M.Sc., ZOOLOGY

SYLLABUS
(2021-22 onwards)

Department of Biology
The Gandhigram Rural Institute -Deemed to be University
(Ministry of Education, Govt. of India)
Accredited by NAAC with 'A' Grade (3rd Cycle)
Gandhigram – 624 302Dindigul 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
EG	-	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
	21Z00P0422	Dissertation	6	12	-	-	75	75*+ 50**	200
	21GTPP00H1	Human values and Professional ethics	2	2	-	-	50	-	50
		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 CentricCourses(3credits)	**List of Modular Courses(2 Credits)**
21ZOOP03E1 Fisheries and Aquaculture	21ZOOP03M1Advanced Molecular Techniques
21ZOOP03E2 Parasitology	21ZOOP03M2 Bioinformatics
21ZOOP03E3 Animal Cell Culture Technology	21ZOOP04M1 Rural Biotechnology
List of Generic Elective Courses (3 Credits)	21ZOOP04M2 Bionanotechnology
21ZOOP02E1 Ornamental Fish Culture	21ZOOPO4M3 Intellectual Property Rights
21ZOOP02E2 Applied Zoology	

Value Added Courses(21ZOOP0VA)

Course Code	Course Title	Credits
21ZOOPOVA1	Rural Biotechnology	2
21ZOOPOVA2	Fisheries and Aquaculture	2
21ZOOPOVA3	Ornamental Fish Culture	2
21ZOOPOVA4	Applied Zoology	2

Name of the Programme	M.Sc., ZOOLOGY				
Year of Introduction	2007		Year of Revision		2021
Semester -wise Courses and Credit Distribution	I	II	III	IV	Total
No. of Courses	7	8	8	6	29
No. of Credits	22	24	22	22	90

OBE ELEMENTS FOR M.Sc., ZOOLOGY PROGRAMME

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1:To gain technical aptitude and in-depth knowledge in the relevant field.

PEO2: To independently carry out practicals, project and interpret the results scientifically.

PEO3: To utilize the skills developed for gainful employment.

PEO4: To update their knowledge periodically to match international standards.

PEO5: To enhance the intellectual foundation and prepare themselves for life in a complex,dynamic and technological world.

PEO6: To preserve, add to and transmit knowledge in the relevant field.

PROGRAM OUTCOME (PO)

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

PO2: Gain Analytical skills in the relevant field.

PO3: Be able to design/conduct investigations and develop solutions to solve problems using appropriate tools.

PO4: Use knowledge gained from the public health and safety, cultural, societal and environmental needs which are friendly and sustainable.

PO5: Work individually/as group, have professional ethics,able to prepare & execute projects and use knowledge obtained /update it lifelong.

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 thesocietal, 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	30
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 ofvarious theories and concepts in invertebrata K4-Analyze the structure and functions of special organs K5- Economic values of invertebrates		
Course Objectives	The Course aims • to know the international nomenclature and classification of different phyla up to classes • to able to know the feeding,locomotion and reproduction of animals • to familiarizethe morphological and physiological adaptations of animals		

	• to understand the phylogeny, larval forms andmetamorphosis of insects • to understand the structural similarities, fossils and economic importance of Invertebrates

Unit	Content	No. of Hours
I	**BriefIntroduction** Classification - Broad outline - International code of Zoological nomenclature - Organization of coelom –Acoelomates – Pseudocoelomates - Coelomates: Protostomia and Deuterostomia - Classification of phylum (uptoorders with examples)- Protozoa- Amoeba; Porifera - Sponges; Coelenterata - Hydra; Platyhelminthes – Taeniasolium;Aschelminthes- Ascaris;Annelida-Earthworm;Arthropoda-Cockroach,Mollusca-PilaglobosaandEchinodermata - Starfish -Salient features.	11
II	**Protozoa,PoriferaandCoelentrata** 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-Structuralpeculiarities,generalcharactersandaffinities.	14
III	**Platyhelminthes, AschelminthesandAnnelida** Platyhelminthes - Morphological and physiological adaptations-parasitic diseases.Aschelminthes- sexual dimorphism, life cycle and diseases. Annelida-DifferentclassesofAnnelida-Morphologicalfeaturesandaffinities.Metamerismin Annelids.	13
IV	**ArthropodaandMollusca** Arthropoda: Phylogeny of Arthropoda, Crustacean larvae and their significance. Connecting linkbetween annelids and arthropods - Metamorphosis in insects - Mollusca: Origin of Mollusca,Torsionin Gastropoda.	13
V	**EchinodermataandMinorPhyla** Echinodermata-WaterVascularSystem.SignificanceofEchinodermlarvaeMinorPhyla:Structural peculiarities and affinities of Rotifera. Invertebrate fossils -Trilobites, Brachiopoda,CephalopodaandEchinodermata. Economicimportanceof Invertebrates.	13

References

Text Books

1. VasantikaKashyab. 2019. A Text book of Invertebrate Zoology. KNRN Publications, Meerut
2. R.L. Kotpal .2017. Modern text book of Zoology- Invertebrate- Rastogi Publication, Meerut.
3. M.Ekabaranatha Iyar and T.N. Ananthakrishnan (Recent Edition) Manual of Zoology. Vol. I. Part I & II, Visvanathan Publications, Chennai
4. N.C Nair, A. Thangamani, S. Leelavathy, S. Prasanakumar, N. Soundrapandian, T.Murugan L. M. Narayanan and N. Arumugam, 2017, Animal diversity (Invertebrata& Chordata), Saras Publication, Nagarcoil.
5. Fatik Baran Mandal. 2012. Invertebrata Zoology, PHI, Learning Private Limited,

	New Delhi – 110001.
	Reference Books 1. E.L. Jordan and P.S. Verma 2018 Invertebrate Zoology, S. Chand & Company Ltd, New Delhi. 2. R. L. Koptal- 2017, Animal Diversity, Rastogi Publication, Meerut. 3. Fatik Baran Mandal.2012. Invertebrate Zoology. PHI Learning Pvt. Ltd. 4. 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, Coelentrata, Platyhelminthes, Aschelminthes,Annelida, Arthropoda, Mollusca andEchinodermata CO3: Understand the functional activities of organisms CO4: Understand the parasitic adaptations of tape worm, flukes and flatworms & realise the diseases caused by these parasites CO5: 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

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	If revised,Percentage of revision effected	

Revised Course	Course		25
Category	Core		
Scope of the Course	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	The Course aims • 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: Stucture of poisonus gland and biting mechanism - Types of venom-Identification of poisonous and non- poisonous snakes. Birds as glorified reptiles- flight adaptation in birds	8
IV	**Mammals** Mammals - Structural peculiarities ofPrototheria, MetatheriaandEutheria-Dentition in Mammals- Aquatic Mammals and their adaptations.	12
V	**ComparativeAnatomy and Economic importance** Comparative Anatomy- limbs, heart and brain of vertebrates. Comparative account of respiratory organs in vertebrates - Economicimportanceofvertebratessuchasfishes,amphibians,reptiles, birds and mammals.	18

References	**Text Books**
	1. R.K.Saxena and Sumitra Saxena.2019.Comparative Anatomy of Vertebrates.Viva

	Books Pvt. Ltd. New Delhi.pp.227-589. 2. B.N. Yadav and D. Kumar.2018. Vertebrate Zoology.Daya Publishing House, New Delhi 3. R.L. Kotpal-2017, Modern text book of Zoology- Vertebrate- Rastogi Publication, Meerut. 4. Fatik Baran Mandal. 2012. Chordate Zoology, PHI, Learning Private Limited, New Delhi – 110001. 5. M.Ekabaranatha Iyar and T.N.Ananthakrishnan (Recent Edition) Manual of Zoology. Vol. II. Part I & II, Visvanathan Publications, Chennai.
	Reference Books 1. N.C Nair, S. Leelavathy, N. Soundrapandian, T. Murugan and N. Arumugam, 2017, Animal diversity (Invertebrata& Chordata), Saras Publication, 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. 5. Frank. A. Brown. 2002. Chordata, Biotech Books, Delhi – 110035.
	E-Resources 1. http://b-ok.xyz/book/638104/8d1a4d 2. http://b-ok.xyz/book/672318/32fa64
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the principles of taxonomy, nomenclature, binomial and taxonomic keys CO2: Describe the salient features and one example each of prochordata, cephalochordata, hemichordata and urochordata CO3: Identify Reptiles, Aves and Mammals according to their distinctive characters in their phylum and class & order CO4: Describe the structural peculiarities of protheria, metatheria and eutheria CO5: Understand Migration of birds & fishes and their importance and appreciate the parental care exhibited by fishes, amphibians, reptiles, birds & mammals

Mapping of Cos with PSOs

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

Semester	First	Course Code	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	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. Importanceof remote sensing, GIS, Environmentaleducation, 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	The Course aims • to provide fundamental environmental principles that provides an in-depth understanding of our environment. • to understand how environmental systems interfere with population and wealth of our natural resources • to understand the importance of remote sensing, 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
	Natural Resources and Conservation	

II	Natural Resources-Renewable-Biomass, biogas, solar energy, wind, tidal energy and Non-Renewable- Fossil fuels-coal, oil, natural gas, mineral and nuclear energy-Conservation of natural resources- Biodiversity -Status, types, threats and biodiversity hotspots- Wildlife conservation and management- National parks, sanctuaries and biosphere reserves.	14
III	**Remote Sensing,GIS and Environmental Education** Remote sensing-Components, types and applications-GIS and its application-Environmental Education-Objectives, goals, scope, guiding principles and Centre for Environmental Education.	8
IV	**Pollution and Environmental Acts** Pollution-Types-Air, water, soil and radio-active-sources, biological effects and control -Environmental protections acts - Air and water-Environmental Laws.	11
V	**Environmental ImpactAssessment, Monitoring and Treatment** Environmental Impact Assessment- steps and methods - Public participation in environmental decision making– Impact Analysis and Environmental Audit-Green Audit - Environmental Standards-Air and water- Bio indicators and Environmental Monitoring-Bioassay –Application in Environment - Physical, chemical and biological treatment of liquid effluents.	18

References	**Text Books** 1. P.S.Verma and V.K.Agarwal. 2019. Environmental Biology.S.Chand and Company,NewDehi. 2. P.D. Sharma 2017. Ecology and Environment- Rastogi Publication, Meerut. 3. Metcalf and Eddy 2011 Waste water Engineering- Treatment and Reuse.Tata Mc Graw Hill Education Pvt.Ltd, New Delhi. Pp.311-1026. 4. S.K.Agarwal. 2002 Eco – informatics. Vol I, III, IV APH pub. Company, New Delhi. Vol. I: 135 – 165 : 265 – 311; Vol. III : 221 – 259; Vol. IV : 1-140. 5. Kailash Thakur 1997 Environmental protection law and policy in India. Deep and Deep pub. New Delhi. pp. 184-197; 210 – 248.
	Reference Books 1. G.Tyler Miller and Scott E. Spoolman. 2019. Environmental Science.Cengage Learning India Pvt.Ltd.Delhi. 2. P.D. Sharama 2013, Environmental Biology and Toxicology- Rastogi Publication, Meerut. 3. V.S. Kulkariani, S.N. Kaw and R.K. Trivedy 2002. Environmental Impact Assessment for wetland protection. Scientific publishers (India). 4. 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. 5. Rajesh Gopinath and N.Balasubramanya. 2018. Environmental Science and Engineering. Cengage Learning India Pvt.Ltd.pp.36-179.
	E-Resources 1. http://nptel.ac.in/courses/122103039/40 2. http://b-ok.xyz/book/671429/bc900f 3. http://b-ok.xyz/book/2463090/f0ce34
Course	On completion of the course, students should be able to

Outcomes	CO1 : Understand the components of environment,ecosystems, interactions of organisms, and appreciate howelements are cycling in the environment CO2 : Identify the natural resources,types of biodiversity and status and importance of national parks,sanctuaries and biosphere reserves CO3 : Understand remote sensing, GIS and their applications CO4 : Describe the types, biological effects and control of pollution andthe importance of Environmental Acts. CO5 :Recognize the need of Environmental impact assessement,environmental audit, monitoring and treatment of effluents.

