40	60	100
MC	21ZOOP03MX	Modular course	2	2	-	-	50	-	50
VPP	21EXNP03V1	Village Placement Programme	2	-	-	-	50	-	50
	21Z00P0317	Field Visit	2	-	-	-	50	-	50
		Total credits	22						

FOURTH SEMESTER									
	Course code	Course Title	C	L	P	E	CFA	ESE	Total
CORE COURSES	21ZOOP0418	Fundamentals of Microbiology	4	4	-	3	40	60	100
	21ZOOP0419	Animal Biotechnology & Genetic Engineering	4	4	-	3	40	60	100
	21ZOOP0420	Economic Zoology	4	4	-	3	40	60	100
	21ZOOP0421	Fundamentals of Microbiology-Practicals	2	-	4	3	60	40	100
MC	21ZOOP04MY	Modular course	2	2	-	-	50	-	50
		Human Value and Professional Ethics	2	2	-	-	50	-	50
	21Z00P0422	Dissertation	6	12	-	-	75	75*+ 50**	200
		Total credits	24						
		Overall credits 92							

# Courses may 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(3credits)	List of Modular Courses(2 Credits)
21ZOOP03E1 Aquaculture	18ZOOP03M1 Advanced Molecular Techniques
21ZOOP03E2 Parasitology	18ZOOP03M2 Bioinformatics
21ZOOP03E3 Animal Cell Culture Technology	18ZOOP04M1 Rural Biotechnology
List of Generic Elective Courses (3 Credits)	18ZOOP04M2 Bionanotechnology
21ZOOP02E1 Ornamental Fish Culture	
21ZOOP02E2 Applied Zoology	

OBE Elements for Zoology Programme

Name of the Programme	M.Sc., ZOOLOGY				
Year of Introduction				Year of Revision	2021
Semester -wise Courses and Credit Distribution	I	II	III	IV	Total
No. of Courses	7	8	8	7	30
No.of Credits	22	24	22	24	92

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 indepth understanding and awareness of relevant theories, concepts and principles of zoology

PO6:Explicate the environmental interrelationships of life on earth and relate to Physicalfeatures of the environment to the population and community structure andecosystem.

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 pattern, 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	21ZOOP0101
Course Title	ANIMAL DIVERSITY I - INVERTEBRATA		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised	If revised, Percentage of revision effected (Minimum 20%)	
Category	Core Course		
Scope of the Course (may be more than one)	1. Understand the diversity of invertebrate animals 2. Know the different specialized structures of animals belonging to different phyla 3. Learn the economic importance of invertebrates		
Cognitive Levels addressed by the Course	K1-Classification of different phyla K2- Make the students to understand the important invertebrates and its salient features K3-Application of various theories and concepts in invertebrata K4-Analyze the structure and functions of special organs K5- Economic values of invertebrates		
Course Objectives	The Course aims <ul style="list-style-type: none"> • to know the International nomenclature and classification of different phyla up to classes • to able to know the feeding, locomotion and reproduction of animals • to familiarize the morphological and physiological adaptations of animals • to understand the phylogeny, larval forms and metamorphosis of insects • to understand the structural similarities, fossils and economic importance of Invertebrates 		
Unit	Content	No. of Hours	
I	Brief Introduction Classification - Broad outline - International code of Zoological nomenclature - Organization of coelom - Acoelomates - Pseudocoelomates - Coelomates: Protostomia and Deuterostomia - Classification of phylum (upto classes) - Protozoa - Amoeba; Porifera - Sponges; Coelenterata - Hydra; Platyhelminthes - Taeniasolium; Aschelminthes - Ascaris; Annelida - Earthworm; Arthropoda - Cockroach, Mollusca - Pilaglobosa and Echinodermata - Starfish - Salient features.	11	
II	Protozoa, Porifera and Coelenterata Protozoa - feeding, locomotion and reproduction in Amoeba - Porifera - structure of simple sponge-canal system in sponges. Coelenterata - Polymorphism in hydra, Reproduction in Coelenterates - corals and coral reefs - Ctenophora - Structural peculiarities, general characters and affinities.	14	
III	Platyhelminthes, Aschelminthes and Annelida Platyhelminthes - Morphological and physiological adaptations - parasitic diseases. Aschelminthes - sexual dimorphism, life cycle and diseases.		

	Annelida-Different classes of Annelida- Morphological features and affinities. Metamerism in Annelids.	13
IV	Arthropoda and Mollusca Arthropoda: Phylogeny of Arthropoda, Crustacean larvae and their significance. Connecting link between annelids and arthropods - Metamorphosis in insects - Mollusca: Origin of Mollusca, Torsion in Gastropoda.	13
V	Echinodermata and Minor Phyla Echinodermata- Water Vascular System. Significance of Echinoderm larvae. Minor Phyla: Structural peculiarities and affinities of Rotifera. Invertebrate fossils - Trilobites, Brachiopoda, Cephalopoda and Echinodermata. Economic importance of Invertebrates.	13
References	Text Books 1. R.L. Kotpal-2017, Modern text book of Zoology- Invertebrate- Rastogi Publication, Meerut. 2. M. Ekabaranatha Iyar and T.N. Ananthkrishnan (Recent Edition) Manual of Zoology. Vol. I. Part I & II, Visvanathan Publications, Chennai 3. 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, Nagarcoil. 4. Fatik Baran Mandal (2012) Invertebrata Zoology, PHI, Learning Private Limited, New Delhi – 110001. 5. Frank. A. Brown (2002) Invertebrates, Biotech Books, Delhi – 110035	
	Reference Books 1. R. L. Koptal- 2017, Animal Diversity, Rastogi Publication, Meerut. 2. E.L. Jordan and P.S. Verma 2009 Invertebrate Zoology, S.Chand & Company Ltd, New Delhi. 3. N. Arumugam 2002, Invertebrate Zoology, Saras publication, Nagercoil. 5. 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	

	<p>CO4: Understand the parasitic adaptations of tape worm, flukes and flat worms & realise the diseases caused by these parasites</p> <p>CO5: Realise the role of hormones in metamorphosis of insects, torsion in gastropoda, role of water vascular system in echinodermata and economic values of each phylum of invertebrata</p>
--	--

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	21ZOOP0102
Course Title	ANIMAL DIVERSITY II - CHORDATA		
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%)	
Category	Core		
Scope of the Course (may be more than one)	1.Learn the taxonomy and classification of chordates 2. Understand the concept of prochordates 3. Know the economic importance of vertebrates		
Cognitive Levels addressed by the Course	K1-Understand the principles of chordata K2-Realize adaptive radiation of birds K3 -Application of special properties of vertebrates K4 -Identification of poisonous and non-poisonous snakes K5-Comparative anatomy of different organs andeconomic importance vertebrates		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • to know the nomenclature • to know the vertebrates and classification up to order level • to understand the salient features of phylum chordata. • to explain the adaptive radiation and structural peculiarities among vertebrates • to understand the migration,appreciate parental care and economic importance of vertebrates 		
Unit	Content	No. of Hours	
I	Overview Taxonomy- Principles of Taxonomy. Nomenclature: Binomial,taxonomic keys. OutlineclassificationofChordates up to orderlevel.	13	
II	Prochordata,PiscesandAmphibia ConceptofProchordata-Hemichordata- Balanoglossus,Urochordata-Ascidian, retrogressive metamorphosis-Cephalochordata - Amphioxus - Salient features and affinities of amphioxus-Pisces- general characters-accessory respiratory organs – migration of fishes – parental care in fishes.Amphibia– general characters-parental care - adaptiveradiationfromwatertoland.	13	
III	Reptilia andAves ClassificationofclassReptilia andAvesuptoorders.Salientfeatureswithexamples-Poisonous snakes: Types of venom-Identification of poisonous and non-poisonous snakes. Birds as glorified reptiles- flight adaptation in	8	

	birds – migration of birds – parental care in birds.	
IV	Mammals Mammals - Structural peculiarities of Prototheria, Metatheria and Eutheria-Dentition in Mammals- Aquatic Mammals and their adaptations.	12
V	Comparative Anatomy and Economic importance Comparative Anatomy- limbs, heart and brain of vertebrates. Comparative account of respiratory organs in vertebrates - Economic importance of vertebrates such as fishes, amphibians, reptiles, birds and mammals.	18
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. R.L. Kotpal-2017, Modern text book of Zoology- Vertebrate- Rastogi Publication, Meerut. 2. N. Arumugam 2002. Chordate Zoology, Sara's publication, Nagercoil. 3. Fatik Baran Mandal (2012) Chordate Zoology, PHI, Learning Private Limited, New Delhi – 110001. 4. Frank. A. Brown (2002) Chordata, Biotech Books, Delhi – 110035. 5. M.Ekabarathana Iyar and T.N.Ananthakrishnan (Recent Edition) Manual of Zoology. Vol. II. Part I & II, Visvanathan Publications, Chennai <p>Reference Books</p> <ol style="list-style-type: none"> 1. N.C Nair, S. Leelavathy, N. Soundrapandian, T. Murugan and N. Arumugam, 2017, Animal diversity (Invertebrata & Chordata), Saras Publication, Nagarcoil. 2. A. Thangamani, S. Prasanakumar, L. M. Narayanan and N. Arumugam, 2017, Chordate Zoology, Saras Publication, Nagarcoil. 3. E.L.Jordan and P.S. Verma 2011 Chordate Zoology, S.Chand & Company Ltd, New Delhi. 4. Route and Solanki 2002. Learning Prochordata- Mammalia – Theory and Practice Dominant Pub. & Distributors, New Delhi. <p>E-Resources</p> <ol style="list-style-type: none"> 1. http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64 	
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1: Understand the principles of taxonomy, nomenclature, binomial and taxonomic keys</p> <p>CO2: Describe the salient features and one example each of prochordata, cephalochordata, hemichordata and urochordata</p> <p>CO3: Identify Reptiles, Aves and Mammals according to their distinctive characters in their phylum and class & order</p> <p>CO4: Describe the structural peculiarities of protheria, metatheria and eutheria</p> <p>CO5: Understand Migration of birds & fishes and their importance and appreciate the parental care exhibited by fishes, amphibians, reptiles, birds &</p>	

