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From: **Assistant Registrar(PG)** <arpg@unigoa.ac.in>
Date: Sat, Nov 12, 2022 at 3:20 PM
Subject: Agenda-BoS in Zoology
To: Assistant Registrar (General) <argeneral@unigoa.ac.in>, Joint Registrar (Academic) <jointregacad@unigoa.ac.in>

Madam/Sir,

Attached herewith the Agenda Item pertaining to BoS in Zoology to be placed before the AC meeting scheduled on 09/12/2022.

Thanks & Regards
Ashwin Lawande
Assistant Registrar
Academic-PG Depts.,
Goa University.
PH: 8669609021, 8669609065
www.unigoa.ac.in

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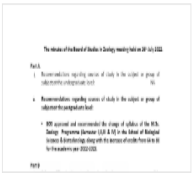

Minutes of BOS In...

Annexure I.doc

Reply Forward

The minutes of the Board of Studies in Zoology meeting held on 26th July 2022.

Part A.

i. Recommendations regarding courses of study in the subject or group of subjectsat the undergraduate level: NA

ii. Recommendations regarding courses of study in the subject or group of subjectsat the postgraduate level:

- **BOS approved and recommended the change of syllabus of the M.Sc. Zoology Programme (Semester I,II,III & IV) in the School of Biological Sciences & Biotechnology along with the increase of credits from 64 to 80 for the academic year 2022-2023.**

Part B

i. Scheme of Examinations at undergraduate level: NA

ii. Panel of examiners for different examinations at the undergraduate level: NA

iii. Scheme of Examinations at postgraduate level: NA

iv. Panel of examiners for different examinations at post-graduate level: NA

Part C.

i. Recommendations regarding preparation and publication of selection of reading material in the subject or group of subjects and the names of the persons recommended for appointment to make the selection: NA

Part D

i. Recommendations regarding general academic requirements in the Departmentsof University or affiliated colleges: NA

ii. Recommendations of the Academic Audit Committee and status thereof: NA

Part E.

i. Recommendations of the text books for the course of study at undergraduatelevel: NA

ii. **Recommendations of the text books for the course of study at post graduate level: Included with the syllabus**

Part F.

Important points for consideration/approval of Academic Council

i. The important points/recommendations of BoS that require

consideration/approval of Academic Council (points to be highlighted) asmentioned below

a) **Major restructuring of the M.Sc. Zoology syllabus with increase in credits from 64 to 80 wef from 2022-2023. (Annexure I)**

ii. The declaration by the chairman that the minutes were readout by the Chairmanat the meeting itself.

Date:
Place: Goa University

Sd/-
Signature of the Chairman

Part G. The Remarks of the Dean of the Faculty

i) The minutes are in order
ii) The minutes may be placed before the Academic Council with remarks if any.
iii)May be recommended for approval of Academic Council.
iv)Special remarks if any.

Date:
Place: Goa University

Sd/-
Signature of the Dean

Annexure I

(M. Sc. Zoology Syllabus)

Goa University

Goa University, Taleigao Plateau, Goa 403 206

Syllabus of M.Sc. (Zoology) Programme in SBSB

(To be followed from the Academic year: 2022-23)

Programme Name: M. Sc. Zoology

Programme Code: ZO

Programme description:

This program is intended to develop learning about Zoology and significance of fauna ranging from single cell to multicellular systems. Keeping in mind the Programme thrust area “Biodiversity, Comparative Animal Physiology, Wildlife, Toxicology and Fisheries'', the current Post graduation curriculum has been totally restructured. A precise balance between the classical courses and modern biological courses has been made to introduce and emphasize the skill based programmes with an Internship experience. Apart from the classical topics on Animal Sciences namely, Taxonomy and Systematics; Biodiversity; Anatomy of Non- chordates and Chordates, Genetics and Ecology this syllabus also covers topics on various aspects of Life Processes such as Animal Physiology, Developmental Biology and Molecular Biology. The restructured M. Sc. programme also focuses on various application based or skilled based courses such as Advanced Aquaculture Techniques and Ornamental Fish Management, Fish Processing, Butterfly Gardening, Environmental Physiology, Neurophysiology, Stem Cell Biology, Herpetology, Ornithology, Wildlife Biology and Ecotourism. Besides, the courses like Immunology, Cell Biology, Vector Biology and Ecotoxicology programs also represent this restructured syllabus. This programme through the dissertation will also help the students to understand the basic principles of nature and will also provide scope for hands-on experience to experiment with nature /animals and thereby enable them to develop aptitude for research in various allied fields of animal sciences. This curriculum will also enable them to overcome several day to day problems faced by our society by providing them with some workable solutions.

Prerequisite for M. Sc. Zoology Programme:

The candidate must pass the Bachelors degree examination in Zoology at T. Y. B.Sc. level or its equivalent credits in Zoology.

Programme Structure:

A student should earn a minimum of 80 Credit Courses to receive M.Sc. (Zoology) degree. Out of 80 credits, 40 credits shall be of Programme Core Courses to be earned during Semester I and II and 40 credits are Optional Courses (Including Programme skilled-based optional and general optional / Interdisciplinary / Dissertation) to be earned during Semester III and IV. Active participation in the Field work component as well as short internship program, included in the laboratory courses, is must for every student. There is also liberty to carry out Dissertation work in any sister departments of Goa University / neighbouring Institute (within Goa) / in the Industry (within Goa) but it should be under the supervision of one of the faculty members of Zoology.

Also, all the Core Courses have to be studied by all students in the first year (Semester I & II). Dissertation (16 Credits) is optional in lieu of the equivalent number of credits of courses from the Optional Courses and shall be undertaken in the second year (Semester III).

Timeline for completion of various credits over four Semesters:

Courses	**Codes**	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Total**
Discipline Specific Core Courses	DSCC	16	16			32
Discipline Specific Optional Course	DSOC	4	4			08
Research Specific Optional Courses	RSOC			8	4	12
Optional Generic Course	OGC			12		12
Discipline Specific Dissertation	DSD				16	16
		20	20	20	20	80

Semester III			
Code	**Research Specific optional Courses**	**Credits**	**Page No.**
ZOTR-501	Neurophysiology (Theory)	3 credits	50
ZOPR-501	Neurophysiology (Practical)	1 credit	52
ZOTR-502	Animal Cell Culture (Theory)	1 credit	53
ZOPR-502	Animal Cell Culture (Practical)	3 credits	54
ZOTR-503	Toxicology (Theory)	3 credits	56
ZOPR-503	Toxicology (Practical)	1 credit	58
ZOTR-504	Herpetology (Theory)	3 credits	59
ZOPR-504	Herpetology (Practical)	1 credit	61
ZOTR-505	Ornithology (Theory)	3 credits	63
ZOPR-505	Ornithology (Practical)	1 credit	66
ZOTR-506	Mammology (Theory)	3 credits	68
ZOPR-506	Mammology (Practical)	1 credit	70
ZOTR-507	Developments in Aquaculture (Theory)	3 credits	71
ZOPR-507	Techniques in Aquaculture (Practical)	1 credit	73
	Optional Generic Course		
ZOTG-501	Immunology	3 credits	75
ZOTG-502	Biological Applications of Nanoparticles and	2	77

	Nanotoxicology	credits	
ZOTG-503	Ecotoxicology	2 credits	78
ZOTG-504	Butterfly Gardening	2 credits	80
ZOTG-505	Ecotourism (Theory)	2 credits	81
ZOPG-505	Ecotourism (Practicals)	1 credit	83
ZOTG-506	Introduction to Animal Biomimetics	2 credits	84
ZOTG-507	Evolutionary Biology	2 credits	86
ZOTG-508	Vector Biology	2 credits	88
ZOTG-509	Ornamental Fish Management (Theory)	1 credit	90
ZOPG-509	Ornamental Fish Management (Practicals)	1 credit	92
ZOTG-510	Biology of Animal Reproduction	2 credits	94
ZOTG-511	Fish Processing	2 credits	96

Semester IV			
Code	**Research Specific optional Courses**	Credits	Page No.
ZOTR-508	Nutritional Biochemistry	2 credits	98
ZOTR-509	Stem Cell Biology	2 credits	100
ZOTR-510	Clinical Genetics I (Theory)	3 credits	101

ZOPR-510	Clinical Genetics I (Practical)	2 credits	103
ZOTR-511	Clinical Genetics II (Theory)	3 credits	105
ZOPR-511	Clinical Genetics II (Practical)	2 credits	107
ZOPI-501	Internship	2 credits	109
ZOPD-501	**Dissertation**	16 credits	110

Course Code: ZOTR-501 **Course Title: Neurophysiology (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on Non-chordate and Chordate anatomy and Physiology is prerequisite for this course.	
Objectives:	1. To develop knowledge about fundamental Neurophysiological concepts in animal models and in humans. 2. To be aware of electrophysiology techniques involved in recording neurological parameters.	
Content:	**Module 1** Review of classification of neurons and their functions. Blood-brain barrier and its physiological importance, CSF composition, formation, and drainage.	**3 hours**
	Physiological characteristics of neuronal cell membrane components for impulse conduction.	**2 hours**
	Myelin ultrastructure and Nodes of Ranvier, nerve impulse conduction in myelinated and unmyelinated neurons.	**4 hours**
	Electrophysiology of neurons. Comparison of action potentials of giant axon of Squid and mammalian neuron.	**3 hours**
	Voltage and Cell-Patch Clamp Techniques.	**3 hours**

	Module 2 Types of synaptic connections (axosomatic, axodendritic, dendro-dendritic, and axo-axonal synapses). Properties of Synapse. The basic concept of Neural integration: Diverging, Converging, and Reverberating circuits.	**2 hours**
	Chemical and electrical synapses and their transmission physiology. Axonal impulse conduction-excitatory and inhibitory synaptic transmission.	**4 hours**
	Neurotransmitters, Neuropeptides, and receptors.	**2 hours**
	Steps involved in the synthesis, transport, and release of neurotransmitters and neuropeptides.	**2 hours**
	Synthesis and release of Acetylcholine, Glutamate, GABA, Dopamine, Norepinephrine, and Epinephrine, Serotonin, Nitric oxide.	**5 hours**
	Module 3	
	Learning and Memory types and its Neural and Cellular basis in Aplysia, Drosophila, Honey bee and Humans.	**4 hours**
	Neurophysiology of Avian song/ call formation.	**2 hours**
	Cognition and its major domains. Mechanoreception, Photoreception, Chemoreception.	**4 hours**
	Neurophysiology of balance and posture.	**3 hours**
	Neurophysiology of sleep.	**2 hours**
Pedagogy:	Lectures/ tutorials/Group discussions/PBL/self-study	
Learning Outcome:	1. Understanding of neurophysiological concepts. 2. Understanding of learning, memory formation and cognition.	
References /Reading	1. Siegel, G. J.; Agranoff, B. W.; Albers, R. W., et al., (2011). Basic Neurochemistry: Molecular, Cellular and Medical Aspects. Academic Press. 2. Hammond, C. (2008). Cellular and Molecular Neurophysiology. Academic	

	Press. 3. Carpenter, R; Reddi, B. (2012). Neurophysiology: A Conceptual Approach,. Hodder and Arnold. UK. 4. Purves, D.; Augustine, G. J.; Fitzpatrick, D.; et al. (2018). Neuroscience. Oxford University Press. 5. Menzel, R.; Benjamin, P. (2013). Invertebrate Learning and Memory, Volume 22. Academic Press. 6. Gazzaniga, M. S. (2009). The Cognitive Neurosciences. A Bradford Book the MIT Press Cambridge , Massachusetts London, England.