Mapping of Cos with PSOs

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

Semester	First	Course Code	21ZOOP0104
Course Title	**MOLECULAR BIOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	30
Category	Core		
Scope of the Course (may be more than one)	1.Learn the central dogma of molecular biology 2. Understand the structure and functions of DNA, RNA and proteins 3. Know the molecular basis of DNA replication, transcription and translation		
Cognitive Levels addressed by the Course	K1- Ability to remember historical developments of molecular biology K2- Comprehensive knowledge on molecules of life K3- Use molecular techniques for better understanding of structures of DNA, RNA and Proteins K4- Capacity to analyse mutagenesis and molecular recombination K5- Make new techniques to study molecular mechanism of antisense molecules K6- Assessment of functions of DNA, RNA and Proteins		
Course	The course aims		

Objectives	• 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	**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.	13
II	**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 – 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 - RNAploymerases – 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 -	13

	biochemistry of ribozyme (hammerhead, hairpin, and other ribozyme) – strategies for designing ribozymes – applications of antisense and ribozyme technologies.	
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 – link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene expression. Functional genomics, Validation of gene function. Gene silencing, PTGS, RNai, Antisense technology, Applications. Molecular Pharming. Genome Editing tools- ZFNs, TALENs and CRISPR-Cas9.	12

References	**Text Books** 1. David Freifelder, 2020, Molecular Biology, 4th Reprint., Narosa Publishing House, New Delhi, India. 2. George M.Malacinski.2019. Freifelder's Essentials of Molecular Biology.Jones&Barlett India Pvt.Ltd 3. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017. Lewin's Genes XII Oxford University Press. 4. Alberts et al., 2012.Molecular Biology of the Cell, Garland Publications. 5. B. Lewin 2000, Genes VII Oxford University Press.
	Reference Books 1. K.Saminathan and G.Nagarajan.2018. Fundamentals of Molecular Biology.Sonali Publications. 2. J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick.2012. LEWINS Gene XI. Jones and Barttlett Publishers. 3. David Rawn .2012. Biochemistry. Panima Publishers. 4. Richard Calendar. 2005. The Bacteriophages, 2nd Edition, Oxford University Press. 5. Buchanan, Gruissum and Jones. 2000. Biochemistry and Molecular Biology of Plant; ASPP, USA. *(NPTEL) - National Programme on Technology Enhanced Learning.
	E-Resources 1. www.cellbio.com/education.html 2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html 3. global.oup.com/uk/orc/biosciences/molbio/ 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html
Course Outcomes	On completion of the course, students should be able to
	CO1: Outline the fundamental concepts of 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 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	35
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. Visittoseashoreandobservationof economically important crustaceans, molluscs,echinodermsandfishes.		
Cognitive Levels addressed by the Course `	K1 - To understand the microscopic animals of different phyla K2 - To learn the different types of animals K3 - To identify the different organisms K4 - Analyze the characteristics of insects of different orders K5 - Assess the morphometrics of fishes and prawns		
Course Objectives	The Course aims • 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. • to study the morphometrics of fish and prawns • to identify teleosts, elasmobranches, amphibians, reptiles, aves& chosen Mammals.

Practicals	Contents	No. of Hours
1.	Identification and study of protozoans– Amoeba,Euglena,Volvox,Chlamydomonas,Trypanosoma and Paramecium.	4
2.	Identification and study of Poriferans – Sponges	4
3.	Identification and study of Coelenterates – Hydra,Jellyfish and Corals.	4
4.	Identification and study ofPlatyhelminthes – LiverflukeandTapeworm).	4
5.	Observation of Nematodes (Round worm, Pin worm, Whip worm, Microfilaria and Hookworm).	4
6.	Identificationof Annelids - Earthworm,Nereis andLeech	4
7.	Identification of insectsofdifferentorders andarachnids	4
8.	Study of morphometricsoffishandprawns.	4
9.	Identificationofteleosts,Elasmobranchs,amphibians,reptiles,aves&chosenmammals	4
	Visittoseashoreandobservationofcrustaceans, molluscs,echinodermsandfishes.	4
10.	Visittofishfarms, aquariumandmuseum.	8
	CFA	8
11.	Record Work	4
		6

	References 1. S.S. Lal-2018, Practical Zoology- Invertebrate. Rastogi Publication, Meerut. 2. S.S. Lal-2018, Practical Zoology- Vertebrate. Rastogi Publication, Meerut. 3. Jeyasurya,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	On completion of the course, students should be able to
	CO1 : Identify the important microscopic animals of different phyla. CO2 : Know the types of worms CO3 : Identify earthworms, Nereis, leech ,insects of different orders and Arachnids CO4 : Observation of crustaceans, molluscs, echinoderms; Gaining knowledge

	through field visit to sea shore and fish farms CO5 : Identify teleosts, elasmobranchs, amphibians, reptiles, aves& Mammals.

Mapping of Cos with PSOs

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

Semester	First	Course Code	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%)	25
Category	Core		
Scope of the Course (may be more than one)	1. Opportunity to understand the basic concepts of experiments in Environmental Biology 2. Exposure of students to approaches and techniques of Environmental Biology 3. Providing skills to handle the experiments in Environmental Biology		
Cognitive Levels addressed by the Course	K1- Emphasis the importance of physico-chemical parameters in Environment K2- Understand the different parameters of the environment K3-Apply the methods of studying the population of plants K4- Analyze the importance of remote sensing, GIS and Environmental Education K5-Evaluate the effect of industrial effluents and pesticides on Organisms		
Course Objectives	The Course aims • to estimate total solids,dissolved solids and suspended solids,dissolved oxygen, carbon dioxide, total alkalinity, chloride, hardness, and turbidity in different water samples • to know the importance of BOD and COD in polluted water samples		

	• to understand how to study the population of plants. • to understand how to design bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae. • to know the applications of remote sensing and GIS

Practicals	Content	No. of Hours
1.	Estimation of Total Solids, Dissolved solidsand Suspended Solids.	3
2.	Estimation of Dissolved oxygen	3
3.	Estimation of Carbon dioxide	3
4.	Estimation of BOD & COD in different water samples (Demonstration).	6
5.	Estimation of Total Alkalinity.	3
6.	Estimation of Chloride.	3
7.	Estimation of Total hardness.	3
8.	Estimation of Turbidity	3
9.	Quadrant study on population.	3
10.	Bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae.	6
11.	Visit to Centre for Geology, GRI, Gandhigram for remote sensing & GIS.	3
12.	Visit to Drinking water and effluent treatment plants.	6
	Reagent Preparation	10
	CFA	4
	Record Work	3

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 andwaste water (20^{th} Edition). American Public Health Association, Washington. D.C.

Course Outcomes	On completion of the course, students should be able to
	CO1 : Understand how to estimate Total Solids, Dissolved solids, suspended Solids, Dissolved oxygen,Carbon dioxide, Total alkalinity, Chloride, hardness, turbidity, BOD and COD in different water samples CO2 : Understand how to study on population of plants. CO3 :Understand the Bioassay studies on industrial effluents/ pesticides using fish, aquatic insects and larvae. CO4 : Understand the applications of remote sensing and GIS in environment. CO5 : Know the methods of treating drinking and effluent water samples.

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

21GTPP0001 GANDHI IN EVERYDAY LIFE Credits : 2
(Offered by Department of Gandhian Thought and Peace Science, GRI-DU, Gandhigram)

Semester	First	Course Code	21GTPP0001
Course Title	**GANDHI IN EVERYDAY LIFE**		
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			
Scope of the Course (may be more than one)			
Cognitive Levels addressed by the Course			
Course Objectives	The Course aims • To understand and appreciate the principles and practices of Gandhi and their relevance in the contemporary times. • To develop noble character and attitude to enable the students to cope up with the challenges of daily life.		

Unit	Content	No. of Hours
I	**Understanding Gandhi:** Childhood days, Student days, influence of dramas, books, individuals, religions, family and social factors - Gandhi as rebel, mimicking western civilization, acquaintance with vegetarianism, as lawyer - encountering and transforming humiliation in India: with British Agent - in south Africa: train incident, Coach incident, on path way, at court, attack by protesters - Gandhi as political leader, social reformer and Constructive worker.	
II	**Management**: Gandhi's experiments in managing family - Eleven vows - Managing Organizations - community living and financial ethics - Managing Social and political movements - Transvaal March - Noncooperation movement and Salt Satyagraha - non - attachment to position.	
III	**Conflict Resolution**: Pursuance of Truth and nonviolence - Rights and duties, Ends and means - Openness, love and kindness in handling relationship - nonviolent communication - nonviolent Direct Action (Satyagraha) and conflict Transformation - Conflict resolution practices in interpersonal relations, forgiveness and reconciliation - Shanti Sena.	
IV	**Humanism**: Trust in goodness of human nature - Respect for individual and pluralistic nature of society - equal regard for all religions (SarvadharmaSamabhava) - simple and ethical life - swadeshi and unity of humankind.	12

V	**Sarvodaya**: Concept of Sarvodaya - Constructive Programmes - Gandhian alternatives to poverty, terrorism, environmental degradation, issues in education, science and technology, centralization of power and governance and health and hygiene.	13

References	M.K. Gandhi, An Autobiography or The Story of My Experiments with Truth, Navajivan Publishing House, Ahmedabad. ---. Satyagraha in South Africa, Navajivan Publishing House, Ahmedabad. ---. Constructive Programme: Its Meaning and Place, Navajivan Publishing House, Ahmedabad. ---. Key to Health, Navajivan Publishing House, Ahmedabad. ---. Diet and Diet Reform, Navajivan Publishing House, Ahmedabad. ---. Basic Education, Navajivan Publishing House, Ahmedabad. ---. Village Industries, Navajivan Publishing House, Ahmedabad. ---. Hind Swaraj, Navajivan Publishing House, Ahmedabad. ---. Trusteeship, Navajivan Publishing House, Ahmedabad. ---. India of my Dreams, Navajivan Publishing House, Ahmedabad. Vinoba, Shanti Sena, Sarva Seva Sangh Prakashan, Varanasi. V.P.Varma, Political Philosophy of Mahatma Gandhi and Sarvodaya, Lakshmi Narain Agarwal, Agra. Louis Fisher, Gandhi: His Life and Message . B.R. Nanda. Mahatma Gandhi: A Biography, Allied Publishers Private Ltd., New Delhi. N.K. Bose. Studies in Gandhism, Navajivan Publishing House, Ahmedabad. Gopinath Dhawan, The Political Philosophy of Mahatma Gandhi, Navajivan Publishing House, Ahmedabad. N. Radhakrishnan, Gandhi's Constructive Programmes: An Antidote to Globalized Economic Planning?, Gandhigram Rural Institute, 2006.
	Web Link: www.mkgandhi.org https://www.mkgandhi.org/ebks/gandhian_thought.pdf
	Films. Richard Attenborough, **Gandhi.** SyamBenegal**, Making of The Mahatma.** Anupam P. Kher, **Mein Gandhi Ko Nahin Mara**. Peter Ackerman and Jack Duvall, **A Force More Powerful**.
Course	On completion of the course, students should be able to

Outcomes	CO1: Understand the life and message of Gandhi in modernity. CO2 :Know the Gandhian way of Management. CO3: Practice the Gandhian model of conflict resolution. CO4 :Lead a humane life on Gandhian lines. CO5 :Become a Gandhian constructive worker.