	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	21ZOOP0103
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 (Minimum 20%)	
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 <ul style="list-style-type: none"> • 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, GIS and 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.	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-	14	

	Conservation of natural resources- Biodiversity -Status, types, threats and biodiversity hotspots- Wildlife conservation and management- National parks, sanctuaries and biosphere reserves.	
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	Pollutionand Environmental Acts Pollution-Types-Air, water, soil and radio-active-sources, biological effects andcontrol-Environmental protections acts - Air and water-Environmental Laws.	11
V	EnvironmentalAssessment, 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.D. Sharma2017 Ecology and Environment- Rastogi Publication, Meerut. 2. N. Arumugam and V. Kumaresan- 2017 Environmental Biology, Saras Publication, Nagarcoil. 3. Purohit,Shammi& Agrawal 2012 Environmental Sciences – A New Approach Agrobios (India), Jodhpur. 4. Sharma, P.D. 2002 Environmental biology Rastogi and company, New Delhi 5. Metcalf and Eddy 2011 Waste water Engineering- Treatment and Reuse.Tata Mc Graw Hill Education Pvt.Ltd, New Delhi. Pp.311-1026.	
	Reference Books 1.P.D. Sharama 2013, Environmental Biology and Toxicology- Rastogi Publication, Meerut. 2. Pushpa Dahiya and Manisha Ahlawat 2013 Environmental Science- A	

	<p>New Approach, Narosa Pub. House, New Delhi. pp.2.1-2.60.</p> <p>3. Agarwal, S.K. 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.</p> <p>4. V.S. Kulkariani, S.N. Kaw and R.K. Trivedy 2002. Environmental Impact Assessment for wetland protection. Scientific publishers (India).</p> <p>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.</p> <p>6. Kailash Thakur 1997 Environmental protection law and policy in India. Deep and Deep pub. New Delhi. pp. 184-197; 210 – 248.</p>
	<p>E-Resources</p> <p>http://nptel.ac.in/courses/122103039/40</p> <p>2. http://b-ok.xyz/book/671429/bc900f</p> <p>3. http://b-ok.xyz/book/2463090/f0ce34</p>
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1 : Understand the components of environment, ecosystems, interactions of organisms, and appreciate how elements are cycling in the environment</p> <p>CO2 : Identify the natural resources, types of biodiversity and status and importance of national parks, sanctuaries and biosphere reserves</p> <p>CO3 : Understand remote sensing, GIS and their applications</p> <p>CO4 : Describe the types, biological effects and control of pollution and the importance of Environmental Acts.</p> <p>CO5 : Recognise the need of Environmental impact assessment, environmental audit, monitoring and treatment of effluents.</p>

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	21ZOOP0104
Course Title	MOLECULAR BIOLOGY		
No. of Credits		No. of contact hours per week	
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	
Category	Core		
Scope of the Course (may be more than one)	1. 2. 3.		
Cognitive Levels addressed by the Course	K1- K2- K3- K4- K5-		
Course Objectives (Maximum:5)	<p>The course aims</p> <ul style="list-style-type: none"> • to impart information on the historical developments of molecular biology and molecules of life • to give an in-depth knowledge on mutagenesis • 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	<p>Introduction to Molecular Biology Introduction and historical development - Central dogma of Molecular biology. The Logic of molecular biology – the efficient argument, examination of models and strong inference. Molecules of life – DNA world – RNA world and protein world. Prokaryotic and Eukaryotic Chromosome organization. Genes – definition, types and functional organization. Fine structure of gene - Benzers classical studies on rII locus. Structure of DNA -primary, secondary and different forms (A, B & Z). Gene transfer mechanism- bacterial transformation, conjugation and transduction.</p>	13	
II	<p>Mutagenesis and Recombination at the molecular level Mutation – Types – Molecular and biochemical basis of mutation. Mutagenesis – Spontaneous and induced – Base – analog, physical agents, chemical mutagens, intercalating substances and mutator genes. Reversion – definition –</p>		

	Types – Mechanisms – application (Ames test). Mutants – Types and Uses – bacterial mutants, plant mutants and animal mutants.Recombination at the molecular level. Crossing over during cell divisionbreakage and rejoining of intact DNA molecules, Holliday model of homologous recombination – events at the molecular level; role of recA, recBC and chi sequences, Site- specific recombination – eg.bacteriophageλ; FLP/FRT and Cre/Lox recombination.	13
III	DNA Replication Basic rule. The Geometry of DNA replication – Semi-conservative replication of double – stranded DNA and Circular DNA molecules. Enzymology – DNA Polymerases I and III, DNA ligase and DNA gyrase. Events in the replication fork – Continuous and discontinuous. Plasmid and Ø174 DNA replication- DNA damages – DNA repair mechanism – photoreactivation, excision repair, recombinant repair and DSOS function.	13
IV	Transcription Basic factors of RNA Synthesis - RNAPolymerases – 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.Antisense and Ribozyme technology – Molecular mechanism of antisense molecules - inhibition of splicing, polyadenylation, and transition – disruption of RNA structure and capping -biochemistry of ribozyme (hammerhead, hairpin, and other ribozyme) – strategies for designing ribozymes – applications of antisense and ribozyme technologies.	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; global nutrient (carbon, nitrogen) status sensing mechanisms	12

	<p>– link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene expression.</p> <p>Functional genomics, Validation of gene function. Gene silencing, PTGS, RNai, Antisense technology, Applications. Molecular Pharming. Genome Editing tools- ZFNs, TALENs and CRISPR-Cas9.</p>	
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. Lansing M. Prescott, John P. Harley and Donald A. Klein(2002). Microbiology. Mc Graw Hill companies. 2. B. Lewin 2000, Genes VII Oxford University Press. 3. David Freifelder, 1996, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 4. H.D. Kumar, 1993, Molecular Biology & Biotechnology, Vikas publishing house Pvt. Ltd., New Delhi. 5. S.C. Rastogi, V.N. Sharma, Biology & Biotechnology, Vikas Publishing House Pvt. Ltd., New Delhi. 	
	<p>Reference Books</p> <ol style="list-style-type: none"> 1. R.F. Weaver and P.W. Hedrick 1992, Genetics Wh.C. Brown publishers, Dubuque. 2. E.J. Gardener <i>et al.</i>, 1991 Principles of Genetics (8th Ed.,) John Wiley & Sons, New York. 3. Buchanan, Gruissum and Jones, (2000). Biochemistry and Molecular Biology of Plant; ASPP, USA. 4. David Rawn(2012). Biochemistry. Panima Publishers. 5. Richard Calendar (2005). The Bacteriophages, 2nd Edition, Oxford University Press. 6. J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick(2012). LEWINS Gene XI. Jones and Bartlett Publishers. 7. Alberts <i>et al.</i>, Molecular Biology of the Cell, Garland Publications, (2012). 	
	<p>*(NPTEL) - National Programme on Technology Enhanced Learning.</p>	
	<p>E-Resources</p> <ol style="list-style-type: none"> 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	<p>On completion of the course, students should be able to</p>	
	<p>CO1: Outline the fundamental concepts of molecules of life CO2: Discuss the various kinds of mutagenesis and their importance 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</p>	

	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	21ZOOP0105
Course Title	ANIMAL DIVERSITY I & II-Practicals		
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 than one)	1. Observe the taxonomic characteristics of animals belonging to different phylum. 2. Identification and knowing the salient features of helminth parasites. 3. Visittoseashoreandobservationofeconomically important crustaceans, molluscs,echinodermsandfishes.		
Cognitive Levels addressed by the Course `	K1 - Understand the microscopic animals of different phyla. K2 - Learn the morphological characteristics of marine coelenterates. K3 - Identify the disease causing helminthes and nematodes. K4 – Analyze the characteristics of insects of different orders K5 -Assess the morphometrics of fishes and prawns		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • to identify the important microscopic animals of different phyla. • to identify and know the different types of worms • to observe crustaceans, molluscs, echinoderms and fishes through field visit to sea shore and fish farms. <ul style="list-style-type: none"> • to study the morphometrics of fish and prawns • to identify teleosts, elasmobranches, amphibians, reptiles, aves& chosen Mammals. 		
Unit	Contents	No. of Hours	
1.	Identification and study of protozoans– Amoeba,Euglena,Volvox,Chlamydomonas, Trypanosoma and Paramecium.	48	
2.	Identification and study of Poriferans –Sponges		
3.	Identification and study of Coelenterates – Hydra,Jellyfish and Corals.		
4.	Identification and study ofPlatyhelminthes – LiverflukeandTapeworm).		
5.	Observation of Nematodes (Round worm, Pin worm, Whip worm, Microfilaria and Hookworm).		
6.	Identificationof Annelids - Earthworm,Nereis andLeech		
7.	Identification of insectsofdifferentorders andarachnids		
8.	Study of morphometricsoffishandprawns.		
9.	Identificationofteleosts,elasmobranchs,amphibians,reptiles,aves&chosenmammals		
10.	Visittoseashoreandobservationofcrustaceans, molluscs,echinodermsandfishes.		
11.	Visittofishfarms, aquariumandmuseum.		
	References		

