ATMANIRBHAR BHARAT
SWAYAMPURNA GOA

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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2024/261 Date: 02.07.2024

Ref: Circular No. GU/Acad –PG/BoS -NEP/2023/102/37 dated 16.06.2023
Circular No. GU/Acad –PG/BoS -NEP/2024/152 dated 27.05.2024
Corrigendum No. GU/Acad –PG/BoS -NEP/2024/252 dated 27.06.2024

CORRIGENDUM

In supersession to the above referred Circulars and Corrigendum, the updated Syllabus of **Bachelor of Science in Zoology** Programme with the following changes is enclosed.

- Course ZOO-111 Understanding Applications of Zoology shall be of 4 credit theory only, the syllabus for the Course is given below in the syllabus content.

As approved by the Standing Committee of the Academic Council in its meeting held on 11th, 15th and 22nd May 2023.

Consequently, the decision taken by the Academic Council of not including practical component in minor course of Semester I & II stands.

The Dean/ Vice-Deans of the School of Biological Sciences and Biotechnology and Principals of the Affiliated Colleges offering the **Bachelor of Science in Zoology** Programme are requested to take note of the above and bring the contents to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.07.02 17:08:51 +05'30'

(Ashwin Lawande)
Deputy Registrar – Academic

To,

The Principals of Affiliated Colleges offering the Bachelor of Science in Zoology Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Biological Sciences and Biotechnology, Goa University.
3. The Vice-Deans, School of Biological Sciences and Biotechnology**,** Goa University.
4. The Chairperson, BOS in Zoology.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Programme Structure for Semester I to VIII for Undergraduate Programme - Zoology									
Semester	**Major – Core**	**Minor**	**MC**	**AEC**	**SEC**	**I**	**VAC**	**Total Credits**	**Exit**
I	**ZOO-100 Amazing World of Animals (4)**	**ZOO-111 Understanding Applications of Zoology (4)**	**ZOO-131 Food, Nutrition and Health (3)** **OR** **ZOO-132 Environmental Health (3)**		**ZOO-141 Skills for Zoologists (3)** **OR** **ZOO-142 Vermi-technology (3)** **OR** **ZOO-143 Aquarium Fish Keeping (3)** **OR** **ZOO-144 Value Added fish products (3)**			**20**	**-**
II			**ZOO-133 Public Health and hygiene (3)** **OR** **ZOO-134 Environmental Ethics (3)**						**ZOO-161 Dairy Technology (4)**

III	**ZOO-200 Biology of Non-chordates (4)** **ZOO-201 Cell Biology and Genetics (4)**	**ZOO-211 Vector Borne Diseases (4)**	**ZOO-231 Standard First Aid (3)**		**ZOO-241 Value Added Fish Products (3)** **OR** **ZOO-242 Wildlife and Ecotourism (3)**				**-**
IV	**ZOO-202 Biology of Chordates (4)** **ZOO-203 Biochemistry (4)** **ZOO-204 Vertebrate Anatomy (4)**	**ZOO-221 Bio instrumentation (4) (VET)**	**-**		**-**				**ZOO-261 Poultry Technology (4)**

	ZOO-205 Basic Entomology (2)								
V	**ZOO-300 Molecular Biology (4)** **ZOO-301 Human Physiology (4)** **ZOO-302 Histology and Endocrinology (4)** **ZOO-303 Bio-entrepreneurship (2)**	**ZOO-321 Biostatistics and Data Analytics (4) (VET)**	**-**		**-**	**Internship (2)**	**-**		**-**
VI	**ZOO-304 Concepts in Genetic Engineering (4)**	**ZOO 322 Environmental Impact Assessment (4) (VET)**	**-**		**-**	**-**	**-**		**-**

	ZOO-305 Evolution (4) **ZOO-306 Biochemistry of Metabolic Processes (4)** **ZOO-307 Minor Project (4)**								
VII	**ZOO-400 Developmental Biology (4)** **ZOO-401 Haematology and Immunology (4)** **ZOO-402 Parasitology (4)**	**ZOO-411 Traditional Ecological Knowledge Systems (4)**	-		-	-	-		-

	ZOO-403 Environmental Biology (4) **ZOO-404 Research Methodology (4) *** **ZOO-405 Practical Entomology (2) **								
VIII	**ZOO-406 Marine Zoology (4)** **ZOO-407 Fish and Fisheries (4)** **ZOO-408 Animal Behaviour (4)**	**ZOO-412 Wetland Ecology (4)**	-		-	-	-		-

	ZOO-409 Toxicology (4)								

The starred papers are shown in this syllabus so as to avoid inconsistencies in paper codes.