Mapping of Cos with PSOs

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

Semester	Second	Course Code	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	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	The Course aims • to study the classification, structure and properties of different biomolecules and enzymes. • to understand the various physiological mechanisms and functioning in the animal kingdom. • to enable the students to understand the physiological aspects of life. • to apply the knowledge in day-to-day life. • to know the anatomy of different organ system and their specific functions.		

Unit	Content	No. of Hours
I	**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 – 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, substrate strain theory-Factors affecting enzyme activity-Effect of pH, temperature, time, light, radiation, enzyme concentration, substrate concentration and Michael's – Menten equation-Enzyme specificity and enzyme inhibition.	12

III	**Nutrition, Digestion,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&parathyroid,pancreas,ovary&testis.(Source:NPTEL).	13

References

Text Books

1. S. Rajan and R.Selvichristy. Biochemistry.2020. CBS Publishers & Distributors Pvt.Ltd.New Delhi.pp.1-60;144-160.
2. KeshawTrehan. 2019. Biochemistry. New Age International Publishers.pp.55-88;291-311.
3. S. Prasanakumar, A. Meena, R.P. Meyyan Pillai, Dulsy Fathima, L.M. Narayanan, and K Nallasingam.2017, Animal Physiology and Biochemistry, Saras Publication, Nagarcoil.
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. T.A.Brown.2018.Biochemistry.Viva Books,New Delhi. pp.36-150.
2. K. V. Sastry& Priyanka, Mathur- 2018, Animal Physiology and Biochemistry, Rastogi Publication, Meerut.
3. U.Satyanarayana and U.Chakrapani. 2017. Fundamentals of Biochemistry.Books and Allied (P) Ltd. Kolkotta.pp.4-31.
4. Eckert and Randall Second Edition, Animal Physiology – Mechanisms and Adaptations W.B. Sounders Company, Philadelphia
5. C. Ladd Prosser (Third Edition), Comparative Animal Physiology.1973. W.N. Sounders Company, Philadelphia

E-Resources

1. https://onlinecourse.nptel.ac.in/noc18bt14/preview.
2. https://b-ok.org/book/2595944/cab169
3. https://b-ok.org/book/989964/a5ob8a

*(NPTEL) -National Programme on Technology Enhanced Learning.

Course Outcomes	On completion of the course, students should be able to
	CO1: Learn the Classification, structure and properties of protein, carbohydrate, Lipids and enzymes CO2 : Learn animal foods & nutritive types, feeding mechanisms in different animals and process and role of enzymes in digestion, absorption & assimilation CO3: Recognize the presence of different types of respiratory pigments &their Functions CO4 : Identify organs involved in respiration, circulation and excretion among mammals CO5 : Able to understand the structure and functions of receptors, nerve, muscle and endocrine glands.

Mapping of Cos with PSOs

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

Semester	Second	Course Code	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	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	K1- Understand the structure and life cycle of insects K2- Learn the medically important and forensic insects K3- Evaluate the economic importance helpful and productive insects K4- Realize the insect pest of economically important plants K5- Analyze the different methods of pest control and need for transgenic plants		

Course Objectives	The Course aims • to understand the insects by studying their general organisation, structure, life cycle and importance. • to know the life cycle and control of medically important 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	13
II	**Medical and Forensic Entomology** Medical entomology – Bionomics, life cycle and control of Arthropods of medical importance:mosquitoes,sand fly,fleas and lice. Insects of forensic importance- Corpse feeders – Maggots – life cycle -Role of insects in crime investigation.	13
III	**Plant Pests** Plant pests – Leaf folder in rice; pink bollworm in cotton;PyrillaPerpusilla insugarcane;fruit fly infruits;fruit borer in Pomogranate;ground nut – red hairy caterpillar in groundnut –Rhinocerosbeetleincoconut –pests ofstored products – Callosobruchus maculatus in Pulses – Sitophilus oryzae in rice;Apple scale.	13
IV	**Economic Importance** Productive & helpful insects: Bionomics, life cycle and economic importance – silkworm, honey bee, lac insect, pollinators and other helpful insects.	11
V	**Pest Control** Insect Control: Natural control, cultural control, applied control and legal control. Role of pheromones in pest 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.	12

References	**Text Books** 1. P.K. Sehgal. 2018. Entomology -An Illustrated Textbook, New India Publishing Company, New Delhi.pp.243-276. 2. M.S.NalinaSundari and R.Santhi.2017.Entomology.MJP Publishers, Chennai.pp.133-238;241-257;291-338. 3. K.K. Nayar, T.N. Ananthakrishnan& B.V. David.1996. General&Applied entomology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 4. Larry P, Pedigo.1996. Entomology and Pest management. Prentice Hall of India Ltd., New Delhi. 5. Ashok Kumar & Prem Mohan Nigam. 1991 Economic & Applied Entomology Emkay Publications, Delhi.

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

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21ZOOP0208
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	The Course aims		

Objectives	• To evaluate the structure of cell and its various organelles • To demonstrate the organization of genes and chromosomes • To analyse the various aspects of organization of Chromosomes • 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,structureofchromatinandchromosomes,heterochromatin,euchromatin,transposons). Cell division and cell cycle; Mitosis and meiosisregulationandcontrol 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 inducting 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. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	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

References	**Text Books** 1. Aminul Islam. 2018. Essentials of Cell Biology. Books and Allied (P)Ltd, Kolkotta 2. Verma, P.S. and Agarwal, V.K. 2018. Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S.Chand& Company Ltd. New Delhi. 3. SundaraRajan, S. 2003. Introduction to Cell Biology. Vikas PublishingHouse Pvt.Ltd., New Delhi. 4. M.M.Moris. 2020. Genetics Vol.I& II.CBS Publishers & DistributorsPvt.Ltd. New Delhi 5. Benjamin A. Pierce. 2012. Genetics- A conceptual Approach. W.H. Freeman and Company, New York, England.
	Reference Books 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 nd 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.
	E-Resources 1. www.oxfordtextbook.co.uk/orc/thrive/. 2. https://t.co/LJhgVker0g 3. https://acadamic.oup.com/genetics 4. www.oup.com/uK/maneely
Course Outcomes	On completion of the course, students should be able to
	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.

Mapping of Cos with PSOs

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

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 • 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

1. Veer Bala Rastogi, Biostatistics, Medtech publication, (3rd revised Edition), 2017.
2. Qazi Shoeb Ahmad, Viseme Ismail, Biostatistics, University Science press, new Delhi, (1st Edition), 2008.
3. Sampath Kumar V.S; Bio-Statistics, ManomaniamSundaranar University Publication, Tirunelveli, 1997.
4. Verma B.L, Shukla G.D and Srivastava.R.N, Biostatistics – Perspectives in Health Care; Research and Practice, New Delhi: CBS Publishers & Distributors, 1993.
5. W.G.Cochran, Sampling Techniques, Wiley Eastern Ltd, New Delhi, (1985).

Reference Books

1. Rangaswamy, A Textbook of Agricultural Statistics, (3rd Ed), New Age International Publishers, New Delhi, 2020.
2. Gupta. S.P, Statistical Methods, New Delhi: Sultan Chand, 2017.
3. Hogg. R.T. and A.T. Craig. A.T, Introduction to mathematical Statistics, (7thEd), 2012.
4. Rohatgi, V. K. and A. K. md.EhsanesSaleh(2009) An Introduction to Probability Theory and Mathematical Statistics, 2nd Edition, Wiley Eastern Limited, New Delhi.
5. Gupta. C.B, An Introduction to Statistical Methods, New Delhi: Vikas Publishers, (23rd Ed), 2004.

E-Resources

1. https://www.biostat.washington.edu/about/biostatististics

	2. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_BiostatisticsBasics 3. https://www.edx.org/course/biostatistics-0
Course Outcomes	On completion of the course, students should be able to
	CO1: Get acquainted with basic concepts of statistics and its relevance 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	3	3	3	1	2
CO2	3	2	3	1	3
CO3	3	3	1	3	3
CO4	3	3	1	3	3
CO5	3	3	1	2	3

Semester	Second	Course Code	21ZOOP0210
Course Title	**BIOCHEMISTRY AND ANIMAL PHYSIOLOGY PRACTICALS**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	20
Category	Core		
Scope of the Course(may be more than one)	1. 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	K1- Learn the importance of protein, carbohydrate, lipids and enzymes K2- Gain knowledge on biochemistry of blood groups K3- Analyze ammonia, urea, glucose and vitamin C K4- Estimate the total cholesterol K5- Evaluate the amounts of free aminoacids		
Course Objectives	The Course aims • 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

Practicals	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.	Qualitative detection of proteins, carbohydrates and lipid in animal tissue samples.	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	Opercular activity of fish in relation to temperature	4
	CFA	4
	Chemicals preparation for each practical -10 X 1	10
	Record Work	7
References	Reference Books 1. S. Rajan and R.Selvi Christy.2020. Experimental Procedures in Life Sciences. Anjana Book House, Chennai 2. J.Sinha, A.K.Chatterjee and P.Chattopadhyay. 2017. Advanced Practical Zoology. Books and Allied(P) Ltd. Kolkotta	
Course Outcomes	On completion of the course, students should be able to	
	CO1 : Understand the importance of estimating protein, free amino acids, total carbohydrates, cholesterol. CO2 : Understand the estimation of enzymes CO3 : Identify the ABO blood groups CO4 : Understand the importance of estimating ammonia and urea CO5 : Understand the role of glucose in urea and importance of vitamin C	

Mapping of Cos with PSOs

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

Semester	Second	Course Code	**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 • 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. *Mastering Communication Skills and Soft Skills*. Blomsbury, 2015.

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/ RevisedCourse	Revised Course	If revised,Percentage of revision effected	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	The Course aims • To understand the principles and applications of ordinary and electron microscopes • To learn the techniques in isolation and separation of cell organelles, micro and macromolecules. • To imbibe the principle and applications of Electrophoresis, colorimetry and calorimeter • To understand the research methods,thesis writing and presentation • To learn the article publication,ethics and IPR.		

Unit	Content	No. of Hours
I	**Microscopy, pH and Buffer** Microscopy- Principle and Applications- Light,phase contrast,Confocal and Fluorescence – Electron Microscopy -SEM and TEM(Source: NPTEL) - 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 (Source: NPTEL) – Chromatography- Paper, thin layer, Ion-exchange, column- separation of amino acids and sugars- Gas liquid chromatography, GC-MS,HPLC.	13
III	**Electrophoresis, Colorimetry and Calorimeter** Electrophoresis- General Principles Horizontal & Vertical gel electrophoresis and immune electrophoresis (Source: NPTEL)-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	13

	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	
V	**Article Publication,Ethics and Intellectual Property Rights** Writing scientific paper- Organization of scientific paper- Publication in research journals-Standards of Research journals- Peer review-Types- Impact factor-citation index,h-index,i10 index-Preparation of manuscript- Proof correction-proof correction symbols- Method of correcting proof- Plagiarism checking-Use of plagiarism softwares– Preparation of Research proposal and funding agencies and Research fellowships- Ethics in research-Plants and animals - Intellectual Property Rights- Origin and history of Indian Patent system- Basis of patentability- Patent application procedure in India.	14

References

Text Books

1. L.Veerakumari.2019.Bioinstrumentation.MJP Publishers, Chennai. pp.39-98;113-153;185-375.
2. C.R.Kothari and Gaurav Garg.2019. Research Methodology- Methods and Techniques. New Age International Publishers,New Delhi.pp.1-25.
3. Biju Dharmapalan 2012 Scientific Research Methodology. Narosa Publishing House, New Delhi.
4. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai.
5. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani

Reference Books

1. Sahu, P.K. 2013. Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and other related fields. Springer, New Delhi.
2. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi.
3. Keith Wilson and John Walker 2002 Practical biochemistry – Principles and techniques. Fifth Edn. Cambridge Univ. Press.
4. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First Edition – Chinnaa publications, Melvisharam, Vellore
5. Rodney Boyer 2001 Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.