	<ol style="list-style-type: none"> 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, Nagarcoil.
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1 : Identify the important microscopic animals of different phyla. CO2 : Know the types of parasitic worms CO3 :Identify earthworms, nereis, leech,insects of different orders and Arachnids CO4 :Observation of crustaceans, molluscs, echinoderms; gaining knowledgethrough field visit to sea shore and fish farms CO5 :Identify teleosts, elasmobranches, amphibians, reptiles, aves& Mammals.</p>

Mapping of Cos with PSOs

PSO CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3
CO2	2	2	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	21ZOOP0106
Course Title	Environmental Biology Practicals		
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 than one)	1. 2. 3.		
Cognitive Levels addressed by the Course	K1 - To understand the different parameters of the environment K2 -To apply the methods of studying the population of plants K3 -To evaluate the effect of industrial effluents and pesticides on Organisms K4 - K5 -		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • to estimate total dissolved solids,dissolved oxygen, carbon dioxide, total alkalinity, chloride, hardnessin 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 		
Unit	Content	No. of Hours	
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.	Estimation of TotalDissolved solids. Estimation of Dissolved oxygen Estimation of Carbon dioxide Estimation of BOD & COD in different water samples (Demonstration). Estimation of Total Alkalinity. Estimation of Chloride. Estimation of Total hardness. Quadrant study on population. Bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae. Visit to Centre for Geology, GRI, Gandhigram for remote sensing & GIS. Visit to Drinking water and effluent treatment plants.	48	
	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 (20 th Edition). American Public Health Association,		

	Washington. D.C.
Course Outcomes	On completion of the course, students should be able to
	<p>CO1 : Understand how to estimate Total Dissolved solids, Dissolved oxygen, Carbon dioxide, Total alkalinity, Chloride, hardness, BOD and COD in different water samples</p> <p>CO2 : Understand how to study on population of plants.</p> <p>CO3 : Understand the Bioassay studies on industrial effluents/ pesticides Using fish, aquatic insects and larvae.</p> <p>CO 4 : Understand the applications of remote sensing and GIS in environment.</p> <p>CO5 : Know the methods of treating drinking and effluent water samples.</p>

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

Semester	Second	Course Code	21ZOOP0207
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 (Minimum 20%)	
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 <ul style="list-style-type: none"> • 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	Classification, structure and properties of protein, carbohydrate and lipids Classification of protein – Based on source, shape, composition and solubility – carbohydrates – Monosaccharide, oligosaccharides and polysaccharides – Lipids – simple, compound and derived. Structure – protein – primary, secondary, Tertiary and quaternary – Carbohydrates and lipids – Properties – physical and chemical properties of protein, carbohydrate and lipids.	11	
II	Enzymes 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,	12	

	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.	
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 (Source:NPTEL).	16
IV	Osmoregulation and Excretion Osmoregulation and Excretion: Osmoregulation – Basic principles – Mechanism – Osmoregulation of freshwater, marine and terrestrial environment. Excretion –Nitrogenous wastes – Ammonia, Urea – Ornithine cycle – Uric acid, Organs of excretion – without special excretory tubules – Nephridia, Malpighian tubules, Vertebrate – nephron – Anatomy of mammalian kidney and urine formation.	12
V	Muscle, Nerve and Endocrine Glands General organization, classification and function of muscles and nerves– synapse and neuromuscular junction-Receptors – Mechanoreceptors – Chemoreceptors –Photoreceptors- Endocrineglands– pituitary,thyroid¶thyroid,pancreas,ovary&testis.(Source:NPTEL).	13
References	Text Books 1. S. Prasanakumar, A. Meena, R.P. Meyyan Pillai, DulsyFathima, L.M. Narayanan, and K Nallasingam.2017, Animal Physiology and Biochemistry, Saras Publication, Nagarcoil. 2. S. N. Gupta, 2016, A. Text Book of Biochemistry- Rastogi Publication, Meerut. 3. G.S. Sandhu 2002 Text book of biochemistry 18 th Edn. Campus books International, New Delhi pp. 24-208. 4. 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. 5. William S. Hoar 1987 General and comparative Physiology Third Edition Printice - Hall International INC, Englewood cliffs, N.S. USA Reference Books 1. K. V. Sastry& Priyanka, Mathur- 2018, Animal Physiology and Biochemistry, Rastogi Publication, Meerut. 2. J.H. Well 1997. General biochemistry. 6 th Edn. New Age International (P) Ltd pub; New Delhi. 3. EricE.Conn, Paul K. Stumpf, George Bruening and Roy H. Doi 1995. Outlines of Biochemistry. John Wiley of sons, New York. pp: 1 – 67 4. Mohan P. Arora 1989 Animal Physiology Himalaya Publishing House,	

	<p>New Delhi</p> <p>5. Eckert and Randall Second Edition, Animal Physiology – Mechanisms and Adaptations W.B. Saunders Company, Philadelphia</p> <p>6. C. Ladd Prosser (Third Edition), Comparative Animal Physiology (1973) W.N. Saunders Company, Philadelphia</p>
	<p>E-Resources</p> <p>1. https://onlinecourse.nptel.ac.in/noc18bt14/preview.</p> <p>2. https://b-ok.org/book/2595944/cab169</p> <p>3. https://b-ok.org/book/989964/a5ob8a</p> <p>*(NPTEL) -National Programme on Technology Enhanced Learning.</p>
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1:Learn the classification, structure and properties of protein,carbohydrate,lipids and enzymes</p> <p>CO2 :Learn animal foods & nutritive types, feeding mechanisms in different animals and process and role of enzymes in digestion, absorption& assimilation</p> <p>CO3: Recognize the presence of different types of respiratory pigments & their functions</p> <p>CO4 :Identify organs involved in respiration, circulation and excretion among mammals</p> <p>CO5 : Able to understand the structure and functions of receptors, nerve, muscle and endocrine glands.</p>

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21ZOOP0208
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 (Minimum 20%)	
Category	Core		
Scope of the Course (may be more than one)	1. Understand the concept of Entomology and general organization of insects. 2. Learn the role of insects in forensic investigation and transmission of diseases. 3. Know the beneficial insects and importance of insect pest control		
Cognitive Levels addressed by the Course	K-1 Understand the structure and life cycle of insects K-2 Learn the medically important and forensic insects K-3 Evaluate the economic importance helpful and productive insects K-4 Realize the insect pest of economically important plants K-5 Analyze the different methods of pest control and need for transgenic plants		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • to understand the insects by studying their general organisation, structure, life cycle and importance. • to know the life cycle and control of medically important insects • to understand the plant pests of rice, legumes, sugarcane, fruits, groundnut and coconut • to know the economic importance of 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; pheromones; reasons for the dominance of insects; reasons for insects reaching pest status	16	
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.		
III	Plant Pests Plant pests - Leaf folder in rice; pink bollworm in cotton; <i>Pyrausta nautalis</i> in sugarcane; fruit fly in fruits; fruit borer in Pomogranate; ground nut - red		

	<p>hairy caterpillar in groundnut - Rhinoceros beetle in coconut - pests of stored products - Callosobruchus maculatus in Pulses – Sitophilus oryzae in rice; Apple scale.</p>	
IV	<p>Economic Importance Productive & helpful insects: Bionomics, life cycle and economic importance - silkworm, honey bee, lac insect, pollinators and other helpful insects.</p>	
V	<p>Pest Control Insect Control: Natural control, cultural control, applied control and legal control. Biological control of insect pests - merits and demerits; Chemical classification of insecticides; ill effects of insecticides. Integrated Pest Management (IPM) and its importance. Transgenic plants: history, Bacillus thuringiensis and its mode of action on insect.</p>	
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. K.K. Nayar, T.N. Ananthkrishnan & B.V. David (1996) General & applied entomology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 2. Larry P, Pedigo (1996) Entomology and Pest management. Prentice Hall of India Ltd., New Delhi. 3. Ashok Kumar & Prem Mohan Nigam (1991) Economic & Applied Entomology Emkay Publications, Delhi. 4. H.F. Van Enden. (1989) Pest Control 2nd edition. Cambridge University Press, Cambridge. <p>Reference Books</p> <ol style="list-style-type: none"> 1. Lalit kumar Jha (1987) Applied Agricultural Entomology. New Central Book Agency, Calcutta. 2. A.D. Imms. (1965) A General Text Book of Entomology, 9th edition. ELBS edition, Great Britain. 3. V.B. Wigglesworth (1965). The Principles of Insects Physiology, ELBS edition, Great Britain. <p>E-Resources</p> <ol style="list-style-type: none"> 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	

	<p>CO1 : Realize the different parts of insects and their functions.</p> <p>CO2 :Know the medical importance of insects</p> <p>CO3 :Understand the agricultural importance of insects</p> <p>CO4 :Understand the elementary classification and economically important insects</p> <p>CO5 :Understand the insect Control, merits and demerits and importance of Integrated Pest Management system</p>
--	--