Course Code: ZOPR-501 **Course Title: Neurophysiology (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on Non-chordate and Chordate anatomy and Physiology is prerequisite for this course.	
Objectives:	1. To develop knowledge about fundamental Neurophysiological concepts in animal models and in humans. 2. To be aware of electrophysiology techniques involved in recording neurological parameters.	
Content:	1. Estimation of Glutamate and GABA from brain tissue (Chicken head) either by Spectrophotometric/ Chromatographic/ Fluorospectrophotometric methods. 2. Primary culture of neurons from the chicken brain. 3. Primary culture of neurons from Chick embryo brain 4. Numerical and pictorial memory analysis using memory drum. 5. Learning and short-term memory formation analysis in human subjects. 6. Pressure phosphene, Balancing analysis using human subject. 7. Visual test analysis for photoreception in human subjects	**15 x 2 hours**
Pedagogy:	Lectures/ tutorials/Group discussions/PBL/self-study	
Learning Outcome:	1. Understanding of Neurophysiological concepts. 2. Understanding of learning, memory formation and cognition.	

References /Reading	7. Siegel, G. J.; Agranoff, B. W.; Albers, R. W., et al., (2011). Basic Neurochemistry: Molecular, Cellular and Medical Aspects. Academic Press. 8. Hammond, C. (2008). Cellular and Molecular Neurophysiology. Academic Press. 9. Carpenter, R; Reddi, B. (2012). Neurophysiology: A Conceptual Approach,. Hodder and Arnold. UK. 10. Purves, D.; Augustine, G. J.; Fitzpatrick, D.; et al. (2018). Neuroscience. Oxford University Press. 11. Menzel, R.; Benjamin, P. (2013). Invertebrate Learning and Memory, Volume 22. Academic Press. 12. Gazzaniga, M. S. (2009). The Cognitive Neurosciences. A Bradford Book the MIT Press Cambridge , Massachusetts London, England.

Course Code: ZOTR-502 **Course Title: Animal Cell Culture (Theory)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on organization of cells, their structure and function in animal body	
Objectives:	1. To understand the structure, growth and function of animal cells. 2. To understand the technology involved in cell and tissue culture establishment, characterization and its maintenance.	
Content:	**Module 1** Basics of animal cell culture, Laboratory layout and sterile handling, Equipments, Chemicals and other requisites for animal cell culture, safety during Animal cell culture. Primary cell culture (Explant and free cell culture), subculture and cell line. Maintenance of cell culture, characterization of cultured cells, Advantages of Animal cell culture, Stem cells (Embryonic and Adult) and their applications.	**7 hours** **8 hours**
Pedagogy:	Lectures/ tutorials/assignments/self-study/presentation	
Learning Outcome:	1. Theoretical idea to isolate and culture cells using different techniques 2. Ability to explain sterile techniques for growing culture and identifying contaminants.	

	3. Ability to describe the culture and *in-vitro* maintenance of the cells
References /Reading	1. Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons. 2. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & Thomson, J. A. (Eds.). (2005). Essentials of stem cell biology. Elsevier. 3. Masters, J. (Ed.). (2000). Animal cell culture: a practical approach (Vol. 232). OUP Oxford. 4. Boulton, A. A., Baker, G. B., & Walz, W. (Eds.). (1992). Practical cell culture techniques (Vol. 23). Totowa, New Jersey: Humana Press.

Course Code: ZOPR-502 **Course Title: Animal Cell Culture (Practicals)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of Anatomy, Cell Biology, & Laboratory setup	
Objectives:	. 1. Maintaining aseptic environment for cell culture . 2. Hands on training in different cell culture techniques.	
Content:	**Module 1** . 1. Sterilization of Animal cell culture/Tissue culture Room . 2. Preparation of Laminar Flow hood for cell culture . 3. Sterilization techniques: Steam & Hot Air . 4. Preparation and sterilization of medias and buffers **Module 2** . 1. Isolation and inoculation of gill cells from bivalves by mechanical (trituration) dissociation . 2. Isolation of mantle cells from bivalves by explant culture method . 3. Isolation of siphon cells from bivalves by enzymatic (Trypsinization) dissociation . 4. Isolation and culture of cells from hepatopancreas of prawns/crabs . 5. Isolation and primary culture of hepatocytes from fish **Module 3** . 1. Primary cultures of fibroblast from chick embryo. . 2. Isolation and maintenance of chicken embryonic stem cell from	**15 x 2 hours** **15 x 2 hours** **15 x 2**

	. blastoderm. . 3. Isolation and culture of chicken cartilage Stem/Progenitor . cells. . 4. Isolation and inoculation of mesenchymal stem cells from . chicken compact bones. . 5. Isolation and culture of dermis-derived mesenchymal . Stem/Progenitor cells from chick embryo.	**hours**
Pedagogy:	Practicals/Mini projects/Group activities/presentations.	
Learning Outcome:	Hands on training in Animal cell culture techniques.	
References /Reading	1. Boulton, A. A., Baker, G. B., & Walz, W. (Eds.). (1992). Practical cell culture techniques (Vol. 23). Totowa, New Jersey: Humana Press. 2. Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons. 3. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E. D., & Thomson, J. A. (Eds.). (2005). Essentials of stem cell biology. Elsevier. 4. Masters, J. (Ed.). (2000). Animal cell culture: a practical approach (Vol. 232). OUP Oxford. 5. Mitsuhashi, J. (2002). Invertebrate tissue culture methods. Springer science & business media.	

Course Code: ZOTR-503 **Course Title: Toxicology (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on Chemistry, Anatomy, Physiology and Ecology.	
Objectives:	1. To understand everyday toxic substances and their routes of exposures and its fate in the animal body and in the environment. 2. To understand significance of toxicological studies in forensic science.	
Content:	**Module 1** Introduction to toxicology: Definition and Scope, History of Toxicology, Branches of Toxicology. Classification of Toxicants (based on 1] Source, 2] Use, 3] Target organ 4] Reactivity). Toxicokinetics: Definitions and concepts of Exposure, Dose and response. Metabolism of toxicants (Phase I and Phase II reactions), Absorption, Distribution, Biotransformation and Elimination of Toxicants (Renal Elimination, Hepatic Elimination,	**15 hours**

	Respiratory Elimination), Toxic actions /mechanism (Acute, Sub-chronic & Chronic). Toxicokinetic models (Descriptive and Physiological Models). **Module 2** Environmental Toxicity: Environmental contaminants, Dilution paradigm and Boomerang paradigm, Ways of poisoning food chain, Environmental persistence. Pollution: Air pollution, Noise pollution, water pollution and thermal pollution: types and sources, effects of pollutants on human health. Solid waste pollution: sources and effects of solid waste toxicity on human health. Pesticide and Heavy metal toxicity: effects of pesticides and heavy metals on ecosystem, mechanism of pesticides toxicity, heavy metal toxicity and their effects on human health. Zootoxins, phytotoxins and bacteriotoxins **Module 3** Forensic toxicology: Disciplines of Forensic toxicology (Definition of poisons, Forensic classification of poison, factors affecting the mode of action of poisons, extraction and isolation of poisons from biological samples. Drugs included in routine post-mortem toxicology, Forensic DNA typing system. Applications of forensic toxicology Alkaloid toxicity: definition, classification and isolation of alkaloids from biological samples, general properties of toxic alkaloids. Food poisoning- definition and common sources. Analysis of food products for adulterants by physical, chemical and instrumental techniques.	**15 hours** **15 hours**
Pedagogy:	Lectures/Tutorials/Videos/Assignments/ Group discussions/Self-study.	
Learning Outcome:	1. Understanding application of different routes of exposure for toxicological studies and dose findings. 2. Understanding of the physiological and environmental effects of toxins. 3. Knowledge of various techniques for Toxicity evaluation.	
References/ Reading	1. Timbrell J. Introduction to ToxicologyThird Edition (2002), Taylor and Francis Inc. 2. Klaassen C, John Watkins J. Casarett & Doull's Essentials of Toxicology, Third Edition (2015). McGraw-Hill Education publication. 3. Stine K., Brown TM. Principles of Toxicology. Third Edition (2015). CRC Press. 4. Wallace A H. Principles and Methods of Toxicology. Fifth edition (2007).	

	Informa Healthcare Publication, USA 5. Kwong T, Magnani B, Rosano T,Shaw L. The Clinical Toxicology Laboratory: Contemporary Practice of Poisoning Evaluation, Second Edition (2013). AACC Press. 6. Pandey G, Sahani YP. Toxicological Laboratory Manual. First Edition (2013)International E-Publication, India. 7. Levine B. Principles of Forensic Toxicology. Second Edition (2003)Amer Assn for Clinical Chemistry Press. 8. Hodgson E. A Textbook of Modern Toxicology. Fourth Edition (2010). Willey Publication. 9. Durrant M. Handbook of Clinical Toxicology. First Edition (2019). Hayle Medical Publishers.

Course Code: ZOPR-503 **Course Title: Toxicology (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on Chemistry, Anatomy, Physiology and Ecology.	
Objectives:	1. To understand everyday toxic substances and their routes of exposures and its fate in the animal body and in the environment. 2. To understand significance of toxicological studies in forensic science.	
Content:	1. Detection of heavy metals in water samples 2. Detection of additives in food items 3. Detection of microplastics in water samples 4. Determination of LD50 from given data using Probit analysis. 5. Effect of heavy metal pollution physiological process in crabs/fishes 6. Estimation of oxidative damage in organisms exposed to pollutants 7. Understanding the classes of drugs and their modes of action	**15 x 2 hours**
Pedagogy:	Lectures/Tutorials/Videos/Assignments/ Group discussions/Self-study.	

Learning Outcome:	1. Understanding application of different routes of exposure for toxicological studies and dose findings. 2. Understanding of the physiological and environmental effects of toxins. 3. Knowledge of various techniques for Toxicity evaluation.
References/ Reading	1. Timbrell J. Introduction to ToxicologyThird Edition (2002), Taylor and Francis Inc. 2. Klaassen C, John Watkins J. Casarett & Doull's Essentials of Toxicology, Third Edition (2015). McGraw-Hill Education publication. 3. Stine K., Brown TM. Principles of Toxicology. Third Edition (2015). CRC Press. 4. Wallace A H. Principles and Methods of Toxicology. Fifth edition (2007). Informa Healthcare Publication, USA 5. Kwong T, Magnani B, Rosano T,Shaw L. The Clinical Toxicology Laboratory: Contemporary Practice of Poisoning Evaluation, Second Edition (2013). AACC Press. 6. Pandey G, Sahani YP. Toxicological Laboratory Manual. First Edition (2013)International E-Publication, India. 7. Levine B. Principles of Forensic Toxicology. Second Edition (2003)Amer Assn for Clinical Chemistry Press. 8. Hodgson E. A Textbook of Modern Toxicology. Fourth Edition (2010). Willey Publication. 9. Durrant M. Handbook of Clinical Toxicology. First Edition (2019). Hayle Medical Publishers.

Course Code: ZOTR-504 **Course Title: Herpetology (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on herpetofauna its identification at taxonomic level and the systematics	
Objectives:	1. Students will be introduced to the diversity and biology of amphibians and reptiles. 2. The lecture component will have a national, global and diverse focus, covering topics of phylogenetics, the origin and evolution of amphibians and reptiles, the global diversity of taxa, and their biogeography, biology, habitat, ecology and conservation.	
Content:	**Module 1:** Introduction to herpetology: shared characteristics of Amphibians and Reptiles, significance of studying Amphibians and Reptiles, the diversity of Amphibians and Reptiles.	**15 hours**

	Thermal Ecology: Heat Exchange in the environment (Absorption of radiant energy, radiative loss, conduction, convention, evaporative cooling, role of body size and shape in heat exchange), Response to environmental temperatures (Basking, Perching, Breezing, Postural changes, Shade seeking and shuttling, Burrowing, Dial patterns of response to temperature), Costs and benefits of Ectothermy and Endothermy. Water relations in amphibians and reptiles, Aestivation, Hibernation and other Eco physiological adaptations in reptiles and amphibians	
	Module 2: Factors affecting distribution and abundance of amphibians and reptiles, Biogeography of Amphibians and reptiles, Communication in Amphibians and reptiles, Diet and foraging behaviour, Parental care in Amphibians and Reptiles, The Ecology and Behaviour of Amphibian Larvae, the niche (niche theory, interspecific competition, niche overlap and resource partitioning, factors influencing resource partitioning)	**15 hours**
	Module 3: Systematics and diversity of extant Amphibian & Reptiles: life history, skin, reproduction, sensory systems. Taxonomy, morphology, reproduction, life history & fossil Records (Caudata, Anura & Gymnophiona), Taxonomy, Morphology, Reproduction, Life History & Fossil Records (Squamata, Testudines, Crocodilia, Sphenodontia)	**15 hours**
Pedagogy:	Lectures/ tutorials/assignments/self-study	
Learning Outcome:	1. Students will learn about the Diversity, Habitat-Ecology, Behavior, Adaptation, Taxonomy of the Amphibian and reptiles. 2. Identification of the local herpetofauna through direct field experience. The course assumes that students are familiar with basic evolutionary theory and general biology.	
References /Reading	1. Porter, K.R. 1972. Herpetology. W. B. Saunders Co., Philadelphia. xi, 524 pages. 8o. 2. Adler, K. (Ed.). 1989. Contributions to the History of Herpetology. K. Adler: Herpetologists of the past; J. S. Applegarth: Index of authors in taxonomic 3. Herpetology; R. Altig: Academic lineages of doctoral degrees in herpetology. Contributions to Herpetology, No. 5, Society for the Study of Amphibians and Reptiles, Oxford, Ohio, 202 pages, 1 plate. 4o.	