E-Resources

1. http://nptel.ac.in/syllabus.php?subject Id= 102107028.
2. http://b-ok.xyz/book/674611/288bc3
3. http://www.researchgate.net/publication/317181728- Lecture Notes on Laboratory Instrumentation and Techniques.
4. iiscs.wssu.edu/drupal/node/4673
5. http://www.studocu.com/en/search/research methodology?languages=language_en&type =document

*(NPTEL) -National Programme on Technology Enhanced Learning.

Course Outcomes	On completion of the course, students should be able to
	CO1:Enabling the students to understand the principles and applications of different Typesof microscopes, pH meter and buffers. CO2:Providing excellence in isolation and separation techniques. CO3:Enhance the application and separation techniques of various micro and macromolecules CO4:Explain the basic information on research methods CO5: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	
Category	Core		
Scope of the Course (may be more than one)	1. Understand the basic principle and theories of evolution 2. Make the students to learn the basis of molecular evolution 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	The Course aims • To understand the concept of evolution. • To understand the role of genes in evolution • To learn the concept of species and speciation • To gain knowledge on variations and mutations in evolution • To know the aspects of human evolution and human races.		

Unit	Content	No. of Hours
I	**Evolutionary Theories** Principles of Lamarckism, Neo-Lamarckism, Darwinism and Neo-Darwinism, Mutation Theory, Biogenetic Law. Genetic variability, Natural selection, Genetic drift, Founder Principles. Behavioral Evolution- Altruism and evolution – Group selection and kin selection.	13
II	**Molecular Evolution** 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 Haemoglobin1, Cytochrome C - Molecular clocks.	13
III	**Variations** Types of Variation, Cytological basis of variations, Chromosomal aberrations- Population genetics - Gene frequency, genetic equilibrium, Hardy Weinberg's Law of equilibrium.	12
IV	**Speciation** Isolation – Isolating mechanisms. Concept of Species, types of speciation - Migration and Gene flow, Darwin finches, Speciation, adaptive radiation, adaptive divergence, mimicry - Monophyly and Polyphyly	13
V	**Human Evolution** Evolution of Man, Origin of Man, Special features of primates, Compelling causes of evolution of Man, Evolutionary trends, Cultural evolution, Civilization, human races, future of man.	13

References

Text Books

1. Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. & Patel, N.H. 2007. Evolution. CSHL Press.
2. Futuyama, D. 2005. Evolution. Sinauer Associates, INC.
3. Stearns, S. C. &Hoeskstra, R. F. 2005. Evolution. Blackwell Science Ltd.
4. Bipin Kumar. 2001.Organic Evolution.Campus Books International, New Delhi .
5. S.N.Prasad. Evolutionary Biology. Campus Books International, 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 UniversityPress.
5. King, M. Species Evolution –The role of chromosomal change.The Cambridge University Press, Cambridge.

E-Resources

1. https://www.yourgenome.org
2. https://ncert.nic.in

Course Outcomes	On completion of the course, students should be able to
	CO1: Gain knowledge on evolutionary theories and mechanism of natural selection CO2: Understand the molecular evolution and gene families. CO3: Realize the types of speciation and isolating mechanisms CO4:Learn the origin of life and human evolution. CO5:Know the Hardy-Weinberg equilibrium and population genetics

Mapping of Cos with PSOs

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

Semester	Third	Course Code	21ZOOP0314
Course Title	**DEVELOPMENTAL ZOOLOGY AND IMMUNOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	40
Category	Core		
Scope of the Course (may be more than one)	1. Enable the students to know about the process of gametogenesis, structure of spermatozoa & ova and mechanism of fertilization 2. Reveal the process of organogenesis and development of brain, heart and ear 3. Help the students to understand the basis of immunity and functions of immune system		
Cognitive Levels addressed by the Course	K1- Make the students to understand the various concepts in developmental biology and immunology K2- Apply basic 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	The Course aims • to make the students to understand the various concepts of development. • to enable the students to understand the basic principles of growth and development • to understand the application of developmental biology • to understand the nature and components of defence mechanism of human body • to identify major components of the immune system at organ, cellular and molecular levels		

Unit	Content	No. of Hours
I	**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	**Genes and Development** Development of chick embryo – 24, 48, 72 & 96 hrs.Extra embryonic membranes.Placentationinmammals. Developmental genetic defects-Regeneration, aging (source NPTEL) and teratogenesis. Assisted Reproductive Technology (ART) – Male infertility – Sperm abnormalities – Superovulation – IVF, ICSI, GIFT.	7
IV	**Immunity** 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.	10
V	**Antigen,Immunogenicity and Immunoglobins** Antigen – Classification – Exogenous, endogenous, autoantigens, tumor antigens, allogenic, xenogeneic, idiotypic- Immunogenicity – Chemical characteristics-Foreignness ,molecular size, chemical complexity, MHC,HLA and transplantation -antigen processing and presenting- Biological characteristics-Genotype of the host, Immunogen dose and route of administration-Antigenicity, Haptens, Epitopes and types, Adjuvant types, mitogens, Types, properties and functions(Available NPTEL)-Immunoglobins – Types, structure and properties of immunoglobin - Antigen determinants of immunoglobulins-isotypes, allotypes and idiotypes.	10
References	**Text Books** 1. K.V. Sastry and Vineeta Shukla. 2018. Developmental Biology, Rastogi Publication,Meerut 2. N.Arumugam.2017.DevelopmentalZoology,SarasPublication,Nagarcoil 3. ShyamasreeGhosh.2017.ImmunologyandImmunitechnology,BooksandAllied(P)Ltd,Kolkata. 4. AjoyPaul.2016.TextbookofImmunology,BooksandAllied(P)Ltd, Kolkata. 5. Ramesh Mathur & Meenakshi Mehta. 2002. Embryology, Anmol Publication Pvt.Ltd.NewDelhi.	

	Reference Books 1. Frederick R Bailey. 2018. Text-Book of Embryology, Forgotten Books. 2. Balinsky B.I. 2012. An Introduction to Embryology (5 Ed.), CengageLearning India 3. C.Vaman Rao.2017.Immunology. Narosa Publishing House Pvt.Ltd. New Delhi.pp.2.1-7.1. 4. S.S.LalandSanjeevKumar-2015 Immunology–RastogiPublication, Meerut. 5. T.Subramanian.2002.Developmental Biology.NarosaPublishingHouse, NewDelhi.
	E-Resources 1. http://nptel.ac.in/syllabus/syllabus. Php?subject Id= 102103038 2. http://b-ok.xyz/book/463534/11604b 3. http://www.studocu.com/en/document/ university-of-leads/animal developmental- biology/lecture-notes/animal-developmental-biology- lecture-notes-lecture-1/60800/view. 4. http://www.studocu.com/en/document/hogeschool-van-arnhem-en- nijjmegan/immunologie/summaries/samenvatting-boek-immunology-immunologie- am/810272/view.
Course Outcomes	On completion of the course, students should be able to
	CO1 : Realize the egg interaction,sperm entry and know the physiological factors in fertilization process. CO2 : Understand the mechanism of blastulation process CO3 : Realize the development of organs CO4 : Appreciate the contribution of great immunologists and to Know the types of lymphoid organs, lymph nodes and their functions CO5: Understand the types, functions of Immunoglobins and Antigen- antibody reactions

Mapping of Cos with PSOs

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

Semester	Third	Course Code	21ZOOP0315
Course Title	**BIOINSTRUMENTATION–PRACTICALS**		
No. of Credits	2	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	30
Category	Core		
Scope of the Course (may be more than one)	1. Rewarding opportunity to update the recent techniques in bioinstrumentation 2.Able to learn the principles, procedures and applications of chromatography,electrophoresis,UV-Vis spectroscopy,FT-IR,SEM, AAS and NMR. 3. Enhance the potential to handle the bioinstuments		
Cognitive Levels addressed by the Course	K1- Exposure to the instruments in biological sciences K2- Imbibe the techniques involved in bioinstrumentation K3- Demonstrate knowledge and understanding on the basic principle of bioinstuments K4- Implementation of Experimental protocols K5-Assessment of experimental results		
Course Objectives	The Course aims • to know the preparation of buffers and determination of pH. • to separate amino acids and sugars using chromatography and electrophoresis • to separate gas and organic acids using GC and HPLC • to estimate proteins, sugars, nucleic acids,chlorophyll,sodium, potassium, calcium and magnesium using different equipments. • to know the protocols involved in the estimation of biological samples using SEM,FT-IR,AAS and NMR.		

Practicals	Content	No. of Hours
1.	Preparation of buffers.	3
2.	Determination of pH in water and soil samples.	3
3.	Separation of amino acids and sugars using paper chromatography (2D)	3
4.	Separation of amino acids and sugars using thin layer	3
5.	chromatography	3
6.	Separation of pigments by column chromatography	3
7.	Differential centrifugation of samples.	3
8.	Separation of gas and organic acids using GC and HPLC (Demonstration).	3
9.	Separation of proteins using vertical gel electrophoresis.	3
10.	Estimation of Protein using Spectrophotometer	3
11.	Estimation of sodium, potassium, calcium and magnesium using Flame photometer	3
12	Estimation of calorific value of feed/ fire wood samples.	12

	Demonstration of Biological samples using SEM, FT-IR, AAS, NMR. Preparation of Reagents CFA Record Work	10 4 5
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 amino acids and sugars using 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 ofdisease-causing microorganisms
Course Objectives	The Course aims • 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 – Haekel's three kingtom 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	12

	method. Staining techniques - Gram's, acid fast, spore and capsule staining	
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** 1. Jeffery C. Pommerville. 2016. Alcamo's Fundamentals of Microbiology (Third Edition). Jones and Bartlett Learning. LLC, Burlington, MA 01803. 2. Tortora, G.J, Funke B.R. and Case,C.L.2010. Microbiology: An introduction 10th Ed, Benjamin Cummings, N.Y. 3. Wiley, J.M., Sherwood, L.M. and Wodverton, C.J. 2009. Prescott's principle of Microbiology, Mc Graw Hill, New York. 4. Dubey, R.C and Maheswari, D.K 2005. A text book of Microbiology, Revised Edt., S.Chand Publishers, New Delhi. 5. Pelczar, Jr., Michael, Chan E. C. S. and Kreig Noel. 2000. Microbiology. 5th Ed. Tata McGraw Hill Book Company.	
	Reference Books 1. Stanier, Y. Roger, John L. Ingrahm, Mark L. Wheelis and Page R. Painter. 2003. General Microbiology. V Ed. MacMillan Press Ltd. New Jersey. pp: 621-626; 655-670. 2. Sundararajan, S. 2003. Microorganisms. I Ed. Anmol Publications Pvt. Ltd. New Delhi. 3. Hans G. Schlegel. 2012(Reprint). General Microbiology. VII Ed. Cambridge University Press. UK. 4. Salle, A. J. 2001. Fundamental and Principles of Bacteriology. 7th Ed. Tata McGraw Hill Publishing Co. Ltd. 5. John L. Ingrahm and Catherine Ingrahm.. 2000. Introduction to Microbiology. II Ed. Brooks/Cole, Thompson Learning division. USA.	
	E-Resources 1. https://www.cliffsnotes.com › biology › microbiology 2. https://www.livescience.com 3. https://www.nature.com › ... › microbiology techniques	
Course Outcomes	On completion of the course, students should be able to	
	CO 1: Discuss important milestones and accomplishments to appreciate the historical aspect CO2: Identify key organelles and their functions in both eukaryotes and prokaryotes CO3: Describe how to control microorganism and the factors affecting the growth of microbes. CO4: Demonstrate the different cultural techniques in microbiology CO5: Explain the interactions and characteristics of microorganisms	

Mapping of Cos with PSOs

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

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	
Category	Core		
Scope of the Course(may be more than one)	1. Understand the history, scope and applications of animal cell culture 2. Inculcate the development of biosensors for environmental protection 3. Learn the applications of biopharming		
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 K4 -Analyse the concept of gene cloning and transgenic animals K5 - Assess the significance of gene therapy in prevention of diseases		
Course Objectives	The course aims • to impart knowledge on the concepts & scope in biotechnology • to provide an in-depth study on biotransformation techniques and biosensors • to enhance interest in alternate energy resources. • to understand genetic engineering concepts & techniques. • to know the transgenic organisms and to acquire knowledge on GMOs.		