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21ZOOP0209
Course Title	CELL BIOLOGY AND GENETICS		
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. Differentiate plant and animal cells 2. Inculcate the structural organization of genes 3. Learn the Mendelian principles and inheritance of characters		
Cognitive Levels addressed by the Course	K1- To understand the different cell organelles and genetics K2- To learn the structure and functions of cell organelles K3- To evaluate the role of different organelles in cell synthesis K4- Assess the importance of eugenics in human betterment K5- Evaluate the genetic effects of chromosomal mutation		
Course Objectives	The Course aims <ul style="list-style-type: none"> To evaluate the structure of cell and its various organelles To demonstrate the organization of genes and chromosomes To analyse the the principles of cell communications and signal transduction pathways. To create broad knowledge on basic and recent trends of genetics To explain the structure of Cell signaling; Hormones and their receptors. 		
Unit	Content	No. of Hours	
I	Structure of Cell and cell membranes Ultra structure 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	Organization of Chromosome and Cell Cycle Organization of genes and chromosomes (operon, unique and repetitive DNA, interrupted genes, genefamilies, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).Cell division and cell cycle Mitosis and meiosis-regulationandcontrol ofcellcycle –positive (cyclins and cyclin-dependent kinases) and negative regulation (retinoblastoma protein (Rb), p53, and p21).Genetics and cancer: Differences between normal and cancer cell- Oncogenes- tumor inducing retroviruses and viral oncogenes–Environmental factors inducing cancer.	13	
III	Cell signaling Cell signaling; Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	14	
IV	Mendelian genetics Mendelian principles : Dominance, segregation, independent assortment: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests. Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Eugenics – human betterment; Sex determination and Sex linked inheritance.	12	
V	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, maternal 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.	12	
Referen ces	Text Books <ol style="list-style-type: none"> Aminul Islam. 2018. Essentials of Cell Biology. Books and Allied (P)Ltd, Kolkotta Verma, P.S. and Agarwal, V.K. 2018. Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S.Chand& Company Ltd. New Delhi. SundaraRajan, S. 2003. Introduction to Cell Biology. Vikas PublishingHousePvt.Ltd., New Delhi. M.M.Moris. 2020. Genetics Vol.I& II.CBS Publishers &DistributorsPvt.Ltd. New Delhi Benjamin A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England. 		

	<p>Reference Books</p> <ol style="list-style-type: none"> 1. Satyesh Chandra Roy and Kalyan Kumar De. 2018. Cell Biology. New Central Book Agency(P)Ltd 2. Abhilash Jain.2018. Basic Cell Biology. Campus Books International, New Delhi 3. Eldon J. Gardner. 2004. Principles of Genetics 8th edition, John Wiley and Sons, New York. 4. Monroe W. Strickberger.2019. Genetics.Pearson India Education Services Pvt.Ltd. 5. Edmund, W. Sinnott, L.C. Dunn and Dobzhansky, T. 1990. Principles of Genetics, 5th Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. <p>E-Resources</p> <ol style="list-style-type: none"> 1. www.oxfordtextbook.co.uk/orc/thrive/. 2. https://t.co/LJhgVker0g 3. https://academic.oup.com/genetics 4. www.oup.com/uK/maneely
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>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 various factors determining the heredity from one generation to another CO5: Critique the mechanism of Sex determination in organisms.</p>

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21APRP0204
Course Title	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. Differentiate plant and animal cells 2. Inculcate the structural organization of genes 3. Learn the Mendelian principles and inheritance of characters		
Cognitive Levels addressed by the Course	K1- Understanding basic concepts in Biostatistics K2- Comprehending statistical measures in the biological data analysis K3- Ability to interpret the statistical inference		
Course Objectives	The Course aims <ul style="list-style-type: none"> to 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	Introduction to Biostatistics Development of Biostatistics and its applications - Sources of biological data - Secondary and Primary sources - Classification and tabulation of data - frequency distribution -Diagrammatic and Graphical representation of statistical data.	12	
II	Sampling Techniques Meaning - Advantages, concept of parameter and statistics, sample size, sampling error, sampling frame. Types of samples – Probability sampling – simple, systematic, stratified, cluster, multi-stage sampling. Non-probability sampling – Purposive, Convenience, Judgment and snowball techniques.	13	
III	Descriptive Statistics Measures of central tendency - Mean, Median, Mode - Measures of Dispersion: –Range, Quartile Deviation, Mean Deviation, and Standard Deviation. Absolute and relative measures of dispersion. Skewness and kurtosis measures.	13	
IV	Correlation and Regression Analysis Definition, uses, types of correlation, Regression Lines – Properties of regression lines and coefficients; Introduction to probability and its applications – Theoretical Distributions – Binomial, Poisson, and Normal distributions; Properties, uses and applications.	13	
V	Inferential Statistics and Biological Measures Hypothesis testing and Tests of significance - Test of attributes, small and large sample tests - Analysis of variance – one-way and two-way classifications; Measurement of risk, odds ratio and Bioassay and dose responses.	13	
References	Text Books <ol style="list-style-type: none"> Veer Bala Rastogi, Biostatistics, Medtech publication, (3rd revised Edition), 2017. Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008. Sampath Kumar V.S; Bio-Statistics, ManomaniamSundaranar University Publication, Tirunelveli, 1997. Verma B.L, Shukla G.D and Srivastava.R.N, Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 1993. W.G.Cochran, Sampling Techniques, Wiley Eastern Ltd, New Delhi, (1985). Reference Books <ol style="list-style-type: none"> Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020. Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017. Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012. Rohatgi, V. K. and A. K. md.EhsanesSaleh(2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi. Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004. E-Resources <ol style="list-style-type: none"> https://www.biostat.washington.edu/about/biostatistics http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics https://www.edx.org/course/biostatistics-0 		
Course	On completion of the course, students should be able to		

Outcomes	CO1: Get acquainted with basic concepts of statistics and its relevance with 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						
CO2						
CO3						
CO4						
CO5						

Semester	Second	Course Code	21ZOOP0210
Course Title	BIOCHEMISTRY AND ANIMAL PHYSIOLOGY PRACTICALS		
No. of Credits		No. of contact hours per week	
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected (Minimum 20%)	
Category	Core		
Scope of the Course (may be more than one)	1. Know the estimation of carbohydrates, proteins, lipids and Vitamin C 2. Observe the salivary amylase activity and estimate glucose level in urine. 3. Identify human blood groups and qualitatively analyze excretory products		
Cognitive Levels addressed by the Course	K-1 Learn the importance of protein, carbohydrate, lipids and enzymes K-2 Gain knowledge on biochemistry of blood groups K-3 Analyze ammonia, urea, glucose and vitamin C K-4 Estimate the total cholesterol K-5 Evaluate the amounts of free amino acids		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> to understand the importance of estimating protein, free amino acids, total carbohydrates and cholesterol to know the activity of enzymes to identify the ABO blood groups to know how to estimate ammonia and urea to estimate the glucose in urine and vitamin C 		
Unit	Content	No. of Hours	
1.	Estimation of protein	3	
2.	Estimation of free amino acids	3	
3.	Estimation of total soluble carbohydrates	6	
4.	Estimation of total cholesterol	3	
5.	Quantitative estimation of amylase activity	3	
6.	Enzyme assay – Nitrate reductase	6	
7.	Identification of ABO blood groups	3	
8.	Estimation of glucose level in urine	8	
9.	Qualitative estimation of ammonia and urea	4	
10	Estimation of vitamin C	4	
	CFA	4	
	Chemicals preparation for each practical -10 X 1	10	
	Record Work	7	
References	Text Books		
	Reference Books		
	E-Resources		
Course Outcomes	On completion of the course, students should be able to		

	<p>CO1 : Understand the importance of estimating protein, free amino acids, totalcarbohydrates, cholesterol.</p> <p>CO2 : Understand the estimation of enzymes</p> <p>CO3 :Identify the ABO blood groups</p> <p>CO4 :Understand the importance of estimating ammonia and urea</p> <p>CO5 : Understand the role of glucose in urea and importance of vitamin C</p>
--	---

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21ENGP00C1
Course Title	COMMUNICATION AND SOFT SKILLS		
No. of Credits	2	No. of contact hours per week	2
New Course/ Revised Course	Revised Course	If revised, Percentage of revision effected	20
Category	Soft Skills		
Course Objectives	The Course aims <ul style="list-style-type: none"> To help the students improve their communication and life and soft skills; and To enhance their personality and employability skills. 		
Unit	Content	No. of Hours	
I	Basics of Communication Barriers to Communication	3	
II	Communication and Language Skills Communicating in a Global Language	3	
III	Resumes and Cover Letters Group Discussions	3	
IV	Business communication Intercultural Communication	3	
V	Professional Communication Interviews	3	
References	Text Books Krishnaswamy, Dhariwal and Krishnaswamy. <i>Mastering Communication Skills and Soft Skills</i> . Blomsbury, 2015.		