	4. Biology of Reptiles: D.R. Khanna and P.R. Yadav, Discovery Pub, 2004, ix, 414 p, figs, ISBN 5. An Introduction to Reptiles: H.S. Bhamrah and Kavita Juneja, Anmol, 2002, Reprint, vi, 193 p, 6. The Reptile Fauna of India: A Source Book by T.S.N. Murthy, B.R. Pub, 2010, xx, 332 p 7. A Pocket Book on Indian Reptiles: Crocodiles, Testudines, Lizards and Snakes, T.S.N. Murthy, Nature Books India, 2009, viii, 88 p 8. The book of Indian Reptiles and Amphibians, By J. C. Daniel, BNHS 9. Snakes of India, The Field Guide, by, R. Whitaker and Ashok Captain. 10. The Fauna of British India, Ceylon and Burma, Reptilia and Amphibia, VOL III – Serpentes, By Malcom A. Smith. 11. The Fauna of British India, Ceylon and Burma, Reptilia and Amphibia, VOL II – Sauria, By Malcom A. Smith. 12. Ecology of Reptiles, Heatwole & Taylor, 1987 13. Snakes Ecology & Behavior, Seigel and Collins

Course Code: ZOPR-504 **Course Title: Herpetology (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on herpetofauna its identification at taxonomic level and the systematics	
Objectives:	Laboratory training based on skilled based courses on Herpetology.	
Content:	1. The identification of the amphibian families through basic external anatomy 2. The identification of the reptile families through basic external anatomy 3. Identification of reptiles through scale count 4. Learning handling techniques of Amphibians and Reptiles 5. Beta diversity of herpetofauna in the Goa University campus 6. Identification of venomous and non-venomous snakes	**15 x 2 hours**

Pedagogy:	Lectures/ tutorials/assignments/self-study
Learning Outcome:	3. Students will learn about the Diversity, Habitat-Ecology, Behavior, Adaptation, Taxonomy of the Amphibian and reptiles. 4. Identification of the local herpetofauna through direct field experience.
References /Reading	1. Porter, K.R. 1972. Herpetology. W. B. Saunders Co., Philadelphia. xi, 524 pages. 8o. 2. Adler, K. (Ed.). 1989. Contributions to the History of Herpetology. K. Adler: Herpetologists of the past; J. S. Applegarth: Index of authors in taxonomic 3. Herpetology; R. Altig: Academic lineages of doctoral degrees in herpetology. Contributions to Herpetology, No. 5, Society for the Study of Amphibians and Reptiles, Oxford, Ohio, 202 pages, 1 plate. 4o. 4. Biology of Reptiles: D.R. Khanna and P.R. Yadav, Discovery Pub, 2004, ix, 414 p, figs, ISBN 5. An Introduction to Reptiles: H.S. Bhamrah and Kavita Juneja, Anmol, 2002, Reprint, vi, 193 p, 6. The Reptile Fauna of India: A Source Book by T.S.N. Murthy, B.R. Pub, 2010, xx, 332 p 7. A Pocket Book on Indian Reptiles: Crocodiles, Testudines, Lizards and Snakes, T.S.N. Murthy, Nature Books India, 2009, viii, 88 p 8. The book of Indian Reptiles and Amphibians, By J. C. Daniel, BNHS 9. Snakes of India, The Field Guide, by, R. Whitaker and Ashok Captain. 10. The Fauna of British India, Ceylon and Burma, Reptilia and Amphibia, VOL III – Serpentes, By Malcom A. Smith. 11. The Fauna of British India, Ceylon and Burma, Reptilia and Amphibia, VOL II – Sauria, By Malcom A. Smith. 12. Ecology of Reptiles, Heatwole & Taylor, 1987 13. Snakes Ecology & Behavior, Seigel and Collins

Course Code: ZOTR-505 **Course Title: Ornithology (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on birds and their identification at taxonomic level and the systematics
Objectives:	This course develops major concepts in ornithology, including avian origin, evolution, systematics, distribution, flight adaptations, physiology, ecology and applied ornithology.

Content:	**Module 1** Avian origin, evolution, systematics, distribution, flight adaptations and physiology: Evolution- Diversification of modern birds – Adaptive radiation & speciation in birds. Flightless birds and adaptations Topography of bird, types of beaks, types of feet, types of feathers, types of pigments, visual functions of plumage, flight: forms, mechanisms & energetics Avian systematics - avian classification, diversity and distribution of birds of India. Endemism in Indian avifauna – Endemic Bird Areas of India. Flight Adaptations - morphological, anatomical and physiological. Physiology- vocal organ and vocalization, Neurophysiology of song control system, Analysis of bird song using Acoustic spectroscopy, colour physiology of iridescent and non- iridescent feathers and gloss production; Thermoregulatory mechanisms; avian eye and its adaptations Biology of moulting in birds (periodic and forced moulting).	**15 hours**
	Module 2 Avian Ecology: Avian food and foraging - diversity of foods and foraging behaviors, feeding specialization and generalization, resource partitioning, colonial behaviour, cooperation, competition and conflicts. Breeding- nesting territories, communal nesting, bird songs, courtship, mating systems, types of nests, clutch size, parental care, nest parasitism. Migration - types of migration, flyways of migrations, physiological aspects of migration, orientation & navigation in migratory birds, threats to migratory bird populations. Roosting behaviour	**15 hours**
	Module 3 Applied ornithology: Importance of bird population monitoring; census techniques - applications, assumptions & limitations; methods: Line transects, point counts, fixed and variable width and call counts. Bird Banding- Principles of mist-netting; types of marking birds: rings/bands, flags, tags, dyes, and natural markers – Radio-tracking of birds & satellite telemetry. - Conservation of threatened avifauna - Captive breeding & ex-situ conservation of critically endangered	**15 hours**

	birds - Birds as indicators of environmental health – Merits and limitations of birds as ecological indicators, Birds as model systems in applied genetic studies. -Birds as pests in agriculture, pisciculture, apiculture, sericulture, and free-ranging poultry farms – Role of birds in the dispersal of weeds, parasitic, and invasive plants – Birds as vectors of pathogens and parasites – Zoonoses. – Bird strike hazards to aircraft & their management, - Birdwatching as an emerging eco-tourism venture - Biomimicry & birds – Aerodynamic studies, bionic bird, bullet train inspired by Kingfisher. -Recent research in the field of ornithology.	
Pedagogy:	1. Use of conventional, online and ICT Methods. 2. Field visit/project/self-study/Lecture/Tutorials/Assignments	
Learning Outcome:	1. Identification of birds on the field and familiarity of methods for bird studies. 2. Understand various aspects of avian biology such as evolution, taxonomy, anatomy, and physiology. 3. Understand ecology of birds with respect to their feeding, breeding, roosting and migration. 4. Gain insight into applied ornithology and recent research in the field of ornithology.	
References /Reading	1. Ali S (2016): The Book of Indian Birds. Bombay Natural History Society and Oxford University Press, India. 2. Bibby CJ, Burgess ND, Hill A (1992): Bird Census Techniques. Academic Press, UK. 3. Brainard, M. S. and Doupe, A. J. (2000). Auditory feedback in learning and maintenance of vocal behavior. Nature Rev. Neurosci. 1, 31-40. 4. Faborg J and Chaplin SB (1988): Ornithology: an Ecological Approach. Prentice Hall Inc. New Jersey. 6. Gill, F. B. (2007) Ornithology. (3rd ed.) W. H. Freeman and Company, New York, NY. 758 pp 7. Goodfellow P (1977): Birds as Builders. Arco Publishing Co., New York. 8. Lovette I. J. and Fitzpatrick J. W. (2016) Handbook of Bird biology (3rd Ed) Wiley publishers. 9. Inskipp C, Grimmett R and Inskipp T (2011): Birds of the Indian Subcontinent, Princeton University Press. 10. Meyer D.B. (1977) The Avian Eye and its Adaptations. In: Crescitelli F. (eds) The Visual System in Vertebrates. Handbook of Sensory Physiology, vol 7 / 5. Springer, Berlin, Heidelberg.	

	11. Sturkie, P. D. (1998). Sturkie's Avian Physiology. 5th Edition. Academic Press, San Diego. 12. Ziegler, Harris Philip; Bisch of, Hans-Joachim, eds. (1993). Vision, Brain, and Behavior in Birds: A comparative review. MIT Press

Course Code: ZOPR-505 **Course Title: Ornithology (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on birds and their identification at taxonomic level and the systematics	
Objectives:	This course develops major concepts in ornithology, including avian origin, evolution, systematics, distribution, flight adaptations, physiology, ecology and applied ornithology.	
Content:	1. Identification of birds on the field, based on colour, size, flight, and call. 2. Comparative study of resident and migratory birds with respect to habitats (Plateau, Forest and Wetland). 3. Analysis of ornithological data using statistical software. 4. Study of nesting behaviour of Baya Weaver. 5. Acoustic analysis of bird calls and songs. 6. Structural and functional analysis of avian feathers. 7. Anatomy of bird (poultry chicken): flight muscles, digestive system, respiratory system, urinogenital system, skeletal system, and brain.	**15 x 2 hours**
Pedagogy:	1. Use of conventional, online and ICT Methods. 2. Field visit/project/self-study/Lecture/Tutorials/Assignments	
Learning Outcome:	1. Identification of birds on the field and familiarity of methods for bird studies. 2. Understand various aspects of avian biology such as evolution, taxonomy, anatomy, and physiology. 3. Understand ecology of birds with respect to their feeding, breeding, roosting and migration. 4. Gain insight into applied ornithology and recent research in the field of ornithology.	