Unit	Content	No. of Hours
I	**Concepts and Scope in Animal Biotechnology** Historical development – Animal tissue cultures techniques – primary culture, cell strains and cell lines – culture medias – Small scale and large scale culture techniques – Animal bioreactors. Germplasm and cryopreservation.	13
II	**Biotransformation and Biosensors *(Source NPTEL course)*** Biotransformation and production of useful compounds – Glycerol, butanol, acetone, alkene oxide, Poly hydroxy butyrate and valerate(PHBV), Xanthangum and Microbial Leaching. Biosensors – definition and outline design- types of electrode systems – Oxygen electrode system, Fuel cell type electrode, Potentiostatic, Piezoelectric membrane and Dye-coupled electrode 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).	13
III	**Biotechnological application in animal improvements** Embryo biotechniques, in vivo and in vitro embryo production and preservation, sexing, micromanipulation and cloning, transgenic animal and biopharming. Mapping of genome and genome sequencing. Marker assisted selection. Gene banking. Nutritional biotechnology including bioconversion of lignocellulose, genetic manipulation of microbes to improve feed utilization and health.	13
IV	**Genetic Engineering *(Source NPTEL course)*** 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.	13
V	**Animal transgenesis and Rules and regulation in biotechnology** GMOS –Transgenic animals –development of Transgenic animals – Mechanism of transferring genes into specific animal tissues and cell lines. Production of transgenic animals (cattle, mice, sheep, goat, pig and fish) and chimeras. Artificial insemination and embryo transfer.Application of transgenic animals: Production of useful proteins and other products in transgenic animals (production of regulatory proteins, blood products, vaccines, hormones, and other therapeutic proteins). Gene therapy:	12

	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	**Text Books** 1. R.C. Dubey.2019. A Textbook of Biotechnology. S. Chand and Company. New Delhi 2. S.B. Primrose, R.M. Twyman, and R.W. Old.2012.Principles of Gene Manipulations; 6thEdn. Blackwell Science. 3. Chhatoval G.R., 1995. Text book of Biotechnology, 1st Ed, Anmol Publications Pvt. Ltd., New Delhi. 4. Kumar H.D., 1991. A text book on Biotechnology 2nd Ed, East-west Press Private Ltd., New Delhi. Pg.1-250; 411-472; 534-555. 5. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.
	Reference Books 1. Dubey R.C., 2014.Advanced Biotechnology 1st Edition. S. Chand &Company Ltd., New Delhi. 2. Robert F. Weaver, 2012Molecular Biology; McGraw Hill 3. Keith Wilson and John Walker 2010 Principles and Techniques of Biochemistry and Molecular Biology; 7thEdn. 4. T. A. Brown 2006 Gene Cloning and DNA analysis- An Introduction;, 5th Edition, Wiley Blackwell Publishing 5. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.
	E-Resources 1.https://www.edx.org/learn/biotechnology 2.https://biog.feedspot.com/genetics-blogs/ 3.learn.genetics.utah.edu/ 4.http://bmc biotechnol.biomedcentral.com
Course Outcomes	On completion of the course, students should be able to
	CO1: Discuss on the history and concepts of animal biotechnology CO2:Explain on biotransformation methods and working systems of biosensors CO3: Compare alternate energy sources and generation of bioenergy products from biomass CO4: Outline on concepts and techniques of Genetic Engineering CO5: Assess applications of GMOs and on Ethical issues

Mapping of Cos with PSOs

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

CO4	3	2	1	2	2
CO5	3	2	1	2	2

Semester	Fourth	Course Code	21ZOOP0420
Course Title	**ECONOMIC ZOOLOGY**		
No. of Credits	4	No. of contact hours per week	4
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	20
Category	Core		
Scope of the Course(may be more than one)	1. Provide theoretical knowledge on aquaculture, apiculture, sericulture and lac culture 2. Gain knowledge on the economic importance of honey, silk and lac 3. Assist in learning the breeding of live stocks, poultry and rearing of earthworms		
Cognitive Levels addressed by the Course	K1- Understand the 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	The Course aims • To understand the National and International status of aquaculture, economics of fish and prawn farming,fishery by-products and fishery contribution. • To understand the importance of apiculture and lac culture. • To understand the importance of sericulture. • To know the economic importance of live stock and poultry. • To know the vermicomposting and vermiproducts.		

Unit	Content	No. of Hours
I	**Aquaculture Potential:** Status of aquaculture – National and International – Economics of aquaculture-Production and marketing – Fish and Prawn. Fishery Byproducts –Fish meal, fish oil, fish silage, fish glue, fish fertilizer,tatami iwashi, Isinglass, fish skin, fish insulin - 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:** Types of Mulberry - Species of silkworm- - 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, diseaseandeconomics.	16
V	**Vermiculture:** Introduction to vermiculture- types of earthworm-rearing of earthworms- Vermicomposting technology-methods-Uses of worms in Agriculture- Vermiproducts.	10

References

Text Books

1. G.S.ShuklaandV.B.Upadhyay-2017-EconomicZoology-RastogiPublication,Meerut.
2. S.Sarkar, G.Kundu and K.K.Chaki. 2016.Introduction to Economic Zoology. New Central Book Agency(P) Ltd.Kolkotta.pp.33-151;205-220;404-515.
3. Jeyasurya,N.C.Nair,N.SoundaraPandian,A.Thangamani,L.M.Narayana n,N.Arumugam,S. LeelavathiandT.Murugan-2017-Economic Zoology.SarasPublication,Nagarcoil.
4. Q.J.ShammiandS.Bhatnagar.2002. AppliedFisheries.Agrobios(India)
5. ArvindKumar.Verms&Vermitechnology,APHPub.Corporation,NewDelhi, 2005.

Reference Books

1. Sagarika Chaudhuri.2017.EconomicZoology.New Central Book Agency(P)Ltd.Kolkotta.PP.9-267;323-334;641-677.
2. N.Arumugam,T.Murugan,J.JohnsonandP.RamPrabhu,AppliedZ oology-2017-SarasPublication, Nagarcoil.
3. G.C. Banerjee. 2010.A Text book of Animal Husbandry 9thEdn. Oxford & IBH Pub. NewDelhi.
4. V.G. Jhingran. Fish and Fisheries of India. Hindustan Publishing corporation (India)Delhi.1997.
5. T.V.Sathe.VermicultureandOrganicFarmingDayaPub.Home,Delhi.2004

	E-Resources 1. gurukpo.com/applied zoology-ethology-biostatics 2. http://ia800306.us.archive.org/O/items/economic zoology. Ooosbogoog/economic zoology Ooosbogoog. Pdf
Course Outcomes	On completion of the course, students should be able to
	CO1: Learn the status, economics, byproducts and of aquaculture CO2: Understand the importance of apiculture and lac culture CO3: Recognize the importance of sericulture CO4: Learn the importance of Livestock and poultry CO5: Understand the importance of vermiculture

Mapping of Cos with PSOs

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

Semester	Fourth	Course Code	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	60
Category	Core		
Scope of the Course(may be more than one)	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 • 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.

Practical	Content	No. of Hours
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	3
2.	a) Microscopic Examination of Living Organisms – Demonstration of Motility (Hanging drop method). b) Measurement of Microorganisms using Micrometry.	3
3.	Staining Techniques – Grams staining, capsular staining, endospore staining and acid fast staining	3
4.	Preparation of Culture Media for Microorganisms. Preparation and sterilization.	3
5.	Demonstration techniques for pure culture of microorganisms- serial dilution technique, pour plate, spread plate and streak plate technique.	3
6.	Methods of culture preservation and maintenance- maintenance by sub culturing	3
7.	Enumeration and isolation of Bacteria, Fungi and actinomycetes from soil using serial dilution and plating technique.	3
8.	Enumeration of microorganisms from Air using Air sampler	3
9.	Standard Qualitative Analysis of Water by MPN test	3
10.	Standard Qualitative Analysis of Water by MPN test	3
11.	Isolation of anaerobic bacteria	

References	1. James. G. Cappucino. And Natabe Sherman, 2004. Microbiology – A Laboratory Manual, VI Ed., (I Indian Reprint). Pearson Education (Singapore) Pvt. Ltd., India. 2. Dubey, R.C and Maheswari, D.K. 2002. Practical Microbiology, I Ed., Chand and Company Ltd., India. 3. 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. 4. Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
Course Outcomes	On completion of the course, students should be able to
	CO1: Demonstrate standard methods for the isolation, identification and Culturing of microorganisms. CO2: Explain the ubiquitous nature of microorganisms CO3: Identify the different groups of microorganisms from different habitats. CO4: Evaluate the microbial load in soil and food samples CO5: Examine the microbial quality of air and water

Mapping of Cos with PSOs

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

19/21GTPP00H1- HUMAN VALUES AND PROFESSIONAL ETHICS
(Two Credits)

MODULAR COURSE FOR P.G. PROGRAMMES

Credits: 2 **CFA: 20+25+5**
Total: 50

Objectives:

- To enable students to acquire basic knowledge and exposure to human values and professional ethics.
- to motivate the students to imbibe and practice values and ethics in their profession and social interactions.

Learning Outcome

Students will be able to

- Comprehend the significance and importance of values and their pervasiveness
- Gain knowledge on the different aspects of values and ethics
- Have exposure on the practical dimensions of professional ethics

Unit 1 **Concept of Human values:** need for values and ethics in human life, types of values: **Personal and moral values:** love, truth, tolerance, wisdom, sacrifice, sincerity, self-control, altruism and scientific vision - **Social values:** equality, humaneness, universal brotherhood, empathy, probity.

Unit 2 **Political and Constitutional values:** democracy, socialism, secularism, equality, justice, liberty, freedom and fraternity - **Religious values:** faith, love, compassion, forgiveness, tolerance, equal respect for all religions, selflessness, awareness, nonattachment, character and virtues.

Unit 3 **Aesthetic values:** appreciation of literature and fine arts and nature - **Economic values:** fairness, honesty, business integrity, eco-centric - **Environmental values:** respect and concern for nature and its fauna and flora - **Professional values:** quest for knowledge, competency, sincerity in profession, regularity, punctuality.

Unit 4 **Ethics:** Meaning, domains of ethics, need for ethics, challenges to ethics, ethics and morality, role of ethics in work environment.

Unit 5 **Professional Ethics:** pride in their work, trust with confidences, honesty, trustworthy, moral, corruption free and loyal, personal commitment to quality, sharing the burden - take responsibility, **Ethical Intelligence:** Do no harm, make things better, respect others, be fair (no bias / prejudice), be loving.