Mapping of Cos with PSOs

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

21ZOOP0211

SUMMER INTERNSHIP

Credits - 2

Semester	Third	Course Code	21ZOOP0312
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(Minimum 20%)	
Category	Core		
Scope of the Course (may be 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 of thesis and publications K6- Promote and establish the research activities in the field of Zoology		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> 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	Isolation and Separation Isolation of cellular constituents- Chloroplasts, mitochondria, nucleic acids and enzymes- 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.	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.	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- Peerreview-Types- Impact factor- citation index,h-index,i10 index-Preparation of manuscript- Proof correction- proof correction symbols- Method of correcting proof- Plagiarism checking-Use of plagiarism softwares– Urkund&iThenticate– Preparation of Research proposal and funding agencies and Research fellowships- Intellectual Property Rights- Origin and history of Indian Patent system- Basis of patentability- Patent application procedure in India.	14
References	Text Books	
	Reference Books	
	E-Resources	
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:Train the students in the field of research CO5:Crate 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	Third	Course Code	21ZOOP0313
Course Title	EVOLUTION		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised,Percentage of revision effected(Minimum 20%)	
Category	Core		
Scope of the Course (may be more than one)	1. Help the students to understand the basic principle and theories of evolution 2. Make the students to learn the basis of molecular evolution 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 genetic concepts of evolution 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 <ul style="list-style-type: none"> • 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.		
II	Molecular Evolution Role of genes in evolution - Evolution of gene families, Molecular drive - Assessment of molecular variation. Phylogenetic gradualism and punctuated equilibrium, Micro- and Macro-evolution – speciation Evolution of Haemoglobin, Cytochrome C - Molecular clocks.		
III	Variations Types of Variation, Cytological basis of variations, Chromosomal aberrations, polyploidy, aneuploidy, Population genetics - Gene frequency, genetic equilibrium, Hardy Weinberg's Law of equilibrium.		
IV	Speciation Isolation - Isolating mechanisms. Concept of Species,		

	Migration and Gene flow, Darwin finches, Speciation, adaptive radiation, adaptive divergence, radiation evolution. Monophyly and Polyphyly	
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.	
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. & Hoekstra, 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. 4 th 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	
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	21ZOOP0314
Course Title	DEVELOPMENTAL ZOOLOGY AND IMMUNOLOGY		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New	If revised,Percentage of revision effected (Minimum 20%)	
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 indevelopmental biology and immunology K2 - Apply basic principles of growth and development K3 –Analyze the developmental genetic defects and 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 <ul style="list-style-type: none"> • 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	GametogenesisandFertilization Spermatogenesis and Oogenesis – structure of spermatozoa and egg– Types of eggs- Fertilization (external and internal)– Parthenogenesis– Planes and patterns of cleavage; law of cleavage- - – Blastulation- types of blastula	11	
II	GastrulationandOrganFormation Gastrulation–Morphogenetic movements & Fate map-Nuclear transplantation experiments in amphibians- Organizer – concept – Induction process –Organogenesisofheart,brain,eye,ear& gonads.	10	
III	Development Development of chick embryo – 24, 48, 72 & 96 hrs.Extra embryonic membranes.Placentationinmammals. Developmental genetic defects- Regeneration, aging (source NPTEL) and teratogenesis.	7	

IV	<p>Immunity</p> <p>History, 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. .</p>	10
V	<p>Antigen, Immunogenicity and Immunoglobins Antigen – Classification – Exogenous, endogenous, autoantigens, tumor antigens, allogenic, xenogenic, idiotypic- Immunogenicity – Chemical characteristics- Foreignness ,molecular size, chemical complexity, capability of antigen being processed and presented- Biological characteristics-Genotype of the host, Immunogen dose and route of administration- Antigenicity, Haptens, Epitopes and types, Adjuvent types, mitogens, Types, properties and functions(Available NPTEL)- Immunoglobins – Types, structure and properties of immunoglobulin - Antigen determinants of immunoglobulins- isotypes, allotypes and idiotypes.</p>	10
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. K.V. Sastry and Vineeta Shukla (2018) Developmental Biology, Rastogi Publication,Meerut 2. N.Arumugam,(2017)DevelopmentalZoology,SarasPublication,Nagarcoil 3. ShyamasreeGhosh(2017)ImmunologyandImmunitotechnology,BooksandAllied(P)Ltd,Kolkata. 4. AjoyPaul(2016)TextbookofImmunology,BooksandAllied(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. 7. Balinsky B.I. (2012), An Introduction to Embryology (5 Ed.), Cengage Learning India <p>Reference Books</p> <ol style="list-style-type: none"> 1. S.S.LalandSanjeevKumar-2015 Immunology–RastogiPublication,Meerut. 2. P.R.Yadav(2001)ATextBookofEmbryology,Campus BooksInternational, NewDelhi. 3. T.Subramanian(2002)Developmental Biology.NarosaPublishingHouse,NewDelhi. 4. P.M.Lydyard,A.WhelanandM.W.Fanger(2002)InstantNotesinImmunology. 	

	<p>VivaBooksPrivateLtd,NewDelhi.</p> <p>5. C.V.Rao(2002)AnIntroductiontoImmunology.NarosaPublishingHouse,NewDelhi.</p>
	<p>E-Resources</p> <p>1. http://nptel.ac.in/syllabus/syllabus.Php?subjectId=102103038</p> <p>2. http://b-ok.xyz/book/463534/11604b</p> <p>3. http://www.studocu.com/en/document/university-of-leads/animal-developmental-biology/lecture-notes/animal-developmental-biology-lecture-notes-lecture-1/60800/view.</p> <p>4. http://www.studocu.com/en/document/hogeschool-van-arnhem-en-nijmegen/immunologie/summaries/samenvatting-boek-immunologie-immunologie-am/810272/view.</p>
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1 : Realize the sperm-egg interaction, sperm entry and know the physiological factors in fertilization process.</p> <p>CO2 : Understand the mechanism of blastulation process</p> <p>CO3 : Realize the development of organs</p> <p>CO4 : Appreciate the contribution of great immunologists and to know the types of lymphoid organs, lymph nodes and their functions</p> <p>CO5: Understand the types, functions of Immunoglobins and Antigen- antibody Reactions</p>

Mapping of Cos with PSOs

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

Semester	Third	Course Code	21ZOOP0315
Course Title	BIOINSTRUMENTATION AND RESEARCH METHODS–Practicals		
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 than one)	1. Know the basic principle and applications of different bioinstruments 2. Able to learn the principles, procedures and applications of chromatography, electrophoresis, UV-Vis spectroscopy, FT-IR, SEM, AAS and NMR 3. Understand the methods of buffer preparation and determination of pH		
Cognitive Levels addressed by the Course	K1-Remember the different types of buffer solution and methods of adjustment of pH K2-Realize the importance of paper, thin layer and column chromatography K3-Assess the quantity of sodium, calcium and magnesium using flame photometer K4-Visualize the presence of proteins by gel electrophoresis K5-Evaluate the calorific value of food stuffs		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • To know the preparation of buffers and determination of pH. • To separate amino acids and sugars using chromatography and electrophoresis • To estimate proteins, sugars, nucleic acids, chlorophyll, sodium, potassium, calcium and magnesium using different equipments. 		
Unit	Content	No. of Hours	
1.	Preparation of buffers.		
2.	Determination of pH in water and soil samples.		
3.	Separation of amino acids and sugars using paper chromatography (2D)		
4.	Separation of amino acids and sugars using thin layer chromatography		
5.	Separation of pigments by column chromatography		
6.	Differential centrifugation of samples.		
7.	Separation of gas and organic acids using GC and HPLC (Demonstration).		
8.	Separation of proteins using vertical gel electrophoresis.		
9.	Estimation of Protein using Spectrophotometer		
10.	Estimation of sodium, potassium, calcium and magnesium using Flame photometer		
11.	Estimation of calorific value of feed/ fire wood samples.		

12	Demonstration of Biological samples using SEM, FT-IR, AAS, NMR.	
References	1. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India. 2. J.Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi.	
Course Outcomes	On completion of the course, students should be able to CO1: Prepare buffers of desired pH CO2: Separate aminoacids and sugars by paper and thin layer chromatography CO3: Estimate proteins, sodium, potassium, calcium and magnesium using spectrophotometer and flame photometer CO4: Separate proteins using vertical gel electrophoresis CO5: Know the biological applications of SEM, FT-IR, AAS and NMR	

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	21ZOOP0416
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	40
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	K1- Ability to remember historical and recent developments in microbiology K2- Grasp the comprehensive knowledge on Systematic bacteriology K3- Use microbiological tools for better understanding of microbial structures and their functions K4- Capacity to analyze factors influencing microbial growth K5- Make new techniques to study microbial activity in nature K6- Assessment of disease-causing microorganisms		
Course Objectives	The Course aims <ul style="list-style-type: none"> • 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. • make the students knowledgeable on classification and diversity of microorganisms • develop knowledge in microbial control techniques and 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, Phase contrast, Fluorescence and Electron microscopy.	13	
II	Taxonomy and Diversity of Microorganisms General principles of classification of microorganisms – Major Characteristics Used in Taxonomy – Haeckel's three kingdom concept – Whittaker's five kingdom concept – three domain concept of Carl Woese. Brief view on bacterial classification according to Bergey's manual of Systematic bacteriology. Classification and salient features of algae, fungi, protozoa and viruses. Overview on the microbial culture collections.	13	
III	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	
IV	Microbiological Techniques Microbial control – Physical methods - Chemical methods – Evaluation and monitoring of sterilization procedures- Use dilution tests, Disc-Diffusion method – Decimal reduction time (D Value). 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, micronutrients, 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	12	
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; Bacterial diseases: Staphylococcus, Streptococcus, Neisseria; Corynebacterium, Clostridium, Vibrio, Yersinia, Haemophilus, Mycobacterium. Fungal diseases of man, Epidemiology. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Viral diseases: Pox viruses; Herpes virus, Hepatitis viruses, corona viruses and Human Immunodeficiency viruses (HIV)	12	
References	Text Books <ol style="list-style-type: none"> 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. 5 th Ed. Tata McGraw Hill Book Company.
	Reference Books <ol style="list-style-type: none"> 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.
	E-Resources <ol style="list-style-type: none"> 1. https://www.cliffsnotes.com › biology › microbiology 2. https://www.livescience.com 3. https://www.nature.com › ... › microbiology techniques
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO 1: Discuss important milestones and accomplishments to appreciate the historical aspect</p> <p>CO2: Identify key organelles and their functions in both eukaryotes and prokaryotes</p> <p>CO3: Describe how to control microorganism and the factors affecting the growth of microbes.</p> <p>CO4: Demonstrate the different cultural techniques in microbiology</p> <p>CO5: Explain the interactions and characteristics of microorganisms</p>