References /Reading	1. Ali S (2016): The Book of Indian Birds. Bombay Natural History Society and Oxford University Press, India. 2. Bibby CJ, Burgess ND, Hill A (1992): Bird Census Techniques. Academic Press, UK. 3. Brainard, M. S. and Doupe, A. J. (2000). Auditory feedback in learning and maintenance of vocal behavior. Nature Rev. Neurosci. 1, 31-40. 4. Faborg J and Chaplin SB (1988): Ornithology: an Ecological Approach. Prentice Hall Inc. New Jersey. 6. Gill, F. B. (2007) Ornithology. (3rd ed.) W. H. Freeman and Company, New York, NY. 758 pp 7. Goodfellow P (1977): Birds as Builders. Arco Publishing Co., New York. 8. Lovette I. J. and Fitzpatrick J. W. (2016) Handbook of Bird biology (3rd Ed) Wiley publishers. 9. Inskipp C, Grimmett R and Inskipp T (2011): Birds of the Indian Subcontinent, Princeton University Press. 10. Meyer D.B. (1977) The Avian Eye and its Adaptations. In: Crescitelli F. (eds) The Visual System in Vertebrates. Handbook of Sensory Physiology, vol 7 / 5. Springer, Berlin, Heidelberg. 11. Sturkie, P. D. (1998). Sturkie's Avian Physiology. 5th Edition. Academic Press, San Diego. 12. Ziegler, Harris Philip; Bisch of, Hans-Joachim, eds. (1993). Vision, Brain, and Behavior in Birds: A comparative review. MIT Press

Course Code: ZOTR-506 **Course Title: Mammology (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on mammals and their identification at taxonomic level and the systematics	
Objectives:	This course develops major concepts in Mammalogy, including evolution, systematics, biogeography, adaptations, ecology and mammalian conservation.	
Content:	**Module 1** Significance of study on mammals. Mammalian characteristics Evolution, systematics, Molecular technique in mammalian phylogeny Biogeography, morphology, anatomy and physiology of mammals. **Module 2**	**15 hours** **15 hours**

	Foraging behaviour, Activity rhythm, communication Mammalian reproduction: an ecological perspective, mating systems, cooperative breeding, parental care Social organization, territoriality, communities, migration Adaptation: hibernation, torpor, aestivation, locomotion and water regulation of mammals; Adaptations in mammals based on habits and habitat: aquatic, desert, polar, fossorial, cursorial, arboreal, flying and gliding Echolocation in bats, biosonar in cetaceans **Module 3** Field techniques to study mammals, indirect methods of identifying mammals. Mammals as indicators of ecosystem, mammals as indicators of trace elements, mammalian keystone species and its significance in different ecosystem Management of mammals in zoological park, captive breeding of threatened mammals, mammalian conservation ethics	**15 hours**
Pedagogy:	1. Use of conventional, online and ICT Methods. 2. Field visit/project/self-study/Lecture/Tutorials/Assignments	
Learning Outcome:	1. Identification of mammals using direct and indirect method. 2. Understand various aspects of mammology such as evolution, systematics, biogeography, adaptations, and ecology. 3. Gain perception of mammalian conservation.	
References /Reading	1. Clutton-Brock T. (2009). Structure and function in mammalian societies. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 364(1533), 3229–3242. https://doi.org/10.1098/rstb.2009.0120 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781877/ 2. George A. Feldhamer, Joseph F. Merritt, Lee C Drickamer, Stephen H. Vessey (2007) Mammalogy - Adaptation, Diversity, Ecology. Johns Hopkins University Press. 3. George A. Feldhamer (2020) Mammalogy - Adaptation, Diversity, Ecology. Johns Hopkins University Press. 4. Vaughan T.A., Ryan J.M., Czaplewski N. J. (2011) Mammology, Jones and Barlett publisher, USA.	

Course Code: ZOPR-506 **Course Title: Mammology (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on mammals and their identification at taxonomic level and the systematics	
Objectives:	This course develops major concepts in Mammalogy, including evolution, systematics, biogeography, adaptations, ecology and mammalian conservation.	
Content:	1. Study of epidermal derivatives of mammals. 2. Identification of hair of different mammals based on cuticular and medullary patterns. 3. Comparative morphology of dentition. 4. Comparative morphology of skull. 5. Anatomy of rat (preserved specimen). 6. Mapping distribution of primates, carnivores and ungulates in the given area. 7. Field visit to identify mammals using direct/ indirect methods.	**15 x 2 hours**
Pedagogy:	1. Use of conventional, online and ICT Methods. 2. Field visit/project/self-study/Lecture/Tutorials/Assignments	
Learning Outcome:	1. Identification of mammals using direct and indirect method. 2. Understand various aspects of mammology such as evolution, systematics, biogeography, adaptations, and ecology. 3. Gain perception of mammalian conservation.	
References /Reading	1. Clutton-Brock T. (2009). Structure and function in mammalian societies. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 364(1533), 3229–3242. https://doi.org/10.1098/rstb.2009.0120 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781877/ 2. George A. Feldhamer, Joseph F. Merritt, Lee C Drickamer, Stephen H. Vessey (2007) Mammalogy - Adaptation, Diversity, Ecology. Johns Hopkins University Press. 3. George A. Feldhamer (2020) Mammalogy - Adaptation, Diversity, Ecology. Johns Hopkins University Press. 4. Vaughan T.A., Ryan J.M., Czaplewski N. J. (2011) Mammology, Jones and Barlett publisher, USA.	

Course Code: ZOTR-507 **Course Title: Developments in Aquaculture (Theory)**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on fish biology and aquaculture	
Objectives:	This course is designed to impart knowledge and technical skills to understand this rapidly changing field of modern Aquaculture. It also aims to empower students to understand the recent trends and challenges of farming society in the field of Aquaculture and get confidence to work on different kinds of aquaculture practices.	
Content:	**Module 1** Review on the fundamentals of Aquaculture: Scope and principles of aquaculture, History of aquaculture, Importance of aquaculture: worldwide, Nationwide, and state-wide. Different sectors of Aquaculture and Types of culture practices: Monoculture, Mono-sex culture, Cage culture, Pen culture, composite culture and other techniques. Hatchery management: types of hatcheries, design, and construction, Pond management, and fertilization; pre-and post-stocking management. Water-quality criteria for Aquaculture. Aquafeed technology: Sources of food, Aquafeed Technology: Balanced diet, Feed formulation, Linear programming, Feed additives, Feed conversion ratio (FCR), Protein retention, Calorie retention. Nutritional requirements at various stages of development of fish & crustaceans. **Module 2** Finfish and Shellfish farming: Freshwater and marine fish seed resources in India. Gears and crafts are used for seed collection and fish collection. Concept of Bundh breeding (Advantages and Disadvantages) Maintenance and criteria for optimum conditions for Hatchery and nursery management (Brood stock collection and transportation, Life cycle, breeding behavior, breeding season, and sexual maturity) of Indian Major Carps, Freshwater prawn, white-leg shrimp, Mud crab, edible oyster, Green mussels.	**15 hours** **15 hours**

	Induced breeding technique in Carps and Salmonids. Advantages of GIFT (Genetically Improved Farmed Tilapia) in Aquaculture. Fish diseases and Integrated health management of the farm. **Module 3** Organic farming techniques: Integrated farming, Biofloc technology. Green aquaculture, Aquaponic system, Bioremediation, Biofiltration, Eco-labelling. Zero water exchange, and Reuse. Aquaculture Industries: Technology of Fish products and By-products, Environmental considerations: Impact of Climate Change on aquaculture, Mitigation, and adaptive strategies.	**15 hours**
Pedagogy:	Lectures/ tutorials/assignments/self-study/Presentation	
Learning Outcome:	Understanding aquaculture sectors, scope its importance and t, and technologies with a broad range of knowledge in development principles of fisheries and aquaculture, capable to apply the modern methods and techniques in planning, design, management of fish farms, understanding competitive ability principles of aquaculture and fisheries, able to flexibility in understanding the e for entrepreneurship and research environment and technological developments and needs.	
References /Reading	1. Robert R. Stickney. (2022). Aquaculture-An introductory text. Alex Lainsburry, CABI South Asia Edition. 2. FAO.2020. The Stare of World Fisheries and Aquaculture (2020). Sustainability in action. http://doi.org/10.4060/ca9229en 3. Naylor, R.L. Hardy, RW., Buschmann, A.H.,Bush (2021). A 20-year retrospective review of global aquaculture. Nature,591(7851),pp.551-563. 4. Lucas, J.S.(2019).Aquaculture: Farming aquatic animals and plants. John Wiley & Sons. 5. The state of world fisheries and aquaculture (2018)- The sustainable development goals. FAO. License: CC BY-NC-SA 3.0 IGO 6. Ayyappan, S., (2011). Handbook of Fisheries and Aquaculture, ICAR Publications, New Delhi. 7. Pillay,T.V. and Kutty, M.N. (2005). Aquaculture: Principles and practices (2nd Edition). Blackwell Publishing. 8. Dick Mills. (1998). Aquarium fishes, Dorling Kindersly Ltd, London. 9. Jameson, J.D. and Santhanan, R. (1996). Manual of ornamental fishes and farming technologies, Fisheries College and Research Institute, Tuticorin 10. Joshua, K. et al. (1993). Shrimp Hatchery Operation and Management.	

	Marine Products Export Development Authority, Kochi, India 11. Thakur, N.K. et al. (1998) Culture of live food organisms for aqua hatcheries. Training manual. CIFE (ICAR), Mumbai. 12. Jhingran, V.G. Pullin, R.S.V. (1997). A hatchery manual for the Common, Chinese, and Indian Major Carps. Asian Development Bank, International Center for Living Aquatic Resources Management, Philippines. 13. Ramanathan, N. and Francis, T. (1996.) Manual on breeding and larval rearing of cultivable fishes, Fisheries College and Research Institute, Tuticorin.

Course Code: ZOPR-507 **Course Title: Techniques in Aquaculture (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on fish biology and aquaculture	
Objectives:	This course is designed to impart knowledge and technical skills to understand this rapidly changing field of modern Aquaculture. It also aims to empower students to understand the recent trends and challenges of farming society in the field of Aquaculture and get confidence to work on different kinds of aquaculture practices.	
Content:	1. Measurement of DO, total hardness, and Salinity of the water bodies 2. Preparation of fish feed in the laboratory. 3. Study of common fish diseases. 4. Demonstration of Induced breeding of Indian major carps 5. Demonstration of raft technique for mussel culture. 6. Culture and maintenance of live fish feed (Artemia, algae) 7. Demonstration of a small-scale aquaponics system. 8. Observations of gonadal maturation in fish. 9. Detection of organoleptic changes in fish.	**15 x 2 hours**

	10. Visit fish farms/ Fish breeding units/ Fish Processing industry.	
Pedagogy:	Mini projects/ tutorials/Group discussions/Field visit	
Learning Outcome:	Students will become familiar with principles of ecology and behavior of fishes Students will become familiar with fish anatomy. Students are expected to show mastery in the laboratory and field-based activities, with an emphasis on anatomy and identification of fish species, and understanding the socio-economic development through Fisheries.	
References/ Reading	1. Paul.J .B. 2002. Handbook of Fish Biology and Fisheries (Vol.1). Blackwell Publishing. 2. Selvamani B.R and Mahadevan R.K. (2008) Freshwater fish farming (Campus Books International) 3. Pauly, D., P. Tyedmers, R. Froese, and L. Y. Liu. (2001). Fishing down and farming up the food web. Conservation Biology in Practice 2 (4):25 4. The Diversity of Fishes: Biology, Evolution, and Ecology by Gene Helfman, Bruce B. Collette, Douglas E. Facey, and Brian W. Bowen. ISBN: 978-1-4051-2494-2 736 pages, May 2009, Wiley-Blackwell, price $129.95 5. Bond's Biology of Fishes.2008. 3rd edition by Michael Barton (ISBN:0120798751) 6. Cailliet, G., M. Love, A. Ebeling 1986 Fishes, a field and laboratory manual on their structure, identification and natural history. Waveland Press, Ill.	

Course Code: ZOTG-501 **Course Title: Immunology**
Number of Credits: 3
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on cell biology
Objectives:	1. To enable the student to understand the principles and mechanisms of immunology 2. To update the student on the scope and importance of clinical immunology and create an awareness about the inherent dangers of microbes 3. To impart conceptual understanding of functional organization of immune system and its responsiveness in health and disease

Content:	**Module 1** An overview of immune system, Cells of immune system, Primary and secondary lymphoid organs and their role in immunity. Types of immunity: Concept of innate and acquired- types, functional features. Concept of Antigens, Immunogen, antigenicity and immunogenicity**,** Adjuvants (definition, types and applications). **Module 2** Cellular Immune System**-**Lymphocytes: Development, types, morphology, clones / sub-populations, distribution, B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance **Module 3** Antibody structure, types. Generation of antibody diversity. Complement system Components, three major activation pathways, and immune functions including anaphylaxis and inflammation. Cytokines and Interferons, their salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions; Interferons--Origin, types and functions	**3 hours** **4 hours** **5 hours** **3 hours** **6 hours** **4 hours** **5 hours** **5 hours** **6 hours** **4 hours**
Pedagogy:	Lectures/ tutorials/self-study/videos	
Learning Outcome:	1. Development of knowledge on the cellular ontogeny and organ involvement in immunity and how the immune system can fight infections and diseases. 2. Knowledge on development of body immune mechanisms and their applications. 3. Understanding of current immunology news and issues	
References /Reading:	1. Kuby Immunology, 6th edition (2007), T. J. Kindt, R.A. Goldbye, B.A. Osborne, Publisher: W.H. Freeman and Company. 2. Immunobiology: The Immune System in Health and Diseases, 6th Edition (2005), Charles A. Janeway, Publisher: Garland Science.	