Reference Books:

- Dr.Shiva and Dr. Balaji Loganathan, 2011, Value Education', Sree Gomathi Publications, Chennai.
- Babu Muthuja and R. Usharani, 2009, 'Peace and Value Education', Centrum Press, New Delhi,.
- S.Srinivasan, 2005,Value Based Management', Jaico Books, Mumbai,.
- Herve Morisette, 2001, 'Paths to a New Value Education', Indian Catehetical Association, Bangalore.
- R.S. Naagarazan, 2006, A Textbook on Professional Ethics and Human Values', New Age International Publishers, New Delhi.
- Pushpam Kumar and B. Sudhakara Reddy, 2007, Ecology and Human Well Being', Sage Publications, New Delhi.
- Dr. Kiruba Charles and V. Arul Selvi, 2016, Value Education, Neelkamal; First edition, New Delhi.
- A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi.
- Gaur R.R, Sangal R, 2010, A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi.
- Justin Oakley , Dean Cocking, 2001, Virtue Ethics and Professional Roles, Cambridge University Press, United Kingdom.
- Gogate S.B, 2010, Human Values and Professional Ethics, Human Values and Professional Ethics, Vikas Publishing House; First edition, New Delhi.
- Gregory R Maio,2016, The Psychology of Human Values, Routledge Publications, New York.
- John Clammer, 2018, Cultural Rights and Justice: Sustainable Development, the Arts and the Body, Palgrave Macmillan,1st ed. 2019 edition, U.K.

Weblinks:

- Thich Nhat Hanh, 2008, Good Citizens: Creating Enlightened Society: http://archive.kdd.org/good_citizens_creating_enlightened_society_thich_nhat_hanh.pdf.
- Thought of Human Value education According to Mahatma Gandhi management.nrjp.co.in/index.php/JSSMMS/article/download/155/294.

ELECTIVE COURSES - DISCIPLINE CENTRIC

Semester	Third	Course Code	21ZOOP03D1
Course Title	**FISHERIES AND AQUACULTURE**		
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	Elective -Discipline Centric		
Scope of the Course(may be more than one)	1. Inculcate the importance of inland fisheries and aquaculture in India 2. Provide theoretical knowledge on cultivable fishes 3. Gain knowledge on pond construction, management of fish farms and nutritional requirement of fishes		
Cognitive Levels addressed by the Course	K1 - Realize the status of fisheries and aquaculture K2 - Remember the pond construction techniques and management K3 - Analyze the economic importance of cultivable fishes K4 - Evaluate the nutritional requirements of fishes and types of feeds K5 - Create interest in fish farming, hatching techniques, transportation and disease management		
Course Objectives	The Course aims • To understand the fisheries potential and kinds aquaculture practices in India • To learn the pond construction and management. • To know the culture technique of important fishes • To learn the nutritional requirements of fishes and culture technique of live feeds • To study the importance of induced breeding, methods of fish transportation and fish diseases		

Unit	Content	No. of Hours
I	**Overview** Scope of fisheries and Aquaculture-Present status and prospects of Fisheries and Aquaculture- Fishery resources of India – Inland fishery resources and Coastal aquaculture resources– Types of aquaculture practices –Depending on hydrobiological features - Fresh water aquaculture-Monoculture, monosex culture, polyculture, sewage – fed fish culture-Brackish water aquaculture-Mariculture and Metahaline- Depending on Motive of farming-Extensive,intensive and semi-intensive – Depending on special operational techniques- pen culture, cage culture, prawn and shrimp culture and Integrated fish culture.	9
II	**Pond Construction and Management** Pond construction– Farm site selection – Topography, soil type, water supply – Designing – construction of fish ponds – Bunds, slope – Berm — Bund formation – Inlet and outlet – Types of ponds – Hatching, Nursery, Rearing and	

	stocking- Pond management –Pre-stocking- Renovation of the pond,clearence of weeds- Manual and mechanical,chemical,biological- Eradication of weed and predatory fishes- Addition of lime,fertilizers-Inorganic and organic- Stocking Management- stocking criteria,species combination- stocking density and rate - post- stocking management – Pond fertilization-Application of organic and inorganic manure, liming, supplementary feed, harvesting and Marketing.	11
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- Prawn and Shrimp culture.	10
IV	**Nutrition and Feed Development** Concept of feeding fishes- Types of feeds –Natural, artificial and Live feeds (Artemia & Daphnia) and their culture techniques Nutritional requirements – protein, carbohydrate, lipids, minerals, vitamins-weight budgeting. Feeding Methods –-Feed formulation (square method)-Probiotics - Qualities of good feed.	10
V	**Reproduction, Transportation and Diseases** Bundh breeding, Induced breeding in fishes – Advantages and disadvantages of induced breeding- Factors influencing induced breeding - Hypophyzation– Hatchery -Types-Traditional method using hatching hapa, earthen pot hatchery,glass jar hatchery,eco hatchery– Transport of fish seed and Brood fish– causes of mortality –Factors affecting fish transportation -Methods of packing and transport – open system, closed system – Transport of spawn and fry,fingerlings and brood fish – Use of chemicals in live fish transport– General rules for transportation– Measures of safe transport. Diseases management – bacterial:Cotton mouth disease, tail rot or fin rot, tuberculosis, dropsy, columnaris- fungal : Dermatomycosis, brachiomycosis, systemicmycosis, saprolegniasis-protozoan:Ichthyophthiriusiasis,costiasis, tricodina, scyphida and viral diseases:Epizootic ulcerative syndrome, Infectiushaematopotic hypodermal necrosis, Erythrocytic necrosis, Viral hemorrhagic septicemia.	8

References

Text Books

1. Kamleshwar Pandy and J.P. Shukla, 2017- Fish and Fisheries, Rastogi Publication, Meerut.
2. A.K.Pandey and Kalyani Pandey.2014. Elements of Aquaculture and Fishery Biology. Axis Books Pvt. Ltd. New Delhi.
3. Y.S.Chandrasekhar.2014. Fish Nutrition in Aquaculture. Swastik Publications,New Delhi
4. N.M.Chakrabarty, P.P.Chakraborty and S.C.Mondal 2010 Biology, Breeding and Farming of Important Food Fishes.Narendra Pub. House, Delhi.
5. Q. J. Shammi and S. Bhatnagar 2002. Applied Fisheries. Agrobios (India)

Reference Books

1. Ramachandran Nair.2017. Biotechnology and Genetics in Fisheries and

	Aquaculture. Dominant Publishers & Distributors Pvt Ltd.pp.282-302 2. P.C. Thomas, Suresh Ch. Rath and Kanta Das Mohapatra 2003. Breeding and seed production of Fin Fish and shell fish. Daya pub. House, New Delhi. 3. C.B.L. Srivastava 1999 A text book of Fishery Science and Indian Fisheries. Kitab Mahal, Allahabad. 4. V.G.Jhingram 1997. Fish and Fisheries of India, Hindustan Publishing Corporation (India), Delhi. 5. K.P. Biswas 1992 Prevention and control of fish and prawn diseases. Narendra pub.House, Delhi. pp. 43-69.
	E-Resources 1.http://www.studocu.com/en/document/james- cook-university/introduction-to-aquaculture/lecture-notes/lecture-notes-lecture-all-full-notes/672525/view 2. http://b-ok.xyz/book/614845/az7f54.
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the fishery and aquaculture resources and types of aquaculture practices CO2: Appreciate the importance of pond construction and management. CO3: Familiarize the culture techniques of carps,cat fishes and murrels CO4: Realize the nutrition and feed development techniques. CO5:Recognize the importance of induced breeding, methods of transportation and management of fish diseases.

Mapping of Cos with PSOs

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

Semester	Third	Course Code	21ZOOP03D2
Course Title	**PARASITOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	Revised Course	If revised,Percentage of revision effected	20
Category	Elective -Discipline Centric		
Scope of the Course(may be	1. Learn the types of disease causing parasites and their adaptations 2. Understand the lifecycle and diseases of protozoan, platyhelminthes and		

more than one)	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	The course aims • to understand the concept of parasitology and human welfare • to learn the life cycle and control of protozoan parasites • to gain knowledge on the lifecycle and control of platyhelminth parasites • to know the medical importance of nematode parasites • to study the transmission and prevention of parasitic diseases

Unit	Content	No. of Hours
I	**Introduction to Parasites** Introduction to parasites of man, scope and definition of parasites/parasitology- Animal Association- Types of Parasites and Hosts- Mode of transmission of parasite- Host specificity and parasitic adaptation	8
II	**Protozoan Parasites** Protozoan parasites: Bionomics, life cycle and control – Trypanosoma, Leishmania, Giardia, Trichomonas, Opalina, Entamoeba, Plasmodium and Balantidium.	8
III	**Platyhelminthes Parasites** Platyhelminthes parasites: Bionomics, life cycle and control – tape worm (*Taenia solium*), liver fluke (*Fasciola hepatica*), blood fluke (Schistosoma), *Echinococcus granulosus, Hymenolepisdiminuta, Diphyllobothrium latum*.	10
IV	**Nematode Parasites** Nematode parasites of Animals: Bionomics, life cycle and control – *Ascaris lumbricoides, Trichuris trichuria, Trichinella spiralis, Ancylostomadeuodenale, Enterobius vermicularis, Wuchereriabancrofti, Loa loa, Dracunculus medinensis*.	10
V	**Arthropod Parasites** Arthropod parasites: Bionomics, life cycle and control –*Phthirus pubis, Cimex species,* Reduvids, black fly, *Glossina*, *Pulexirritans, Tabanus*and *Sarcoptesscabiei*.	10

References	**Text Books**
	1. H.S. Singh-2018- Parasitology, Rastogi Publication, Meerut. 2. G.Rathanasamy 2017 Text book of Medical Entomology andParasitology. Viswanathan& Co., Publications, Chennai. 3. J. Park and Park 2013 Social and preventive medicine 22th Edition. 4. Thomas C. Cheng 2006 General Parasitology, Academic Press, USA 5. C.K. Jayaram Paniker. 1997. Text book of Medical Parasitology. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.

	Reference Books 1. M.Rahmatullah 2013 Modern Parasitology, Axis Books Pvt. Ltd. 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 8th edition. John Wiley &Sons,Inc. New York. 5. Larry S. Roberts & John Janovy Jr. Foundations of Parasitology Recent Edition. Wm.C.
	E-Resources 1. https://www.ncbi.nlm.nih.gov/books/NBk8262/ 2. https://www.ncbi.nlm.nih.gov/books/NBK8043/
Course Outcomes	On completion of the course, students should be able to
	CO1: Understand the parasitology and its interference with human welfare CO2: Realize the importance of protozoan parasites CO3: Learn the parasitic adaptation of platyhelminthes 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	3	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Semester	Third	Course Code	21ZOOP03D3
Course Title	**ANIMAL CELL CULTURE TECHNOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised,Percentage of revision effected	-
Category	Elective -Discipline Centric		
Scope of the Course	1. Know the history and advantages of animal cell culture 2. Understand the types of cell culture techniques and basic requirements of		

(may be more than one)	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	The course aims • 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 andtreatment 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.	10
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	**Basics *in vitro* 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	**Cell culture types:** Epithelial cells –Breast, cervix, liver, colon; Mesenchymal cells –bone and cartilage; neurodermal cells –neurons and glial cells, gonads. Stem cell cultures embryonic and adult stem cells and their applications. Cell cultured based vaccines.	10
V	**Applications of Animal Cell Culture:** Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, IVF Technology, toxicology studies.	10

References	**Text Books:** 1. WahiedKhawarBalwan. 2018. Animal Physiology and Biochemistry. Paradise Press, New Delhi. 2. Pinkert, C.A. 2012. Transgenic Animal Technology: ALaboratory Handbook, (2nd ed.): Academic Press. 3. Wilson Aruni, A &Ramadass, P. 2011. *Animal tissue culture*: MJPPublishers. 4. Davis, J. M. 2011. Animal Cell Culture. John Willy and Sons Ltd.USA.