Mapping of Cos with PSOs

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

Semester	Fourth	Course Code	21ZOOP0418
Course Title	ANIMAL BIOTECHNOLOGY AND GENETIC ENGINEERING		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	
Category	Core		
Scope of the Course (may be more than one)	<ol style="list-style-type: none"> 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 <ul style="list-style-type: none"> • 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. • to know the transgenic organisms and to acquire knowledge on GMOs. 		
Unit	Content	No. of Hours	
I	<u>Concepts and Scope in Animal Biotechnology</u> 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	<u>Biotransformation and Biosensors (Source NPTEL course)</u> 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- types of electrode systems – Oxygen electrode system, Fuel cell type electrode, Potentiostatic, Piezoelectric membrane and Dye-coupled electrode	13	

	<p>membrane filter systems –Biosensors for nutrients (glucose sensors). Sensor for cell population (Lactate sensor) – Biosensor for products (alcohol sensor, formic acid sensor and methane sensor) – Biosensor for environmental control (BOD sensor, Ammonia sensor, Nitrite sensor and Sulfite Ion sensor).</p>	
III	<p><u>Biomass and Bio-energy</u> Energy sources – nuclear energy, fossil fuel energy and non-fossil and non-nuclear energy. Biomass energy – Composition of biomass-wastes as sources of renewable source of energy – Composition wastes – sources of wastes (Industrial, agricultural, forestry, municipal sources). Biomass conversion – non-biological process, direct combustion (Pyrolysis, Gasification, liquefaction); biological process (enzymatic digestion, anaerotic digestion, aerobic digestion). Bioenergy products – ethanol, biogas and Hydrogen.</p>	13
IV	<p><u>Genetic Engineering (Source NPTEL course)</u> Definition and outline strategy: Enzymology – Restrict enzymes, DNA ligases, reverse transcriptase, klenow fragment, Alkaline phosphatase, Polynucleotide kinase, terminal transferase, Dnase and Rnase. Vectors used in molecular cloning: Plasmids (eg.pUC, pBlueScript, pGEM vectors; Expression vectors; pMal, GST – based, pET vectors), Bacteriophage λvectors (λgt10, λgt11, λ ZAP and replacement vectors – EMBL), Phagemids (M13, derived vectors), cosmids, Artificial chromosome vectors (YACs; BACs), and Other viral vectors(SVO40, vaccinia, baculovirus & retroviral vectors. Gene cloning strategy – Isolation of foreign DNA and recombinant DNA construct – Transformation – Screening and selection. Transferring genes in to animal oocytes, eggs, embryos and specific animal tissues. Expression of cloned genes in animal systems -Biopharming- Animals as bioreactor for recombinant protein,</p>	13
V	<p><u>Animal transgenesis and Rules and regulation in biotechnology</u> 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. Artificial insemination and embryo transfer.Application of transgenic animals: Production of useful proteins and other products in transgenic animals</p>	12

	(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).	
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. Dubey R.C., 2014. Advanced Biotechnology 1st Edition. S.Chand&Company Ltd., 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. <p>Reference Books</p> <ol style="list-style-type: none"> 1. Dubey R.C., 2001. A text book of Biotechnology 1st Edition. S.Chand&Company Ltd., New Delhi. 2. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC. 3. Kumar, H.D. 1993. Molecular Biology & Biotechnology, Vikas Publishing House Pvt., Ltd., New Delhi. 4. Kumar, H.D. 1991 Biotechnology, 2nd Ed., East – West Press Private Ltd., New Delhi. 5. Trevan, M.D, Boffey, S., Goulding, K.H. and Stanbury, P. 1990. Biotechnology- The basic Principles. Tata McGraw Hill, New Delhi. 6. Demain, A.L., Solomon, N.A. 1986. "Manual of Industrial Microbiology and Biotechnology", ASM Press, Washington. 7. Robert F. Weaver, 2012 Molecular Biology; McGraw Hill 8. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7thEdn. 9. T. A. Brown 2006 Gene Cloning and DNA analysis- An Introduction; 5th Edition, Wiley Blackwell Publishing <p>E-Resources</p> <ol style="list-style-type: none"> 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	

	<p>CO1: Discuss on the history and concepts of animal biotechnology</p> <p>CO2: Explain on biotransformation methods and working systems of biosensors</p> <p>CO3: Compare alternate energy sources and generation of bioenergy products from biomass</p> <p>CO4: Outline on concepts and techniques of Genetic Engineering</p> <p>CO5: Assess applications of GMOs and on Ethical issues</p>
--	---

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	21ZOOP0420
Course Title	ECONOMIC ZOOLOGY		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised	If revised, Percentage of revision effected (Minimum 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 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 <ul style="list-style-type: none"> • To understand the National and International status of aquaculture, economics of fish and prawn farming, fishery byproducts and fishery contribution. • To understand the importance of apiculture and lac culture. • To understand the importance of sericulture. • To know the economic importance of live stock and poultry. • To know the vermicomposting and vermiproducs. 		
Unit	Content	No. of Hours	
I	Aquaculture Potential: Status of aquaculture – National and International – Economics of aquaculture – Fish and Prawn. Fishery Byproducts – Fishery contribution – Fish trade & Marketing.	8	
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- Economic Importance of Honey- Food & Medicinal value, Bee wax, Royal Jelly & bee venom- Lac Culture- Distribution- Life cycle Host plants-harvesting and Cultivation of Lac- Economic importance.	14	
III	Sericulture: Species of silkworm- Mulberry silk moth- Life cycle- Collection of eggs- Incubation of eggs- Rearing of Larvae- Production and Recovery of		

	cocoons- Spinning cocoons- Quality & Marketing- Post-cocoon processing- Shifting, Reeling and spinning- Diseases of silkworm and uses.	14
IV	Economic Importance of Live stocks and poultry: Importantlivestock-Cattle,Goat,Sheep – Breeds,Management,LivestockdiseasesandEconomics-Poultry- Types andbreeds-Management of growers, Layers, Broilers – Feed formulations for chicks, Growers and Broilers-Nutritive value of egg and meat, diseaseand economics.	16
V	Vermiculture: Introduction to vermiculture- types of earthworm-rearing of earthworms-Vermicomposting technology-methods-Uses of worms in Agriculture-Vermiproducs.	10
References	Text Books <ol style="list-style-type: none"> 1. G.S.ShuklaandV.B.Upadhyay-2017-EconomicZoology-RastogiPublication,Meerut. 2. Jeyasurya,N.C.Nair,N.SoundaraPandian,A.Thangamani,L.M.Narayanan, N.Arumugam,S. LeelavathianandT.Murugan-2017- SarasPublication,Nagarcoil. 3. Q.J.ShammiandS.Bhatnagar.AppliedFisheries.Agrobios(India)2002 4. R.P.Parihar,AtextbookofFishBiologyand FisheriescentralPub.House,Allahabad.1996. 5. ArvindKumar.Verms&Vermitechnology,APHPub.Corporation,NewDelhi,2005. Reference Books <ol style="list-style-type: none"> 1. V.G. Jhingran. Fish and Fisheries of India. Hindustan Publishing corporation (India)Delhi.1997. 2. AmitaSaxena.AquariumManagement.DayaPub. House,NewDelhi.2003. 3. Manju52adav.EconomicZoology.DiscoveryPub.House,New Delhi.2008. 4. N.Arumugam,T.Murugan,J.JohnsonandP.RamPrabhu,AppliedZoology- 2017-SarasPublication, Nagarcoil. 5. G.C. Banerjee. A Text book of Animal Husbandry 9thEdn. Oxford & IBH Pub. NewDelhi.2010. 6. T.V.Sathe.VermicultureandOrganicFarmingDayaPub.Home,Delhi.2004 E-Resources <ol style="list-style-type: none"> 1. gurukpo.com/applied zoology-ethology-biostatics 2. http://ia800306.us.archive.org/O/items/economic zoology. Oosbogoog/economic zoologyOosbogoog. 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	21ZOOP0421
Course Title	FUNDAMENTALS OF MICROBIOLOGY-Practicals		
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%)	
Category	Core		
Scope of the Course (may be more than one)	<ol style="list-style-type: none"> 1. Learn the safety rules and handling of microbiological instruments 2. Know the basic microbiological laboratory techniques 3. Understand the determination of water quality and food quality analysis 		
Cognitive Levels addressed by the Course	K1 - Observe the types of media, culture and staining methods K2 - Know the measurement of microorganisms by micrometry K3 - Remember the preparation of media and sterilization methods K4 - Realize the enumeration of bacteria by standard plate count method K5 - Understand the maintenance of pure cultures		
Course Objectives (Maximum:5)	The Course aims <ul style="list-style-type: none"> • 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 working procedure and principles of microscopes. • To know pure culture techniques and methods of culturing preservation and maintenance of microorganisms • To gain skill in isolation of microorganisms from various samples. 		
Unit	Content	No. of Hours	
	<ol style="list-style-type: none"> 1. a) Safety measures and rules of conduct to be followed in a microbiological laboratory. b)Cleaning of Glasswares c) Handling and Care of Microbiological Instruments. 2. a)Microscopic Examination of Living Organisms – Demonstration of motility. b)Sample preparation and characterization of microorganisms using Scanning Electron Microscope (SEM). c) Measurement of Microorganisms using Micrometry. 3. Staining Techniques – Gram's staining, Acid-fast staining, Endospore Staining and Capsule staining. 4. Basic Laboratory and Culture techniques <ol style="list-style-type: none"> a) Preparation of Culture Media for 		