	3. Roitt's Essential Immunology, 11th Edition (2006) Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, Publisher: Wiley-Blackwell. 4. Cellular and Molecular Immunology, 6th Edition (2008) Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai, Publisher: Elsevier, USA. 5. Prescott, Harley, Klein's Microbiology 7th edition (2009), Joanne M Willey, Christopher J Woolverton, Linda M Sherwood, Publisher: McGraw-Hill.

Course Code: ZOTG-502 **Course Title: Biological Applications of Nanoparticles and Nanotoxicology**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of chemistry, physics and biology	
Objectives:	1. To provide kno wledge of nanoscience in the field of biology. 2. To understand the nanoparticles interaction with biological systems. 3. To provide wide range of application in the various fields of biology 4. To reveal the toxicity of the widely used nanoparticles.	
Content:	**Module 1** Overview of nanoscience, Nanoparticles. Various types of nanoparticles, chemically and biologically synthesized nanoparticles, Characterization of nanoparticles, Biocompatibility, Importance of nanoparticles in biology: medicine, drug delivery, cancer therapy, tissue regeneration, prosthesis, Recent advances in nanoscience. **Module 2** Nanotoxicology, Sources of nanoparticles, Nanopollution, Routes of exposure in aquatic and terrestrial animals, Human exposure to nanosized materials. Effect of nanoparticles in cells and biological systems. Preventive measures during nanoparticle handling, Toxicity hazards and assessment of risk, Mitigating strategies.	**15 hours** **15 hours**
Pedagogy:	Lectures/ tutorials/self-study/videos	
Learning Outcome:	1. Basic understanding of nanoscience in biology 2. Good understanding of nanoscience, in the form of its applications and also its adverse effects	
References	1. Sahu, S. C., & Casciano, D. A. (Eds.). (2014). Handbook of nanotoxicology,	

/Reading:	nanomedicine and stem cell use in toxicology. John Wiley & Sons. 2. Lindsay, S. (2010). Introduction to nanoscience. Oxford University Press. 3. Houdy, P., Lahmani, M., & Marano, F. (Eds.). (2011). Nanoethics and nanotoxicology. Springer Science & Business Media. 4. Schaefer, H. E. (2010). Nanoscience: the science of the small in physics, engineering, chemistry, biology and medicine. Springer Science & Business Media. 5. Monteiro-Riviere, N. A., & Tran, C. L. (Eds.). (2007). Nanotoxicology: characterization, dosing and health effects. CRC Press. 6. Zucolotto, V. (2013). Nanotoxicology: materials, methodologies, and assessments. Springer Science & Business Media.

Course Code: ZOTG-503 **Course Title: Ecotoxicology**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of Chemistry, Biology, Physiology and Ecology	
Objectives:	Students will gain full understanding of the effects of toxic substances on ecosystems and their living components. Students will also gain knowledge on the various organisms and methods used in ecotoxicological testing as well as mitigation	
Content:	**Module 1** Introduction to Ecotoxicology: Important concepts of ecotoxicology, Routes by which pollutants enter ecosystems; Major classes of pollutants (heavy metals, hydrocarbons, microplastics, etc), their sources and ecotoxicological effects. Effects of toxic substances and biomonitoring Acute and chronic toxicity, dose response, bioaccumulation, biomagnification, bioavailability, biodegradation; Toxicokinetics: Absorption, Distribution, Metabolism, Biotransformation and Elimination of Toxicants, Physiological and biochemical effects of toxic substances: Genotoxic, neurotoxic compounds, endocrine disruptors; Effects at the molecular level, cellular level, organism level (physiological, reproduction, behaviour) **Module 2** Ecotoxicity tests (lab-based and field tests) in air, water and soil, Use of model organisms for ecotoxicology: fish, helminthes, molluscs, mice, Environmental Risk Assessment	**15 hours** **15 hours**

	Environmental bioindicators of ecotoxicity with faunistic studies Microbial Ecotoxicology: Interaction between microorganisms and pollutants; Role of microorganisms in detoxification and degradation of environmental pollutants Metagenomic techniques to study microbial diversity in polluted environment Biotechnology for mitigating environmental toxicity: Ameliorating nutrient toxicity (Nitrates and Phosphates), Handling sludge toxicity, Microbial and Phytoremediation (wetlands), Treatment of domestic wastewater using wetlands – a case study	
Pedagogy:	In class /Online lectures, Assignments, Group activities, Presentations	
Learning Outcome:	On successful completion, students will be able to 1. Understand the toxic effects of pollutants in ecosystems 2. Apply concepts of ecotoxicology using model organisms and for assessing environmental risk 3. Understand mitigation strategies using micro-organisms	
References / Reading:	1. Walker CH, Sibly RM, Hopkin SP, Peakall DB. (2012) Principles of Ecotoxicology. 4th Edition. CRC Press, Taylor and Francis. 2. Jorgensen SE. (2010) Ecotoxicology: A derivative of encyclopedia of ecology. Academic Press. 3. Moriarty F. (1999) Ecotoxicology: The study of pollutants in ecosystems. 3rd Edition. Academic Press. 4. Peakall D. (1992) Animal Biomarkers as Pollution Indicators. Chapman and Hall. 5. Hayes WA. (2014) Principles and Methods of Toxicology. CRC Press, Taylor and Francis. 6. Naik MM, Dubey SK. (2017) Marine pollution and Microbial remediation. Springer. 7. Cravo-Laureau C, Cagnon C, Duran R, Lauga B. (2017) Microbial Ecotoxicology. Springer 8. Scragg A. (1999) Environmental Biotechnology. Oxford University press	

Course Code: ZOTG-504 **Course Title: Butterfly Gardening**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge on Lepidoptera identification	
Objectives:	1. Students will be introduced to the diversity and biology of Lepidopterans 2. The lecture component will have an importance of conserving species of butterflies and moths. Identifying host and nectar plant and to provide skill to develop butterfly gardens for conserving rear/endemic species.	
Content:	**Module 1** Introduction: Unde rstanding a butterfly (life cycle, the body, Butterfly behaviours, courtship, temperature control, roosting, mud puddling, migration, overwintering, long distance flights, dangers to caterpillars and chrysalides, dangers to adults, methods of protection) Importance of butterfly gardening, conservation perspective of butterfly gardening, procedure for rearing caterpillars. Demonstration and identification of available species in a particular niche. **Module 2** Creating a butterfly garden, site selection (Understanding plant terminology, larval food plants, nectar plants (native, non-native, cultivated), preparing mud puddling, flower visitation, nectar, fragrance, flower shape, other attractants, basking, hibernation), butterfly rearing chamber. Feeding caterpillars. Planting plan (Know your area, decision time, choosing plants, preparing beds, soil, water, mulch, using native plants, planting native seeds, native grass lawn, adopt a weed, seed and plant sources, landscape plans)	**15 hours** **15 hours**
Pedagogy:	Lectures/ tutorials/assignments/self-study	
Learning Outcome:	1. Students will learn about the Diversity, Habitat-Ecology, Behavior, Adaptation of butterfly. 2. Identification of the local species of butterfly through direct field experience. 3. The course will enhance the skill of students to develop butterfly gardens.	
References/ Reading	1. Butterfly Gardening, Jane Hurwitz, 2018 2. Butterfly Gardening for Texas, Geyata Ajilvsgi, 2013 3. Butterflies of Western Ghats (India) by Hemant Ogle, 2018 4. Butterflies of Goa, by Parag Rangnekar 5. Butterflies of India, by Isaac Kehimkar, 2016 (Second addition) 6. The boom of Indian Butterflies, by Isaac Kehimkar, 2008 (First addition)	

Course Code: ZOTG-505 **Course Title: Ecotourism (Theory)**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Graduation in any discipline from a recognized University	
Objectives:	To understand ecotourism potential, resources and management issues	
Content:	**Module 1: Introduction of Ecotourism and Resources in India (Goa in particular)-** Definition, history, scope, characteristics and principles of ecotourism. Tourist motivation, tourist interaction and intensity of interaction with nature. Ecotourist, eco-sensitivity, ecocentrism, ethics of ecotourism, local participation benefits and conservation. Flora and fauna of Wildlife Sanctuaries, Bird Sanctuaries, National Park, sacred grooves, mangroves, backwater, waterfalls, springs, beaches, hill stations, deserts, butterfly parks, spice plantations. Identification and ecology of aquatic faunal resources (Dolphin, crocodile, corals, mollusc) and terrestrial faunal resources (birds, butterflies, other insects) **Module 2: Ecotourism Management** Marketing of ecotourism, Economic impact, development, governance and policy, programme planning, codes of practice, carrying capacity, resource management, Ecotourism impact assessment and management analysis. Visitor activity and impact management, role of interpretation centre. Safety measures on field and first aid.	**15 hours** **15 hours**
Pedagogy:	Use of conventional, online and ICT Methods. Field visit Case study/ ecotourism project proposal/project/self-study Lecture/Tutorials/Assignments	
Learning Outcome:	1. To identify ecotourism potential sites, assess ecoresources. 2. Design and execute visitor management plan and promotional material for ecotourism.	
References/ Reading	1. Bhatia, A.K. (2014) Tourism development: principles and practices, New Delhi: Sterling Publishers Pvt. Ltd. 2. Cooper,Chris (1994) Tourism Principles and practice. Great Britain Pitman	

	publishing . 3. Fennell David S. (2004) Ecotourism 4th edition Routledge Taylor & Francis group 4. Fennell, David A. (2007) Ecotourism policy and planning. CABI Publishing, Wallingford, Oxon, UK 5. Hill Jennifer, Gale Tim (2009) Ecotourism and Environmental sustainability Principles and practice, Aghgate ebook. 6. Raju, Aluri Jacob Solomon (2007) A Textbook of Ecotourism Ecorestoration and Sustainable Development by New Central Book Agency (P) Ltd, Kolkata. 7. Singh, Ratandeep (2003) Indian Ecotourism: Environmental Rules and Regulations Kaniskha Publishers, New Delhi. 8. Singh Jagbir (2020) Ecotourism. Wiley 9. Trivedi, Priya Ranjan (2006) Encyclopaedia of the Ecotourism (Vol. 5): Future of Ecotourism, Jnanada Prakashan, New Delhi. 10. Wearing Stephen, Neil John (2009) Ecotourism, impacts, potentials and possibilities 2nd edition Elsevier.

Course Code: ZOPG-505 **Course Title: Ecotourism (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Graduation in any discipline from a recognized University	
Objectives:	To understand ecotourism potential, resources and management issues	
Content:	1. How to design: interpretation centre, ecotourism websites, portals and documentaries. 2. Visit to the ecotourism sites. 3. Identification of the flora and fauna (plants, butterflies, birds, malacofauna, etc). 4. Demonstration of preventive and safety measures on the field. 5. Handling of tools and instruments in the field (camera, binocular, spot-scope, GPS, etc)	**15 x 2 hours**
Pedagogy:	Use of conventional, online and ICT Methods. Field visit Case study/ ecotourism project proposal/project/self-study Lecture/Tutorials/Assignments	

Learning Outcome:	1. To identify ecotourism potential sites, assess ecoresources. 2. Design and execute visitor management plan and promotional material for ecotourism.
References/ Reading	1. Bhatia, A.K. (2014) Tourism development: principles and practices, New Delhi: Sterling Publishers Pvt. Ltd. 2. Cooper,Chris (1994) Tourism Principles and practice. Great Britain Pitman publishing. 3. Fennell David S. (2004) Ecotourism 4th edition Routledge Taylor & Francis group 4. Fennell, David A. (2007) Ecotourism policy and planning. CABI Publishing, Wallingford, Oxon, UK 5. Hill Jennifer, Gale Tim (2009) Ecotourism and Environmental sustainability Principles and practice, Aghgate ebook. 6. Raju, Aluri Jacob Solomon (2007) A Textbook of Ecotourism Ecorestoration and Sustainable Development by New Central Book Agency (P) Ltd, Kolkata. 7. Singh, Ratandeep (2003) Indian Ecotourism: Environmental Rules and Regulations Kaniskha Publishers, New Delhi. 8. Singh Jagbir (2020) Ecotourism. Wiley 9. Trivedi, Priya Ranjan (2006) Encyclopaedia of the Ecotourism (Vol. 5): Future of Ecotourism, Jnanada Prakashan, New Delhi. 10. Wearing Stephen, Neil John (2009) Ecotourism, impacts, potentials and possibilities 2nd edition Elsevier.