	5. Ian Freshney, R.2010. Culture of animal cells: A manual of basic technique and specialized applications, (6th ed.): Wiley-Blackwell.
	Reference Books: 1. Verma, A. S. and Singh, A. 2014. Animal Biotechnology. Academic Press, Elsevier, USA. 2. Cartwright, E. J. 2009. Transgenesis Techniques. Humana Press.London, UK. 3. McArthur, R. A. and Borsini, F. 2008. Animal and TranslationalModels for CNS Drug Discovery. Elsevier. London, UK. 4. Freshney R. I. 2005. Culture of Animal Cells. John Willy and SonLtd. USA. 5. Butler, M. 2004. Animal Cell Culture and Technology. Taylor andFrancis. New York, USA.
	E-Resources 1. https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978-0- 7503-1347-6ch1 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/
Course Outcomes	On completion of the course, students should be able to
	CO1: Know the basic concept and principles of animal cell culture CO2: Learn the good laboratory management practices in cell culture CO3: Understand the equipments, materials and media needed for cell culture CO4: Differentiate the primary and secondary cell culture CO5: Remember the advantages and applications of animal cell culture

Mapping of Cos with PSOs

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

ELECTIVE COURSES - GENERIC

Semester	Second	Course Code	21ZOOP02G1
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	20
Category	Elective Course -Generic		

Scope of the Course(may be more than one)	1. Inculcate the present status and importance of ornamental fish culture 2. Learn the important freshwater ornamental fishes and their characteristics 3. Understand the breeding, management and economics of ornamental fishes
Cognitive Levels addressed by the Course	K1- Create interest among the students on ornamental fish farming K2- Know the maintenance of aquarium in home K3- Learn the popular freshwater ornamental fishes K4- Analyze the methods of breeding, hatching and feeding of ornamental fishes K5- Evaluate the economic importance of ornamental fish farming
Course Objectives	The Course aims • To know the status of ornamental fish culture and design of setting up of fish tank • To familiarize the popular varieties of ornamental fishes and their characteristics • To understand the importance of food and feeding of ornamental fishes • To know the techniques of breeding of aquarium fishes • To understand the economics commercial farming of ornamental fishes

Unit	Content	No. of Hours
I	**Overview** Present status of ornamental fish culture in India -Importance of ornamental fish culture. Design and setting up of fish tank: Types, construction, accessories and maintenance of home aquarium-Aquarium plants and their uses.	9
II	**Freshwater Ornamental Fish culture** Criteria for the selection of Ornamental fishes -Popular 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** Natural&Artificial feeds-Feed formulation and preparation of pelleted feed – Live feed organisms: Daphnia, tubifex& Artemia - Quantity and time of feeding.	9
IV	**Breeding and Disease Managementof Aquarium Fishes** Mode of reproduction: Identification of sexes, selection of breeding pair - Breeding of egg layers-gold fish, fighter, angel fish and barbs and live bearers-guppy, molly, platy and swordtail – Care of the fry- Diseases-Parasitic, bacterial, viral, protozoan and fungal.	11
V	**Commercial Farming** 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. SaraS Publication, Nagercoil.pp.17-126;421-438. 2. Amita Saxena 2003 Aquarium Management Daya pub. House, New Delhi pp. 87 – 192.

	3. C.B.L. Srivastava 2002 Aquarium fish keeping. Kitab Mahal, Allahabad pp. 87-91. 4. V.G. Jhingram 1997. Fish and Fisheries of India, Hindustan Publishing Corporation(India), Delhi, pp.490-516, 519 -530 5. Cliff W. Emmens 1987 A complete guide to Tropical fish, T.F.H. Publishing. pp. 73-97.
	Reference Books 1. Sagarika Chaudhuri.2017. Economic Zoology. New Central Book Agency(P)Ltd.Kolkotta.pp.554-607. 2. Mary Bailey and Gina Sand ford 2002. The ultimate Aquarium – A Definitive quide to identifying and keeping fresh water and Marine fishes. pp. 16-43; 109-118.
	E-Resources 1. http://b-ok.xyz/book/1240495/OeeO8e 2. http://b-ok.xyz/book/2872234/Oa56ed
Course Outcomes	On completion of the course, students should be able to
	CO1: Realize the present status and importance of ornamental fish culture CO2: Understand the popular varieties of fresh water ornamental fishes and their characteristics CO3: Realize the need of artificial and live food organisms CO4: Familiarize the breeding techniques of ornamental fishes CO5: Understand the economics of commercial farming

Mapping of Cos with PSOs

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

Semester	Second	Course Code	21ZOOP02G2
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	-

Category	Elective Course -Generic
Scope of the Course(may be more than one)	1. Learn the importance of beneficial and harmful insects 2. Know the potential of aquaculture in economy growth 3. Understand the transmission of diseases by animals and maintenance of 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	The Course aims • To understand the aquaculture potential, cultivable fish and prawn, culture methods,types of fish ponds and pond construction and management • To understand the beneficial and harmful effects of insects and economic importance of rodents, snakes, bats. • To understand Infectious and communicable diseases • To know important 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, rhinocerous beetle, aphids, mosquitoes and cockroach- Economic importance of rodents, snakes, bats.	9
III	**Medical Zoology** Infectious / Communicable diseases: Small pox, hepatitis, AIDS, influenza, tuberculosis, plaque, cholera, amoebiasis, malaria, dengue, chikungunya, trypanosomiasis and Elephantiasis.	9
IV	**Veterinary Zoology** Important 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.Tarit Kumar Banerjee.2017. Applied Zoology.New Central BookAgency(P) Ltd. 2. Shukla, G.S and V.B. Upandhyay. 2017. Economic Zoology 5th Rev. Edn. Rastogi Publications, Meerut. 3. Banerjee, G.C.2010. A Text book of Animal Husbandry Oxford & IBH Pub. New Delhi. 4. Pradip. V. Jabde.2005 Text book of Applied Zoology. 5. Parihar, R.P.1996 A Text book of Fish Biology and IndianFisheries.Central Pub. House, Allahabad.
	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. Ashok Kumar and Prem Mohan Nigam. 1991. Economic & Applied Entamology. Emkay Publications, New Delhi.
	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	Third	Course Code	21ZOOPO3M1
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	20
Category	Modular Course		
Scope of the Course (may be more than one)	1. Inculcate the principle and applications of chromatographic and spectrophotometric techniques 2. Learn the separation of proteins by electrophoresis 3. Understand the amino acid sequencing and blotting techniques		
Cognitive Levels addressed by the Course	K1 - Realize the scope and applications of different molecular techniques K2 - Compare the native PAGE and SDS PAGE analysis K3 - Gain knowledge of DNA microarray techniques K4 – Realize the importance of PCR amplification in disease diagnosis K5 – Understand the mapping of genome in forensic studies		
Course Objectives (Maximum:5)	The course aims • to give knowledge on working principle and applications of electrophoresis techniques • to develop interest to acquire latest information on molecular sequencing and its applications • to make knowledge on PCR techniques and its applications • to impart in-depth knowledge on chromatographic and spectrophometric techniques and their uses • to create interest on the importance of genome sequencing and physical mapping analysis		

Unit	Content	No. of Hours
I	**Chromatographic and 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 – oligonucleiotidearray and cDNA array and its applications.	6
IV	**PCR techniques** Principle and applications- types of PCR - enzymology- primer types- methods. PCR amplification for Detection of mutation, monitoring cancer therapy, detect bacterial & viral infections, sex determination of prenatal cells, linkage analysis in sperm cells and studies on molecular evolution.	6
V	**Molecular mapping of genome** Physical mapping and map -based cloning – choice of mapping population & simple sequence repeat loci – southern and fluorescence in situ hybridization for genome analysis - chromosome microdissection and microcloning - molecular markers in genome analysis (RFLP, RAPD, and AFLP analysis) – molecular markers linked disease resistance genes – application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, varietal analysis, animal trafficking and poaching - germplasm maintenance and taxonomy. Molecular mapping of genome.	6

References

Text Books

1. N. Gurumani 2010 Research Methodology for Biological Sciences. MJP Publishers, Chennai.
2. James .D.Watson, Michael Gilman, Jan Wit Koeski and Mark Zuller, 2001. Recombinant DNA. IInd Ed. Scientific American Book, NewYork.
3. Glick, B.R. and Pasternak, J.J 1994. Molecular Biotechnology, ASM Press, Washington DC.
4. B. Lewin 2000. Genes VII Oxford University Press.
5. E.J. Gardener *et al.,* 1991. Principles of Genetics (8^{th} Ed.,) John Wiley & Sons, New York.

Reference Books

1. S. Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani.
2. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi.
3. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edn. Cambridge Univ. Press.
4. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore
5. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.

E-Resources

1. www.cellbio.com/education.html
2. https://www.loc.gov/rr/scitech/selected- interval/molecular.html

	3. global.oup.com/uk/orc/biosciences/molbio 4. https://www.loc.gov/rr/scitech/selected-internet/molecular.html
Course Outcomes	On completion of the course, students should be able to
	CO1: Outline the working principle and applications of electrophoresis techniques CO2: Explain molecular sequencing techniques CO3: Discuss PCR techniques and their applications CO4: Uses of chromatographic and spectrophometric 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)	1. Understand the basics of bioinformatics 2. Learn the analysis of sequence by computational methods 3. Know the importance of protein and nucleic acid databases		
Cognitive Levels addressed by the Course	K1 -Analyze the various tools used in bioinformatics K2 - Realize the use of computer in biological applications K3 - Gain knowledge on detecting DNA polymorphisms K4 - Realize the importance of molecular docking analysis K5 - Understand the significance of protein databases		
Course Objectives (Maximum:5)	The course aims • to study on Bioinformatics, microbial genomics and proteomics • to understand genome analysis, sequence analysis and protein analysis • to explain the tools used in Bioinformatics • to impart information on a comprehensive global view on DNA sequence, DNA expression and molecular confirmations		

	• to know computational biology	
Unit	Content	No. of Hours
I	**Whole genome analysis** Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing.	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** 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 1. Dan E.Krane and Michael L.Raymer.2006.Fundamental Concepts of Bioinformatics. Pearson Education, New Delhi
	E-Resources 1. https://www.bioinformatics.org 2. bioinformaticsonline.com 3. www.ii.uib.no/~inge/list.html
Course Outcomes	On completion of the course, students should be able to
	CO1: Evaluate whole genome analysis methods CO2: Apply the computational tools used for sequence analysis tools CO3: Demonstrate the use of internet in data analysis CO4: Acquire knowledge on DNA microarray techniques CO5: Familiar with the different methods of protein analysis

Mapping of Cos with PSOs

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

Semester	Fourth	Course Code	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)	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 • to create interest on the fundamentals of biogas technology • to expose the technologies related to composting • to impart information on scope of mushroom culture technology • to impart knowledge on *Spirulina* cultivation technology • to know Ornamental Fish culture technology		

Unit	Content	No. of Hours
I	**Biogas technology** Introduction and history – anaerobic digestion – microbes involved – factors influencing methane production – Stages of methane generation – Wastes used in methanogenesis – various bioreactors used for methane generation – Advantages and disadvantages.Visit to biogas production units with field demonstration.	7
	Composting technology	