	<p>Microorganisms. Preparation and sterilization.</p> <p>b) Demonstration of Techniques for Pure Culture of Micro-organisms by Serial Dilution Techniques and determination of Bacterial numbers.</p> <p>i) Streak Plate method.</p> <p>ii) Pour Plate method</p> <p>iii) Spread Plate method</p> <p>iv) Isolation of Anaerobic Bacteria</p> <p>v) Isolation and maintenance of pure cultures.</p> <p>vi) Determination of bacterial numbers</p> <p>5. Isolation of Bacteriophage from Sewage.</p> <p>6. Milk Analysis – Total Aerobic count and Methylene Blue Reductase Test</p> <p>7. a) Standard Qualitative Analysis of Water</p> <p>i) Presumptive Test for Coliform Group of Bacteria.</p> <p>ii) Confirmed Test of Coliform Bacteria.</p> <p>iii) Completed Test for Coliform Bacteria.</p> <p>b) Water Analysis for Total Bacterial Population by Standard Plate Count Method.</p> <p>8. Isolation and Enumeration of selected Microorganisms such as Bacteria, Actinobacteria, Yeast, and Moulds.</p> <p>9. Isolation of Protozoa from soil.</p> <p>10. Isolation of AM spores from soil.</p>	
References	<p>1. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (1 Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India.</p> <p>2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India.</p> <p>3. Aneja. K.R, 2002. Experiments in Microbiology plant pathology tissue culture and mushroom production technology, III Ed. New Age International publishers (P) Ltd, New Delhi.</p> <p>Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 –5) (2001 – 2003).</p>	
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1: Demonstrate standard methods for the isolation, identification and Culturing of microorganisms.</p> <p>CO2: Explain the ubiquitous nature of microorganisms</p> <p>CO3: Identify the different groups of microorganisms from different habitats.</p> <p>CO4: Evaluate the microbial load in soil and food samples</p> <p>CO5: Examine the microbial quality of air and water</p>	

Mapping of Cos with PSOs

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

DISCIPLINE CENTRIC ELECTIVE COURSES

Semester	Third	Course Code	21ZOOP03E1
Course Title	AQUACULTURE AND FISHERIES		
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%)	
Category	Core		
Scope of the Course (may be more than one)	1. Inculcate the importance of aquaculture and inland fisheries in India 2. Provide theoretical knowledge on cultivable fishes 3. Enable the students to gain knowledge on pond construction, management of fish farms and nutritional requirement of fishes		
Cognitive Levels addressed by the Course	K1 –Realize the national and international status of aquaculture K2 –Remember the types and importance of integrated fish farming 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 (Maximum:5)	The Course aims <ul style="list-style-type: none"> • To understand the aquaculture potential and kinds of aquaculture practice in India • To study the importance of Integrated fish culture • 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	Overview Aquaculture-National and Global Scenario –Aquaculture potential of India – Inland fishery resources and Coastal aquaculture resources– Types of aquaculture practices in India – Monoculture, monosex culture, polyculture, sewage – fed fish culture, pen culture, cage culture, prawn culture and Integrated fish culture.	8	
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 – Nursery pond management – Algal blooms – Control of algal blooms – control of predatory aquatic insects and weeds – Biological, mechanical and chemical methods – Physico – Chemical and biological characteristics of fish ponds. Liming –	12	

	Fertilization of ponds – Types of fertilizers – Organic and inorganic – stocking – stocking density, stocking rate and harvesting.	
III	Cultivable Fishes Indian Major Carps – Catla, Rohu, Mrigal – Exotic carps – Silver carp, Grass carp, Common carp – Minor carps – Calbasu, Bata, White carp, Fringelipped carp–Cat fishes – Singhi, Magur, Pangash – Murrel culture – Snake head murrel, Giant snake head – Selection criteria of cultivable fishes.	10
IV	Feeding Nutritional requirements – protein, carbohydrate, lipids, minerals, vitamins-weight budgeting. Feeding Methods – Types of feeds –Natural, artificial and Live feeds (Artemia & Daphnia) and their culture techniques -Feed formulation (square method)- Qualities of good feed.	10
V	Reproduction, Transportation and Diseases Induced breeding – stripping – Induced spawning by hypophyztion technique –Hatching – hatching technique – hatchery – Transport of fish seed – causes of mortality – Methods of packing and transport – open system, closed system – Transport of live fishes – Cans, Dry transport, Barrels and Vats, polythene bags – General rules for transportation– Measures of safe transport. Diseases management –bacterial, fungal, protozoan and viral diseases.	8
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. KamleshwarPandy and J.P. Shukla, 2017- Fish and Fisheries, Rastogi Publication, Meerut. 2. N.M.Chakrabarty, P.P.Chakraborty and S.C.Mondal 2010 Biology, Breeding and Farming of Important Food Fishes.Narendra Pub. House, Delhi. 3. S.C.Agarwal 2007. A Handbook of Fish Farming. Narendra Pub. House, Delhi. 4. Amita Saxena 2003 Aquarium Management Daya pub. House, New Delhi 5. Q. J. Shammi and S. Bhatnagar 2002. Applied Fisheries. Agrobios (India) <p>Reference Books</p> <ol style="list-style-type: none"> 1. 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. 2. C.B.L. Srivastava 2002 Aquarium fish keeping Kitab Mahal, Allahabad 	

	<p>3. C.B.L. Srivastava 1999 A text book of Fishery Science and Indian Fisheries. Kitab Mahal, Allahabad.</p> <p>4. V.G.Jhingram 1997. Fish and Fisheries of India, Hindustan Publishing Corporation (India), Delhi.</p> <p>6. K.P. Biswas 1992 Prevention and control of fish and prawn diseases. Narendra pub.House, Delhi. Pp. 43-69.</p>
	<p>E-Resources</p> <p>1. http://www.studocu.com/en/document/james-cook-university/introduction-to-aquaculture/lecture-notes/lecture-notes-lecture-all-full-notes/672525/view</p> <p>2. http://b-ok.xyz/book/614845/az7f54.</p>
Course Outcomes	<p>On completion of the course, students should be able to</p> <p>CO1: Understand the aquaculture potential and kinds of aquaculture practices</p> <p>CO2: Appreciate the importance of Integrated fish culture and learn the construction of fish ponds</p> <p>CO3: Familiarize the culture techniques of carps, cat fishes and murels</p> <p>CO4: Realize the nutritional requirements of fishes and culture techniques of live feeds</p> <p>CO5: Recognize the importance of induced breeding, methods of transportation and management of fish diseases.</p>

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		Course Code	
Course Title	PARASITOLOGY		
No. of Credits		No. of contact hours per week	
New Course/ Revised Course	Revised	If revised, Percentage of revision effected (Minimum 20%)	
Category			
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 parasitic diseases		
Course Objectives (Maximum:5)	The course aims <ul style="list-style-type: none"> • 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	8	
II	Protozoan Parasites Protozoan parasites: Bionomics, life cycle and control – <i>Trypanosoma</i> , <i>Leishmania</i> , <i>Giardia</i> , <i>Trichomonas</i> , <i>Opalina</i> , <i>Entamoeba</i> , <i>Plasmodium</i> and <i>Balantidium</i> .	8	
III	Platyhelminthes Parasites Platyhelminthes parasites: Bionomics, life cycle and control – tape worm (<i>Taenia solium</i>), liver fluke (<i>Fasciola hepatica</i>), blood fluke (<i>Schistosoma</i>), <i>Echinococcus granulosus</i> , <i>Hymenolepis diminuta</i> , <i>Diphyllobothrium latum</i> .	10	
IV	Nematode Parasites Nematode parasites of Animals: Bionomics, life cycle and		