Course Code: ZOTG-506 **Course Title: Introduction to Animal Biomimetics**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Graduation in any discipline from a recognized University	
Objectives:	To introduce students to Biomimetics To develop a keen interest in observing mechanisms in the nature To evoke their imagination to develop tools through biomimicking	
Content:	**Module 1** Introduction to biomimetics, Mimicking and Inspiration of Nature, Synthetic Life, Artificial Life, Artificial Intelligence. Nature as a Model for Structures and Tools: Constructing Structures from Cells. Biologically Inspired Mechanisms: Digging as the Gopher and the Crab, Inchworm Motors, Pumping Mechanisms, Controlled	**15 hours**

	Adhesion, Biological Clock. Biologically Inspired Structures and Parts: Honeycomb as a Strong, Lightweight Structure, Hand Fan, Fishing Nets and Fins Defense and Attack Mechanisms in Biology: camouflage, body armor, Hooks, Pins, Sting, Syringe, Barb, and the Spear, Decoy Artificial organs Materials and Processes in Biology: Spider Web — Strong Fibers, Honeybee as a Multiple Materials Producer; Swallow as a Clay and Composite Materials Producer, Fluorescence Materials in Fireflies and Road Signs, Impact Sensitive Paint Mimicking Bruised Skin, Mimicking Sea Creatures with Controlled Stiffness Capability, Biology as a Source for Unique Properties and Intelligent Characteristics, Multifunctional Materials, Biomimetic Processes **Module 2:** Bio-Sensors: Miniature Sensors in Biomimetic Robots, MEMS-Based Flow Detector Mimicking Hair Cells with Cilium, Collision Avoidance Using whiskers, Emulating Bats' Acoustic Sensor, Acoustic and Elastic Wave sensors, Fire Monitoring, Sense of Smell and Artificial Nose, Sense of Taste and Artificial Tongue. Robotics Emulating Biology: Artificial Muscles, Aerodynamic and Hydrodynamic Mobility, Social and Other Biological Behaviors. Interfacing Biology and Machines: Telepresence and Teleoperation Biomimetics of Muscle Design Mechanized Cognition: Language, sound, visual. Machine bodies and brains	**15 hours**
Pedagogy:	Use of conventional, online and ICT Methods. Animal behavior observations in the field. Lectures/Tutorials/Assignments / projects/self-study	
Learning Outcome:	Inspired to observe nature with keen interest and think of creating biomimicking tools, beneficial to humans.	
References/ Reading	1. Alexander, R.McN. (2003) Principles of Animal Locomotion, Princeton University Press, Princeton and Oxford, Ch. 2. 2. Breazeal C.L., (2004) Designing Sociable Robots, ISBN 0262524317, MIT Press, Cambridge, Massachusetts, pp. 1–281. 3. Primrose Sandy B. (2020) Biomimetics: Nature-Inspired Design and Innovation. Wiley-Blackwell 4. Vincent J.F.V., (2001) ''Stealing ideas from nature,'' Pellegrino S. (Ed.), Chapter 3 in Deployable Structures, Springer-Verlag, Vienna, pp. 51–58.	

	5. Yoseph Bar-Cohen (2005) BIOMIMETICS: Biologically Inspired Technologies, Edited by, Taylor & Francis Group, New York.

Course Code: ZOTG-5O7 **Course Title: Evolutionary Biology**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic working knowledge of diversity, cell biology, genetics and classical evolutionary biology.	
Objectives:	This course develops major concepts in evolutionary biology, including theories, unicellular/multicellular evolution, evolutionary history and evolutionary time scale. This course also provides a better understanding of population genetics, evolutionary forces and speciation. Additionally, this course throws light on aspects of molecular evolution along with evolutionary models.	
Content:	**Module 1** Emergence of evolutionary thoughts, Creation and evolution, Evolutionary theories and evidences: Contributions of Lamarck, Darwin, Darwin-Wallace postulates, concepts of variation, adaptation, struggle, fitness and natural selection; Spontaneity of mutations; The evolutionary synthesis, limitations of Darwinism, Neo Darwinism. Origin of cells and unicellular evolution: Origin of basic biological molecules, Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane, Experiment of Miller (1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes. Paleontology and Evolutionary History: Overview of evidences - Paleontological, Embryological,Comparative morphological, Anatomical, Genetics and Cytological, Molecular Biological evidences. The Evolutionary time scale: Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo, Human evolution. **Module 2** Population genetics: Populations, Gene pool, Gene frequency; Hardy- Weinberg Law; Evolutionary forces that affect the allelic frequencies: Mutation, Migration, Selection - Stabilizing selection, Directional selection, disruptive selection, Balancing	**15 hours** **15 hours**

	selection, Frequency dependent selection, Density dependent selection, Group and kin selection, Selection coefficient, Selective value, Selection in natural Populations, Genetic drift, Nonrandom mating. Hybridization and speciation: Concept of species and models of speciation based on distribution sympatric, allopatric, stasipatric, genetic drift, genetic revolution, genetic transilience, Founder-flush theory, phylogenetic gradualism, punctuated equilibrium, hybridization, adaptive radiation, isolating mechanisms. Molecular Evolution: Molecular phylogeny, neutral theory, molecular clock.	
Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	1. Understand in detail the various concepts of evolutionary biology such as theories, history and evidences. 2. Study the time scale and understand stages of life formation and evolution. 3. Learn about the intricacies of population genetics in evolution. 4. Understand the various processes related to evolution. 5. Knowledge about molecular evolution, the field that links various aspects in zoology.	
References/ Reading	1. Futuyma DJ. (1998)Evolutionary Biology, 3rd Edition, Sinauer Associates, New York. 2. Ridley M. (2003) Evolution, 3rd edition, Blackwell Publishers, New York. 3. Rose MR and Mueller LD. Evolution and Ecology of the Organism, Prentice Hall, New York. 4. Barton NH, Briggs DEG, Eisen JA, Goldstein AE, Patel NH. (2007) Evolution, Cold Spring Harbor Laboratory Press, New York, USA. 5. Strickberger MW. Evolution (2013) Jones and Bartlett Publisher, Sudbury, USA .	

Course Code: ZOTG-508 **Course Title: Vector Biology**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic working knowledge of taxonomy, biodiversity, and arthropodology.
Objectives:	This course will help the learner to understand the whole concept and components of arthropods, in-depth, involved in causing Vector-borne diseases. Additionally, this course also covers the field of modern vector biology, giving

	exposure to subjects like Proteomics. Moreover, the course also deals with vector control and focus on common mosquito-linked diseases.	
Content:	**Module 1** Introduction to vector biology and its importance in public health management. Arthropods as disease vectors, taxonomy, classification, biology, ecology. Arthropod transmitting bacteria and viruses of medical importance; Major vector-borne diseases; Vector-parasite interaction; Host-pathogen interaction; Factor in disease transmission. Special reference to mosquitoes as vectors, Biology, Bio-ecology, Life history of Anopheles, Culex, and Aedes mosquitoes, Mosquito-borne diseases like malaria, filariasis, dengue, Chikungunya, and Japanese encephalitis (Symptoms, prophylaxis, and treatment) **Module 2** General Characters, classification, history, distribution, morphology, biology, life cycle, mode of infection, signs, and symptoms, diagnosis, molecular biology, drug resistance, treatment, preventive measures, and control of - Flies, Bugs, Fleas, Ticks, And Lice. Modern vector biology; Genomics and Proteogenomic of vectors. Chemical and biological and environmental control of vectors; Integrated vector management, vector resistance mechanism.	**2 hours** **4 hours** **4 hours** **5 hours** **8 hours** **7 hours**
Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	The learner will understand the concept and components of vectors, their behavior, taxonomy, morphology, life cycle, and entire biology. Understand insects as parasites and the various linked diseases. Sufficient knowledge of modern vector biology and proteogenomic. Know about vector control and integrated vector management. Create and communicate knowledge on the causes and prevention of vector-borne disease in the population, to promote health and health services. Learn about mosquito-linked diseases.	

References/ Reading	1. Mani MS (1982), General Entomology, Oxford and IBH Publishing Co., New Delhi. 2. Rathnaswamy GK (1986), A Handbook of Medical Entomology and Elementary Parasitology, S. Vishwanath Pvt.Ltd., India. 3. Bruce ED, Eldridge F and Edman JD (2000), Medical Entomology, Kluwer Academic Publishers, UK. 4. Kahn HA (1983), Introduction of Epidemiology Methods, Oxford University Press, New York. 5. Snodgrass RE (1935), Principles of Insect Morphology, Tata McGraw Hill publishing co. India. 6. Mullen G and Durden L (2002), Medical and Veterinary Entomology, Academic Press, USA. 7. Kettle DS (1984), Medical and Veterinary Entomology, Cabi Press, USA. 8. Service MW (2012), Medical Entomology for students, Cambridge University Press, UK. 9. Service MW (1993), Mosquito Ecology, Field sampling methods, Applied Science Publishing Ltd., London. 10. Marquardt WC (1996), Biology of disease vectors (2nd Edition), Doody Enterprises, Inc. USA.

Course Code: ZOTG-509 **Course Title: Ornamental Fish Management (Theory)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of fish biology and diversity.	
Objectives:	1. To understand the potentiality of ornamental fisheries in India. 2. To introduce the nature and scope of aquarium management and ornamental fish culture 3. To impart knowledge on self-employment opportunities in ornamental fish culture and aquarium management. 4. To impart practical skills to students on aquarium management and ornamental fish culture.	
Content:	**Module 1** Diversity of ornamental fish. Major hotspots of ornamental fish- global and Indian perspective. Ornamental fish trade- global and Indian perspective. Preferred species in trade. Major ornamental fish species of India. Ornamental plants.	**15 hours**

	Different varieties of exotic and indigenous ornamental fishes. Reproductive biology. Sexual dimorphism, mode of reproduction in ornamental fish. Commercial farming technologies Principles of a balanced aquarium. Indigenous ornamental fishes and their culture, propagation, and trade. Coloration and Pigmentation: category; types; formation; dietary, neuronal, hormonal control. Physiology of color changes and its significance. Common aquarium diseases and their control. Feeding and nutrition of ornamental fishes. Nutritional requirements of aquarium fish. Live feed culture. Types of aquarium fish feed. Preparation of aquarium fish food. Packaging, transportation, and marketing of aquarium fishes. Anesthetics used in the trade. Problems in ornamental fish export. Applications of genetics and biotechnology for producing quality strains; Management practices of ornamental fish farms.	
Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	• fabricate an aquarium at home or outdoors. • handle aquarium fishes and different aquarium tools and accessories • Identify various aquarium fishes and know about their breeding biology. • common health problems with fish, in an aquarium. • Understand the scope of the subject concerning entrepreneurship. • Gain knowledge about techniques of ornamental fish breeding, rearing, and its marketing to make them self-sustainable.	
References/ Reading	1. Saha S. (2022): Concept of Aquarium Fish Keeping(2nd Edition). Techno world Publisher. 2. David Alderton (2005), Encyclopedia of Aquarium and Pond Fish , DK Publishing, Inc. 3. Datta, Subhendu. (2014). Aquarium Water Quality Management. 10.13140/2.1.2747.6164 4. Dick Mills, Derek Lambert (2004): Aquarium Fish Handbook, Quatro In 5. Glen S. Axelrod, Brian M. Scott, Neal Pronek (2005): Encyclopedia of Exotic	

	Tropical Fishes For Freshwater Aquariums, TFH Publications. 6. Harro Hieronimus (2009): Guppies, Mollies, Platies, A Complete Pet Owner's Manual, Barron's Educational Series, Inc. 7. Stephen Spottee. (1993.) Marine aquarium keeping. John Wileyy and sons, U.S.A.