II	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	***Spirulina* cultivation technology** Biology of *Spirulina* - cultivation methods, post harvest technology and single cell protein formulation. Visit to *Spirulina* 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	**Text Books** 1. Tripati, G. 2003. Vermiresources technology, 1st Ed., Discovery Publication House, New Delhi. 2. Anita Saxena, 2003. Aquarium management. Daya Pub. House, New Delhi. 3. Kaul, T.N. 1999. Introduction to mushroom science, Oxford & IBH Co., Pvt. Ltd.,New Delhi. 4. Kumar, H.D., 1991. A Textbook on Biotechnology, II Edition, East-west Press Pvt. Ltd., New Delhi. 5. Chawla O.P. 1986. Advances in Biogas Technology, ICAR, New Delhi.
	Reference Books 1. Srivastava, C.B.L, 2002. Aquarium fish keeping. Kitab Mahal, Allhabad. 2. Gaur, A.C., 1999. Microbial technology for Composting of Agricultural Residues by Improved Methods, 1st print, ICAR, New Delhi. 3. Subba Rao, N.S., 1999. Soil Microbiology, 4th Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi. 4. Philip G. Miles, Shu-Ting Chang, 1997. Mushroom biology, World Scientific,Singapore. 5. Chatwal, G.R., 1995. Textbook of Biotechnology, Anmol Publications Pvt. Ltd., New Delhi
	E-Resources 1. https://www.eesi.org 2. https://agritech.tnau.ac.in/org_farm/orgfarm_composting.html 3. https://www.rpcau.ac.in 4. https://www.techno-preneur.net 5. https://www.ncdc.in/
Course	On completion of the course, students should be able to

Outcomes	CO1: Evaluate the different aspects of biogas production technology CO2: Discuss the different types of composting technologies and how to establish a composting units CO3: Explain the methods of mushroom culture and start a mushroom farm CO4: Summerise*Spirulina* cultivation by low-cost method CO5: Understand the culture technique of different ornamental fish and establish an aquarium farm

Mapping of Cos with PSOs

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

Semester	Fourth	Course Code	21ZOOP04M2
Course Title	**BIONANOTECHNOLOGY**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised,Percentage of revision effected	-
Category	Modular Course		
Scope of the Course(may be more than one)	1. Inculcate the principle and scope of bionanotechnology 2. Know the types, synthesis methods and characterization of nanoparticles 3. Enable to know to the biological applications of nanoparticles		
Cognitive Levels addressed by the Course	K1- Create basic knowledge on nanotechnology K2- Know the methods of synthesis of nanoparticles K3- Remember the different characterization techniques of nanoparticle K4- Evaluate the structural and biological properties of nanomaterials K5- Assess the applications of nanoparticles in different fields		
Course Objectives	The Course aims • to acquire broad knowledge on basic concepts, areas, importance, scope, current scenario and prospects of nanotechnology • to understand the synthesis of nanoparticles using different methods. • to know the different equipments used for characterization of nanoparticles and their importance. • to understand the types and properties of nanoparticles.		

	• to know the applications of nanotechnology in various fields

Unit	Content	No. of Hours
I	**Introduction** Origin and concepts- Basics and basis-Emerging areas of nanotechnology Importance of Nanoscience and Nanotechnology- Milestones in Nanotechnology- Scope and Current Scenario and future prospects of Nanotechnology.	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.	6

References	**Text Books**
	1.Rishabh Anand. 2017.Essentials of Nanotechnology. First Edition. MEDTECH -A Division of Scientific International,New Delhi 2. Sulabha K.Kulkarni. 2014. Nanotechnology – Principles and Practices. Third Edition. Capital Publishing Company,Kolkotta. 3. S.Shanmugam. 2011. Nanotechnology. MJP Publishers,Chennai 4. Subbiah Balaji. 2010. Nanobiotechnology. MJP Publishers, Chennai 5. P.K.Sharma. Prospects of Nanotechnology. Vista International Publishing House,Delhi.

	Reference Books 1. D.P.Kothari, V.Velmurugan and Rajit Ram Singh.2018.Nanotechnology and Nanoelectronics.Narosa Publishing House Pvt Ltd. New Delhi 2. Yashwanth Kumar.2017. An Introduction to Nanobiotechnology.Book Enclave Publishers and Exporters, Jaipur
	E-Resources 1. https://onlinelibrary,wiley.com 2. https://www.Sciencedirect.com 3. https://www.Cambridge.org 4. https://www.nanowork.com 5. https://core.ac.uk
Course Outcomes	On completion of the course, students should be able to
	CO1:Acquire the basics of nanobiotechnology and appreciate the importance, current scenario and future prospects of nanotechnology CO2: Acquire knowledge on the methods of synthesis of nanoparticles and their Advantages CO3: Realize the importance of different equipments used for the characterization 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

Semester	Fourth	Course Code	21ZOOPO4M3
Course Title	**INTELLECTUAL PROPERTY RIGHTS**		
No. of Credits	3	No. of contact hours per week	3
New Course/ Revised Course	New Course	If revised,Percentage of revision effected	-
Category	Modular Course		
Scope of the Course(may be more than one)	1. Know the basic concepts and need for intellectual property 2. Understand about copyrights, trademarks and registration of IPRs 3. Learn the criteria of patentability and patentability of biological inventions		

Cognitive Levels addressed by the Course	K1 - Realize the importance of IPR K2 -Analyze the practical aspects of copyright registration K3 - Analyze the patentability of biological materials K4 - Assess the protection of biological resources through patenting K5 - Evaluate the legal protection of biological inventions	
Course Objectives	The Course aims • to evaluate knowledge on Intellectual property Rights • to understand the Copyright and Trademarks and Registration of IPRs • to evaluate the process of Patents & Patentability • to analyse the details of various process of IPR in Life Sciences	
Unit	Content	No. of Hours
I	**Introduction to IPRs.** Basic concepts and need for Intellectual property- Patents, Copyrights, Geographical Indications, Nature of Intellectual Property, Industrial Property, technological Research. Introduction to Intellectual property – Invention and Creativity – Importance – Protection of IPR	6
II	**Copyright and Trademarks and Registration of IPRs:** Copy right – definition, protection, Related Rights, Distinction between related rights and copyrights. Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings. Trade mark – definition, rights, kind of signs, types of trademarks, protection and registration.	6
III	**Patents:** Introduction to Patents – Patentability criteria - Novelty, Non Obviousness and industrial applicability - The Patent Act, 1970 – Inventions not patentable – Patent Specifications: Provisional and complete - Types of patent applications – compulsory licensing – Patent application Forms and fees –Patent search-Types	7
IV	**Patentability:** Patents - Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties	7
V	**IPR in Life Sciences:** Patentability of Biotechnology Inventions - Protection of Genetic Resources - Patenting of seeds Moral Issues in Patenting Biotechnological Inventions – case studies on biotechnology patents Legal protection of Biotechnological inventions. Patenting of Basmati Rice in USA, case study of Glyphosate tolerance, betaine production and revocation of Neem and Turmeric patents.	6
References	**Text Books** 1. Prabuddha Ganguli. 2017. Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education	

	2. Derek Bosworth and Elizabeth Webster.2013.The Management of IntellectualProperty. Edward Elgar Publishing Ltd. 3. Deborah E. Bouchoux.2012. Intellectual: The Law of Trademarks, Copyrights, Patents and Trade secrets, Cengage Learning. Third Edition, 4. Prabuddha Ganguli.2011. Intellectual Property Rights: Unleashing the knowledge Economy. McGraw Hill Education, 5. Chawla, H.S. 2007. Introduction to Plant Biotechnology. Oxford and IBH Publishing Co (P) Ltd. New Delhi.
	Reference Books 1. B.L. Wadehra.2016. Law relating to Intellectual Property, 2011. Universal Law Publishing – An imprint of LexisNexis, 5th Edition 2. R. Radhakrishnan and S. Balasubramanian.2008. Intellectual Property Rights: Text and Cases. Excel books 3. Verma, S.K and Mohit Verma. 2010. Textbook of Plant Physiology, Biochemistry and Biotechnology. S. Chand and Co. New Delhi. 4. P. Narayanan. 2010.Law of Copyright and Industrial Designs; Eastern law House, Delhi, 5. T. M Murray and M.J. Mehlman. 2000. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons
	E-Resources 1. Subramanian, N., &Sundararaman, M. 2018. Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf 2.World Intellectual Property Organization. 2004. WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intpropert y/489/wipo_pub _489.pdf
Course Outcomes	On completion of the course, students should be able to
	CO1: Gain knowledge on Intellectual property Rights CO2: Understand the Copyright, Trademarks and Registration of IPRs CO3: Evaluate the process of Patents CO4 Recognize the importance of Patentability CO5: Analyze the details of various process of IPR in Life Sciences

Mapping of Cos with PSOs

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

Semester	Fourth	Course Code	
Course Title	**HUMAN VALUES AND PROFESSIONAL ETHICS**		
No. of Credits	2	No. of contact hours per week	

New Course/ Revised Course	New Course	If revised, Percentage of revision effected	-
Category	Modular Course		
Scope of the Course (may be more than one)			
Cognitive Levels addressed by the Course			
Course Objectives	The Course aims • to enable students to acquire basic knowledge and exposure to human values and professional ethics. • to motivate the students to imbibe and practice values and ethics in their profession and social interactions.		

Unit	Content	No. of Hours
I	**Concept of Human values:** Need for values and ethics in human life, types of values: Personal and moral values: love, truth, tolerance, wisdom, sacrifice, sincerity, self-control, altruism and scientific vision - Social values: equality, humaneness, universal brotherhood, empathy, probity.	6
II	**Political and Constitutional values:** Democracy, socialism, secularism, equality, justice, liberty, freedom and fraternity - Religious values: faith, love, compassion, forgiveness, tolerance, equal respect for all religions, selflessness, awareness, nonattachment, character and virtues.	6
III	Aesthetic values: Appreciation of literature and fine arts and nature - Economic values: fairness, honesty, business integrity, eco-centric - Environmental values: respect and concern for nature and its fauna and flora - Professional values: quest for knowledge, competency, sincerity in profession, regularity, punctuality.	7
IV	**Ethics:** Meaning, domains of ethics, need for ethics, challenges to ethics, ethics and morality, role of ethics in work environment.	7
V	**Professional Ethics:** Pride in their work, trust with confidences, honesty, trustworthy,moral, corruption free and loyal, personal commitment to quality, sharing the burden - take responsibility, Ethical Intelligence**:** Do no harm, make things better, respect others, be fair (no bias / prejudice), be loving.	6

References	Text Books: 1. Kiruba Charles and V. Arul Selvi, 2016, Value Education, Neelkamal; First edition, New Delhi. 2. Shiva and Balaji Loganathan, 2011, Value Education', SreeGomathi Publications, Chennai. 3.Babu Muthuja and R. Usharani, 2009, 'Peace and Value Education', Centrum Press, New Delhi,. 4.Pushpam Kumar and B. Sudhakara Reddy, 2007, Ecology and Human Well Being', Sage

	Publications, New Delhi. 5.R.S. Naagarazan, 2006, A Textbook on Professional Ethics and Human Values', New Age International Publishers, New Delhi. 6.S.Srinivasan, 2005,Value Based Management', Jaico Books, Mumbai.
	Reference Books 1. John Clammer, 2018, Cultural Rights and Justice: Sustainable Development, the Arts and the Body, Palgrave Macmillan,1st ed. 2019 edition, U.K. 2. Gregory R Maio,2016, The Psychology of Human Values, Routledge Publications, New York. 3. A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi. 4. A.R. Mohapatra and Bijaya Mohapatra, 2014, Value Education: A Study in Human Values and Virtues, Readworthy Publications, New Delhi. 5. Justin Oakley , Dean Cocking, 2001, Virtue Ethics and Professional Roles, Cambridge University Press, United Kingdom.
	E-Resources 1.Thich Nhat Hanh, 2008, Good Citizens: Creating Enlightened Society: http://archive.kdd.org/good_citizens_creating_enlightened_society_thich_nhat_hanh.pdf. 2.Thought of Human Value education According to Mahatma Gandhi management.nrjp.co.in/index.php/JSSMMS/article/download/155/294.
Course Outcomes	On completion of the course, students should be able to
	• Comprehend the significance and importance of values and their pervasiveness • Gain knowledge on the different aspects of values and ethics • Have exposure on the practical dimensions of professional ethics