	control – <i>Ascaris lumbricoides</i> , <i>Trichuris trichuria</i> , <i>Trichinella spiralis</i> , <i>Ancylostomadeuodenale</i> , <i>Enterobius vermicularis</i> , <i>Wuchereriabancrofti</i> , <i>Loa loa</i> , <i>Dracunculus medinensis</i> .	10
V	Arthropod Parasites Arthropod parasites: Bionomics, life cycle and control – <i>Phthirus pubis</i> , <i>Cimex species</i> , Reduvids, black fly, <i>Glossina</i> , <i>Pulexirritans</i> , <i>Tabanus</i> and <i>Sarcoptes scabiei</i> .	10
References	Text Books	
	<ol style="list-style-type: none"> 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	
	<ol style="list-style-type: none"> 1.M.Rahmatullah 2013 Modern Parasitology , Axis Books Pvt. Ltd. New Delhi 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. Wm.C. 	
	E-Resources	
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 parasites 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	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester		Course Code	
Course Title	ANIMAL CELL CULTURE TECHNOLOGY		
No. of Credits		No. of contact hours per week	
New Course/ Revised Course	New	If revised, Percentage of revision effected (Minimum 20%)	
Category			
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 <ul style="list-style-type: none"> • To understand the basic knowledge of animal cell culture. • To learn the types of animal cell culture • To know the equipments, 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: Structure and Organization of animal cell- History, advantages of tissue culture- limitations- types of culture- biology of cultured cells. Good Laboratory Practices (GLP), sterilization methods and techniques.	8	
II	Laboratory designing and components: Equipment and materials, aseptic technology, safety, bioethics and validation, culture vessels, and substrates – define media and supplements and serum free media.	8	
III	Basic <i>in vitro</i> techniques: Primary and established cell lines, measuring parameters of growth. Disaggregation of tissue and primary culture, Measurement of viability and cytotoxicity, apoptosis – characteristic features and molecular mechanisms.	10	

IV	<p>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.</p>	10
V	<p>Applications of Animal Cell Culture: Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, IVF Technology, toxicology studies.</p>	10
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. Castilho, L., Moraes, A., Augusto, E., Butler, M. (2008). Animal cell technology: from biopharmaceuticals to gene therapy, (1sted.): Taylor & Francis. 2. Ian Freshney, R.(2010). Culture of animal cells: A manual of basic technique and specialized applications, (6th ed.): Wiley-Blackwell. 3. John, R & Masters, W. (2000). Animal cell culture: A practical approach, (3rd ed.): OUP Oxford Publishers. 4. Pinkert, C.A. (2012). Transgenic animal technology: a laboratory handbook, (2nd ed.): Academic Press. Wilson Aruni, A & Rramadass, P. (2011). Animal tissue culture: MJP Publishers. 5. Davis, J. M. (2011). Animal Cell Culture. John Willy and Sons Ltd. USA. <hr/> <p>Reference Books</p> <ol style="list-style-type: none"> 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. <hr/> <p>E-Resources</p>	
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

GENERIC ELECTIVE COURSES

Semester		Course Code	
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 (Minimum 20%)	
Category			
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 ornamental fishes K5-Evaluate the economic importance of ornamental fish farming		
Course Objectives (Maximum:5)	<p>The Course aims</p> <ul style="list-style-type: none"> • 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 Popular tropical 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 Artificial feeds-making pelleted feed – quantity and time of feeding.Live feed organisms: Daphnia, tubifex& Artemia.	9	

IV	Breeding of Aquarium Fishes Mode of reproduction: breeding of egg layers-gold fish, fighter, angel fish and barbs and live bearers: guppy, molly, platy and swordtail – Care of the fry	11
V	Commercial Farming Economics of Commercial farming: Construction and Management of commercial ornamental fish farm: types; costs and returns up of an exporting unit.	10
References	Text Books	
	1. K.V.Jayashree, C.S.Thara Devi and N.Arumugam 2015 Home Aquarium and Ornamental Fish Culture. SaraSPublication,Nagercoil.	
	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	
	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		Course Code	
Course Title	APPLIED ZOOLOGY		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised,Percentage of revision effected (Minimum 20%)	
Category			
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 live stock 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 live stock, poultry and goat farming K5-Understand the theoretical knowledge on maintenance of honey bees, silkworm and earthworms		
Course Objectives (Maximum:5)	<p>The Course aims</p> <ul style="list-style-type: none"> • 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 live stock, diseases, parasites, dairy and poultry industries • To understand the importance of api culture, 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, rhinoceros 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 Live stock- Cattle, goat, sheep & rabbit Live-Stock diseases- tetanus, anthrax, ranikhet- Live- Stock parasites- helminthes, flies, ticks, lice and mites- Diary and Poultry industries.	9
V	Apiculture, Sericulture and Vermiculture Apiculture- Honey bees- bee hive, management of bees 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. Pradip. V. Jabde (2005) Text book of Applied Zoology. 2. 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 5 th Rev. Edn. Rastogi Publications, Meerut.	
	Reference Books 1. Gupta, S.K and P.C.Gupta (2006) General and Applied Ichthyology (Fish and 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. 5.	
	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 Live stock, diseases, parasites	

	CO5: Understand the importance of api culture, 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

MODULAR COURSES

Semester		Course Code	
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%)	
Category			
Scope of the Course (may be more than one)	<ol style="list-style-type: none"> 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 <ul style="list-style-type: none"> • 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 Spectrophometric 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.	7	
II	Electrophoresis: Principle and application: paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (Native PAGE and SDS- PAGE) and Immunoelctrophoresis	7	
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 - oligonucleotidearray and cDNA array and its applications.	6	

IV	<p>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.</p>	6
V	<p>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.</p>	6
References	<p>Text Books</p> <ol style="list-style-type: none"> 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. Gardeneret <i>al.</i>,. 1991. Principles of Genetics (8th Ed.,) John Wiley & Sons, New York. <p>Reference Books</p> <ol style="list-style-type: none"> 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. <p>E-Resources</p> <ol style="list-style-type: none"> 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 electrophoresis techniques 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	21ZOOP03M2
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	20
Category	Modular Course		
Scope of the Course (may be more than one)	4. Understand the basics of bioinformatics 5. Learn the analysis of sequence by computational methods 6. 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 <ul style="list-style-type: none"> • 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.	6
II	Sequence analysis Computational methods, homology algorithms (BLAST) for proteins and nucleic acids. PROSITE, PEAM, and Profile Scan.	6
III	Databases Analysis Use of internet, public domain databases for nucleic acid and protein sequences (EMBL, GenBank); database for protein structures (PDB).	6
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.	7
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.	7
References	Text Books	
	<ol style="list-style-type: none"> 1. Akhilash Kumar Sahu.2019. Foundations of Bioinformatics.RandomPublications,New Delhi 2. Read, TD., Nelson, KE., Fraser, CH. 2004. Microbial Genomics. Humana Press Inc., USA. 3. Rashidi, H.H. and Buchler, L.K. 2002 Bioinformatics Basics :Applications in Biological Science and Medicines, CRC Press, London 4. Stephen P. Hont and Rick Liveey (OUP) 2000. Functional Genomics, A practical Approach. 5. Perysju, Jr. and Peruski 1997. The Internet and the New Biology: Tools for Genomic and molecular Research. 	
	Reference Books	
	<ol style="list-style-type: none"> 1. Dan E.Krane and Michael L.Raymer.2006.Fundamental Concepts of Bioinformatics. Pearson Education, New Delhi 	
	E-Resources	
	<ol style="list-style-type: none"> 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

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

Semester	Fourth	Course Code	21ZOOP04M1
Course Title	RURAL BIOTECHNOLOGY		
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)	<ol style="list-style-type: none"> 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	The course aims <ul style="list-style-type: none"> • 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 <i>Spirulina</i> 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 unit with field demonstration.	7	
II	Composting technology Historical background – waste availability – factors influencing – methods- biomaturity- enrichment of Compost and crop productivity. Vermiculture Technologies: History – species – life cycles – methods – different types of waste suitable for vermicomposting. Utilization of vermicompost for crop production. Visit to vermicompost industries with field demonstration.	7	
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.	6	
IV	<i>Spirulina</i> cultivation technology Biology of <i>Spirulina</i> - cultivation methods, post harvest technology and single cell protein formulation. Visit to <i>Spirulina</i> industries with field demonstration.	6	
V	Ornamental Fish culture Present status and importance – popular varieties – Natural, artificial and live feeds – breeding techniques of egg layers – gold fish, angel fish, fighter and barbs – live bearers – guppy, molly, platy and sword tail – Economics.	6	

References	<p>Text Books</p> <ol style="list-style-type: none"> 1. Tripathi, G. 2003. Vermireources 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.
	<p>Reference Books</p> <ol style="list-style-type: none"> 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
	<p>E-Resources</p> <ol style="list-style-type: none"> 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
	<p>CO1: Evaluate the different aspects of biogas production technology</p> <p>CO2: Discuss the different types of composting technologies and how to establish a composting unit</p> <p>CO3: Explain the methods of mushroom culture and start a mushroom farm</p> <p>CO4: Summerise <i>Spirulina</i> cultivation by low-cost method</p> <p>CO5: Understand the culture technique of different ornamental fish and establish an aquarium farm</p>

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	21ZOOP04M
----------	--------	-------------	-----------

			2
Course Title	MODULAR COURSE BIONANOTECHNOLOGY		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised, Percentage of revision effected (Minimum 20%)	
Category			
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 (Maximum:5)	The Course aims <ul style="list-style-type: none"> • 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.	6	
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.	7	
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.	7
IV	Types of nanomaterials Types and their properties- Clusters- Types of clusters - Micro, small, large -Types of magnetic materials – Properties – Structural and mechanical.	6
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.	
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	
	E-Resources	
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 ofdifferent equipments used for the characterization ofnanoparticles 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