Course Code: ZOPG-509 **Course Title: Ornamental Fish Management (Practicals)**
Number of Credits: 1
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of fish biology and diversity.	
Objectives:	To understand the potentiality of ornamental fisheries in India. To introduce the nature and scope of aquarium management and ornamental fish culture To impart knowledge on self-employment opportunities in ornamental fish culture and aquarium management. To impart practical skills to students on aquarium management and ornamental fish culture.	
Content:	1. Sexual dimorphism in ornamental fishes. 2. Propagation methods of ornamental aquarium plants. 3. Identification of formulated fish feeds, preparation and practicing feeding schedules. 4. Maintenance of Freshwater and Marine aquariums. (accessories, water quality, Lighting and aeration; décor etc) 5. Study of Water filtration systems: biological, mechanical, and chemical. 6. Culture of live feed organisms. 7. Identification of common diseases. 8. Demonstration of fish handling and packaging method. 9. Demonstration of ornamental fish breeding.	**15 x 2 hours**
Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	Students will be able to • fabricate an aquarium at home or outdoors. • handle aquarium fishes and different aquarium tools and accessories • Identify various aquarium fishes and know about their breeding biology. • common health problems with fish, in an aquarium.	

	• Understand the scope of the subject concerning entrepreneurship. • Gain knowledge about techniques of ornamental fish breeding, rearing, and its marketing to make them self-sustainable.
References/ Reading	8. Saha S. (2022): Concept of Aquarium Fish Keeping(2nd Edition). Techno world Publisher. 9. David Alderton (2005), Encyclopedia of Aquarium and Pond Fish , DK Publishing, Inc. 10. Datta, Subhendu. (2014). Aquarium Water Quality Management. 10.13140/2.1.2747.6164 11. Dick Mills, Derek Lambert (2004): Aquarium Fish Handbook, Quatro In 12. Glen S. Axelrod, Brian M. Scott, Neal Pronek (2005): Encyclopedia of Exotic Tropical Fishes For Freshwater Aquariums, TFH Publications. 13. Harro Hieronimus (2009): Guppies, Mollies, Platies, A Complete Pet Owner's Manual, Barron's Educational Series, Inc. 14. Stephen Spottee. (1993.) Marine aquarium keeping. John Wileyy and sons, U.S.A.

Course Code: ZOTG-510 **Course Title: Biology of Animal Reproduction**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Elementary knowledge of animal anatomy and physiology.	
Objectives:	To provide fundamental knowledge of animal reproduction at an anatomical, physiological, and endocrinological level to deal with the management of reproduction and fertility in animals and humans.	
Content:	**Module 1** Anatomy, Development, and Hormones: Introduction to reproduction. Male Reproductive System: Biology of spermatozoa. Seminiferous epithelial cycle, Spermatogenesis, sperm activation, Hormonal control of spermatogenesis, hormonal regulation of accessory male reproductive organs. Biochemistry of semen, semen analysis, and its utility in medico-legal cases Female Reproductive System: Reproductive cycles in mammals and their regulations; Oogenesis and ovarian cycle. Hormonal	**8 hours** **7 hours**

	regulation, sequence, and types of implantation. Menstruation, puberty, reproductive aging, and menopause. **Module 2** Endocrine control of pregnancy, Parturition, and Lactation. Contraception: Types and various methods (Hormonal, barrier, spermicides, IUDs, Periodic abstinence, etc.). Advantages and disadvantages. Male and Female sexual response. Surgical sterilization. Reproductive health concern: Infertility (factors responsible). Assisted Reproductive Techniques (ART). Reproductive Tract Disorders: - Symptoms and treatment – Onco-fertility (Endometriosis, Testicular Cancer, Ovarian Cancer, Ovarian cysts). Myths and facts on reproduction.	**8 hours** **7 hours**
Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	● Explanation of how to apply reproductive information to strategies for the management of reproduction and fertility in animals. ● Critically evaluation of the advantages/disadvantages of current and developing reproductive technologies	
References/ Reading	1. Knobil E and Neil JD, Physiology of Reproduction (Vol. I and II),.2015. Raven Press Ltd., New York. Mandal A, A Handbook of Neuroendocrinology, Emkay Publication, New Delhi 2. Schatten H. 2016. Human Reproduction: Updates and New Horizons. Wiley Online Library. 3. Avise, J. C. 2008. Clonality: The Genetics, Ecology, and Evolution of Sexual Abstinence in Vertebrate Animals. New York, NY: Oxford University Press.CrossRef 4. Nelson RJ, An Introduction to Behavioral Endocrinology, Sinaeur Associates, Inc., USA. 5. Pablo De, Scanes CG, and Weintraub BD, Handbook of Endocrine Research Techniques, Academic Press Inc., USA. 6. Saidpur SK, Reproductive Cycles of Indian Vertebrates, Allied Publishers Ltd. New Delhi. 7. Schatten H and Constantinescu GM, Comparative Reproductive Biology, Willey Blackwell Publications, UK.	

Course Code: ZOTG-511 **Course Title: Fish Processing**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of Fish biology, Fishery sciences.	
Objectives:	1. To develop knowledge about post-harvest management of fishes. 2. To understand the various aspects of fish preservation and processing	
Content:	**Module 1** Module 1: Post-Harvest Technology: Principles and importance of fish preservation. Fish spoilage-post mortem changes and rigor mortis, post rigor spoilage. Methods of fish preservation-Icing, Freezing, Cold storage, Drying, Salting, Smoking, Canning, and Fish Pickling. Fish products and Byproduct: Fish Oil, Fish liver oil, Fish meal, Fish manure, Fish flour, fish glue and isinglass, chitin, pearl essence fish silage Perishability of seafood – Microbial spoilage of fish and shellfish. Spoilage microflora. Fish products (frozen food items) Intrinsic and extrinsic factors affecting spoilage. Microflora is associated with body parts. Foodborne pathogens. Sources of contamination. Seafood biotoxins **Module 2** Quality Assurance of Fishery Products: Quality control: basic concepts, quality, and quality control. Sanitation procedures in seafood processing plants. Waste management in fish processing industries. Quality analysis – organoleptic, physical, chemical, microbiological, and instrumental methods. Quality standards in India and major importing countries like the USA, Japan, and the EU. Export of fishery products from India – major countries, important products, export documents, and procedures. Traceability, Quality certifications, Eco-labeling.	**15 hours** **15 hours**

Pedagogy:	Lectures/Tutorials/Videos/Assignments/Group discussion/Self-study.	
Learning Outcome:	1. Understand the basic concepts of fish preservation. 2. Identify the main microbes concerned with fish processing 3. To Understand the importance of quality control in fish farm	
References/ Reading	1. Biswas K.P. (2004). Fish Processing and Preservation. Daya Pub. House. 2. Govindan T.K (1985). Fish Processing Technology. Oxford & IBH Pub. Co. 3. Badapanda K.C (2013). Fish processing and preservation technology. Narendra Publishing House 4. Fernandes R. (2009) Microbiology Handbook: Fish and Seafood. Leatherhead Food Research Association; 2nd New edition. 5. Harry W. Seeley, Paul J. Vandemark, and John J. Lee (1990)- Microbes in Action: A Laboratory Manual of Microbiology 6. Pawar and Diganawala (2010)- General Microbiology – Vol. I and Vol. II. Himalaya Publishing House.	

Course Code: ZOTR-508 **Course Title: Nutritional Biochemistry**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic knowledge of physiology and biochemistry	
Objectives:	1. To make aware the students about the importance of nutrition in maintaining health. 2. To cultivate proper feeding habits. 3. To learn the proper and scientific value of different food items	
Content:	**Module 1** Basic concepts of energy and energy expenditure; Calorific values of food – Basal metabolic rate, energy requirements of man, women, infants and children. Dietary Carbohydrates : Functions, classification, food sources, storage in body, biomedical importance; Dietary Proteins - Functions, classification, food sources, composition, essential & non-essential amino acids, protein deficiency, biomedical importance; Dietary Fats: Function of fats, classification, food sources, composition, saturated and unsaturated fatty acids, biomedical importance. Vitamins: sources and functions, deficiency status.	**15 hours** **15 hours**

	Module 2 Water as nutrient; Electrolyte concentrations of body fluids; Minerals: macro & micronutrients functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium (very brief account); concept of acidosis and alkalosis. Nutritional requirements during pregnancy and lactation; Nutrition during infancy, Nutrition in children, Nutrition during adolescence, Nutrition during adulthood. Nutrigenomics of omega 3 and omega 6 fatty acids, essential amino acids, vitamin A, C, D, E and B complex.	
Pedagogy:	Lectures/ tutorials/self-study/videos	
Learning Outcome:	1. Gaining the knowledge of importance about the nutrition and keeping ourselves in well- being state. 2. Understanding the importance of some nutrients in controlling the expression of genes	
References /Reading:	1. Gopalan.C, BS. Ramasastri & SC Balasubramanian: 1971, Nutritive value of Indian foods. National Institute of Nutrition, Hyderabad. 2. Gopalan.D & K. Vijaya raghavan 1971, Nutrition atlas of India, ICMR, New Delhi. 3. Ghosh.S 1981, The feeding care of infants and young children, UNICEF, New Delhi. 4. Mudambi.SR ,1995. Fudementals of food and nutrition. New age international, New Delhi. 5. Swaminathan.M, 1989. Handbook of food and nutrition. Bappco, Bangalore. 6. Swaminathan.M, 1974 Essentials of food and nutrition. Vol I & II, Ganesh and Co. Madras. 7. Brody T, Nutritional, Biochemistry, Academic Press, New York. 8. Elia M, Ljungqvist O, Stratton R and Lanham SA, Clinical Nutrition, Willey Blackwell Publication, UK. 9. Swaminathan MS, Nutritional Biochemistry, T R Publication, India	

Course Code: ZOTR-509 **Course Title: Stem Cell Biology**
Number of Credits: 2
Effective from AY: 2022 -23

Prerequisite for the Course:	Basic understanding of cytology, histology and cellular types of embryo and adult.
Objectives:	1. To provide broad awareness of current issues and approaches in stem cell biology 2. To get a thorough understanding of stem cell science and the molecular

	nature of pluripotency and differentiation. 3. To appreciate ways in which stem cell science is utilized in therapeutic contexts.	
Content:	**Module 1** Basic Biology of stem cells: Introduction to stem cells and basis of stemness; Embryonic stem cells, embryonal carcinoma cells, adult stem cells, hematopoietic stem cells, mesenchymal stem cells, cancer stem cells, induced pluripotent stem cells. Cellular Mechanisms of Stem Cells: Molecular basis of pluripotency, stem cell niche, mechanisms of stem cell self-renewal. **Module 2** Stem cells isolation and culture: Isolation, characterization and maintenance of embryonic stem cells isolated from: Mouse and Human. Applications of stem cells: Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, eye diseases, stem cells and gene therapy, Ethical and regulatory issues in the use of stem cells.	**8 hours** **7 hours** **7 hours** **8 hours**
Pedagogy:	Lectures/ tutorials/self-study/videos	
Learning Outcome:	1. Understand the isolation process, cultivation and characterization of embryonic stem cells. 1. Understand basic biology/mechanisms of pluripotency, self-renewal of stem cells and stem cell niche in regulating stem cell fate. 2. Gain knowledge of applications of stem cells in diseases, injury and gene therapy. 3. Appreciate the ethical and regulatory issues associated with use of stem cells	
References /Reading:	1. Atala A & Lanza R, (2012). Handbook of Stem Cells, 2nd Edition, Academic Press, 2012. 2. Lanza R, et al, (2013). Essential of Stem Cell Biology, Elsevier Academic Press. 3. Mao JJ, et al, (2007). Translational Approaches in Tissue Engineering & Regenerative Medicine, Artech House. 4. Habib NA, Levièar NY, Gordon M, Jiao L & Fisk N, (2007). Stem Cell Repair and Regeneration, Volume-2, Imperial College Press, 2007	

Course Code: ZOTR-510 **Course Title: Clinical Genetics I (Theory)**

Number of Credits: 3

Effective from AY: 2022 -2023

Prerequisite for the Course:	Basic knowledge of cell biology and genetics.	
Objectives:	● Acquaint students with recent genetic techniques ● Know about the structure and function of genetic material ● Learn about structural and numerical abnormalities their inheritance pattern and pedigree analyses.	
Content:	**Module 1: Introduction to Human Genetics** Growth of human genetics; levels of genetics. Structure and composition of the human chromosome: basic structure of DNA; molecular structure and organization. Classification of Human chromosomes: Paris nomenclature / ISCN; methods of studying chromosomes; identification of individual chromosomes; Flow Karyotyping (Quantification on DNA of individual chromosomes); FACS – Fluorescence-activated cell sorter. **Module 2: Chromosomal Abnormalities** Numerical abnormalities (somies; ploidies; mosaic; chimera; syndromes). Structural: Translocations; Deletions; Duplications; Inversion; isochromosomes; Ring chromosomes; causes for genetic abnormalities- meiotic and mitotic nondisjunction; uniparental disomy; mutations; single gene disorders. **Module 3: Pattern of Inheritance** Autosomal Dominant, Autosomal Recessive, X-linked Dominant, X-linked Recessive, Y-linked, sex limited inheritance, sex influenced inheritance, X inactivation, Multifactorial inheritance, mitochondrial inheritance, imprinting. Pedigree analysis of some genetic disorders: Haemophilia, Color blindness, Duchenne Muscular Dystrophy (DMD), achondroplasia and PKU.	**15hours** **15hours** **15 hours**
Pedagogy:	Lectures/tutorials/assignments/ Presentations/demonstrations.	
Learning Outcome:	By the end of this course, students will be able to 1. Understand the functions of the genetic material. 2. Correlate genetic mutations to diseases in human population. 3. Perform Karyotyping using software.	

	4. Construct and analyse human pedigrees.	
References	1. Jorde L, Carey J and Bamshad M(2016). Medical Genetics. Fifth edition. Elsevier Publication imprint. eBook ISBN: 9780323391979. 2. Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi. 3. Matheiesen A and Roy K(2018). Foundation of Perinatal Genetic counseling. eISBN: 9780190681111 4. Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore 5. De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia. 6. Thompson JS, Thompson MW(1966): Thompson & Thompson Genetics in Medicine,Elsevier Publication, Philadelphia.	

Course Code: ZOPR-510 **Course Title: Clinical Genetics I (Practicals)**

Number of Credits: 2

Effective from AY: 2022 -2023

Prerequisite for the Course:	Basic knowledge of cell biology and genetics.	
Objectives:	● Acquaint students with recent genetic techniques ● Know about the structure and function of genetic material ● Learn about structural and numerical abnormalities their inheritance pattern and pedigree analyses.	
Content:	**Practical Module :** ● Specimen procurement and logging for cytogenetic procedure. ● Culture media preparation ● Identification of Chromosomes. ● Inoculation of Lymphocyte culture/peripheral blood culture. ● Harvesting of Lymphocyte culture to obtain metaphase plates. ● Chromosomal banding technique: GTG Banding. ● Karyotyping of Human chromosomes: ○ use of Cytovision/any other Karyotyping software	**30 x 2 lab hours**

	○ Microphotography ○ Image capturing, image processing, and analysis ● Study of Karyotypes: Normal male and female and various syndromes ● Construction of Pedigree from given data. ● Analysis of pedigree charts to determine the mode of inheritance	
Pedagogy:	Presentations/Practicals/ demonstrations.	
Learning Outcome:	By the end of this course, students will be able to 1. Understand the functions of the genetic material. 2. Correlate genetic mutations to diseases in human population. 3. Perform Karyotyping using software. 4. Construct and analyse human pedigrees.	
References	1. Jorde L, Carey J and Bamshad M(2016). Medical Genetics. Fifth edition. Elsevier Publication imprint. eBook ISBN: 9780323391979. 2. Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi. 3. Matheiesen A and Roy K(2018). Foundation of Perinatal Genetic counseling. eISBN: 9780190681111 4. Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore 5. De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia. 6. Thompson JS, Thompson MW(1966): Thompson & Thompson Genetics in Medicine,Elsevier Publication, Philadelphia. 7. Arumuga N, MeyyanRP (2016): Advances in Genetics Volume 1(Dr. N. Arumugam, R P Meyyan, Saras Publication, Nagercoil, Tamil Nadu. 8. GardnerA and Davies T(2010) Human Genetics 2nd Edition,Viva books publication,Delhi.	

Course Code: ZOTR-511 **Course Title: Clinical Genetics II (Theory)**

Number of Credits: 3

Effective from AY: 2022 -2023

Prerequisite for the Course:	Basic knowledge of Cell biology and genetics	
Objectives:	● To get acquainted with recent procedures used in artificial reproductive techniques and their acceptance in the society. ● Techniques for analysis of samples for success of procedures conducted. ● Knowledge of recent techniques used for better results and treatment. ● To learn about genetic counseling and steps to help guide patient for particular medical treatment available.	
Content:	**Module 1: Molecular genetics, Genetics of Cancer, Dermatoglyphics** Molecular genetic techniques used in genetic diagnosis: Blotting techniques – Southern, Northern and Western, PCR/ RFLP, FISH, DNA sequencing & DNA fingerprinting. Genetics of Cancer: introduction, characteristics of cancer cells, origin of cancer cells, genes associated with cancer, environmental causes of cancer, human genome data tailor diagnosis and treatment. Dermatoglyphics: Introduction, classification, Flexion creases. Dermatoglyphics in clinical disorders, Clinical application & its advantages and limitations. **Module 2: Reproductive technologies, Genetics and Society** Reproductive technologies: infertility and subfertility, assisted reproductive technologies (IUI, surrogate motherhood, IVF, GZIT, ZIFT), preimplantation genetic diagnosis. Genetics and Society : (i) Human genome project : (ii) Forensic science (iii) DNA finger printing application (iv) Gene therapy (v) Eugenics. vi) Stem cell research. **Module 3: Prenatal Diagnosis, Genetic Counselling** Prenatal Diagnosis: Definition: Various procedures - Amniocentesis, Chorionic villus sampling, Ultrasonography and Fetoscopy. Genetic Counselling (Stage1: History and Pedigree Construction, Stage 2: Examination, Stage 3: Diagnosis, Stage 4: Counselling; and Stage 5: Follow up).	**15 hours** **15 hours** **15 hours**
Pedagogy:	Lectures/tutorials/assignments/ Presentations/demonstrations.	
Learning Outcome:	By the end of this course, students will be able to 1. Describe and explain the molecular genetic techniques used in genetic diagnosis and reproductive techniques which can be recommended to overcome infertility.	

	2. Demonstrate the application of dermatoglyphic prints in disease detection. 3. Perform procedures of DNA isolation, Molecular size determination, and disease detection for inborn errors of metabolism. 4. Analyze FISH images and DNA fingerprints.	
References	1. Jorde L, Carey J and Bamshad M(2016). Medical Genetics. Fifth edition. Elsevier Publication imprint. eBook ISBN: 9780323391979. 2. Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi. 3. Matheiesen A and Roy K(2018). Foundation of Perinatal Genetic counseling. eISBN: 978019068111. 4. Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore 5. De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia. 6. Thompson JS, Thompson MW(1966): Thompson & Thompson Genetics in Medicine, Elsevier Publication, Philadelphia. REFERENCE BOOKS FOR PRACTICALS: 1. Arumuga N, MeyyanRP(2016): Advances in Genetics Volume 1(Dr. N. Arumugam, R P Meyyan, Saras Publication, Nagercoil, Tamil Nadu. 2. GardnerA and Davies T(2010) Human Genetics 2nd Edition, Viva books publication, Delhi.	

Course Code: ZOPR-511 **Course Title: Clinical Genetics II (Practical)**

Number of Credits: 2

Effective from AY: 2022 -2023

Prerequisite for the Course:	Basic knowledge of Cell biology and genetics	
Objectives:	● To get acquainted with recent procedures used in artificial reproductive techniques and their acceptance in the society. ● Techniques for analysis of samples for success of procedures conducted. ● Knowledge of recent techniques used for better results and treatment. ● To learn about genetic counseling and steps to help guide patient for particular medical treatment available.	
Content:	**Practical Module:**	

	● Introduction to molecular genetic lab: general rules, handling of chemicals, equipments and biological materials; waste disposal. ● Isolation of DNA from human blood. ● Determination of the molecular size of DNA. ● Analysis of DNA fingerprints and FISH images ● Dermatoglyphics: Recording of print of fingertips and palm. ● Manual DNA sequencing and data analysis. ● Amniotic fluid culture: Flask method and Coverslip method. ● Chorionic villi culture: Short-term culture ● Chromosomal analysis from the product of conception (abortus study) (03 Practicals) ● Disease suspection by spot tests: Fanconi's syndrome, PKU, maple syrup urine disease, Tryptophanuria.	**30 x 2 lab hours**
Pedagogy:	Practicals/ demonstrations.	
Learning Outcome:	By the end of this course, students will be able to 5. Describe and explain the molecular genetic techniques used in genetic diagnosis and reproductive techniques which can be recommended to overcome infertility. 6. Demonstrate the application of dermatoglyphic prints in disease detection. 7. Perform procedures of DNA isolation, Molecular size determination, and disease detection for inborn errors of metabolism. 8. Analyze FISH images and DNA fingerprints.	
References	7. Jorde L, Carey J and Bamshad M(2016). Medical Genetics. Fifth edition. Elsevier Publication imprint. eBook ISBN: 9780323391979. 8. Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi. 9. Matheiesen A and Roy K(2018). Foundation of Perinatal Genetic counseling. eISBN: 978019068111. 10. Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore 11. De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia. 12. Thompson JS, Thompson MW(1966): Thompson & Thompson Genetics in Medicine, Elsevier Publication, Philadelphia.	

	REFERENCE BOOKS FOR PRACTICALS: 3. Arumuga N, MeyyanRP(2016): Advances in Genetics Volume 1(Dr. N. Arumugam, R P Meyyan, Saras Publication, Nagercoil, Tamil Nadu. 4. GardnerA and Davies T(2010) Human Genetics 2nd Edition, Viva books publication, Delhi.	

Course Code: ZOPI-501 **Course Title: Internship**
Number of Credits: 2

Effective from AY: 2022 -23

Prerequisites for the course:	Completion of 40 credits of Sem I and Sem II	
Objective:	To impart skill-based hand-on training and experience.	
Content	Skill-Based hands-on training schedule and techniques adopted by the Institute offering the internships.	**30 x 2 hours**
Pedagogy:	Internship	
References/Readings	As per the instructions of the Institute offering the internships.	
Learning Outcomes	Implementation of the acquired knowledge for entrepreneurship/research opportunities.	

Course Code: ZOPD-501 **Course Title: Dissertation**

Number of Credits: 16

Effective from AY: 2022 -23

Prerequisites for the course:	**As per the ordinance applicable for Dissertation**	
Objective:	**To initialize independent thinking and applications in the research field.**	
Content	**Chosen scientific area.**	
Pedagogy:	**Discussion/ Experimental work/ field study/ /self-study/Presentations**	
References/Readings	1. Scientific Journals 2. Reference Books 3. Any other authentic source	
Learning Outcomes	1. Designing of research work 2. Formulation of research methodology 3. Methods implementation and Gathering of research data and application of statistics. 4. Research result formulation and interpretation.	