* Research Methodology to be offered for single major / double major honors with research

** Practical Entomology to be offered for double major honors

UG Degree (Honors) Programme with Double Major – Zoology (60%)

Semester	Major – Core	Minor	MC	AEC	SEC	I	VAC	Total Credits	Exit
I	ZOO-100 Amazing World of Animals (4)	ZOO-111 Understanding Applications of Zoology (4)	ZOO-131 Food, Nutrition and Health (3) OR ZOO-132 Environmental Health (3)		ZOO-141 Skills for Zoologists (3) OR ZOO-142 Vermi-technology (3) OR ZOO-143 Aquarium Fish Keeping (3) OR ZOO-144 Value Added fish products (3)			20	-
II		ZOO-111 Understanding Applications of Zoology (4)	ZOO-133 Public Health and hygiene (3) OR ZOO-134 Environmental Ethics (3)					20	ZOO-161- Dairy Technology (4)

III	ZOO-200 Biology of Non-chordates (4)	ZOO-211 Vector Borne Diseases (4)	ZOO-231 Standard First Aid (3)		ZOO-241 Value Added Fish Products (3) OR ZOO-242- Wildlife and Ecotourism (3)			20	-
IV	ZOO-202 Biology of Chordates (4) ZOO-203 Biochemistry (4) ZOO-205 Basic Entomology (2)	ZOO-221 Bioinstrumentation (4) (VET)	-		-			20	ZOO-261 Poultry Technology (4)

V	ZOO-300 Molecular Biology (4) ZOO-301 Human Physiology (4) ZOO-303 Bio-entrepreneurship (2)	ZOO-321 Biostatistics and Data Analytics (4) (VET)	-	-	Internship (2)	-	20	-
VI	ZOO-305 Evolution (4)	ZOO 322 Environmental Impact Assessment (4) (VET)	-	-	-	-	20	-

	ZOO-307 Minor Project (4)								
VII	**ZOO-400 Developmental Biology (4)**	**ZOO-411 Traditional Ecological Knowledge Systems (4)**	**-**		**-**	**-**	**-**	**20**	**-**
	ZOO-403 Environmental Biology (4)								
	ZOO-404 Research Methodology (4)*								

	ZOO-405 Practical Entomology (2)								
VIII	**ZOO-408 Animal Behaviour (4)**	**ZOO-412 Wetland Ecology (4)**	**-**		**-**	**-**	**-**	**20**	**-**

UG Degree (Honors) Programme with Double Major – Zoology (40%)

Semester	Major – Core	Minor	MC	AEC	SEC	I	VAC	Total Credits	Exit
I		ZOO-111 Understanding Applications of Zoology (4)	ZOO-131 Food, Nutrition and Health (3) OR ZOO-132 Environmental Health (3)		ZOO-141 Skills for Zoologists (3) OR ZOO-142 Vermi-technology (3) OR ZOO-143 Aquarium Fish Keeping (3) OR ZOO-144 Value Added fish products (3)			20	-
II	ZOO-100 Amazing World of Animals (4)	ZOO-111 Understanding Applications of Zoology (4)	ZOO-133 Public Health and hygiene (3) OR ZOO-134 Environmental Ethics (3)					20	ZOO-161 Dairy Technology (4)
III	ZOO-200 Biology of Non-chordates (4)	ZOO-211 Vector Borne Diseases (4)	ZOO-231 Standard First Aid (3)		ZOO-241 Value Added Fish Products (3)			20	-

					OR **ZOO-242 Wildlife and Ecotourism (3)**				
IV	**ZOO-202 Biology of Chordates (4)**	**ZOO-221 Bioinstrumentation (4) (VET)**	**-**		**-**			**20**	**ZOO-261- Poultry Technology (4)**
V	**ZOO-301 Human Physiology (4)**	**ZOO-321 Biostatistics and Data Analytics (4) (VET)**	**-**		**-**	**Internship (2)**	**-**	**20**	**-**
VI	**ZOO-305 Evolution (4)** **ZOO-306 Biochemistry of Metabolic Processes (4)**	**ZOO 322 Environmental Impact Assessment (4) (VET)**	**-**		**-**	**-**	**-**	**20**	**-**

VII	ZOO-400- Developmental Biology (4) ZOO-403- Environmental Biology (4) ZOO-404 Research Methodology (4) *	ZOO-411 Traditional Ecological Knowledge Systems (4)	-		-	-	-		-
VIII	 ZOO-408 Animal Behaviour (4) 	ZOO-412 Wetland Ecology (4)	-		-	-	-		-

Semester I & II
Name of the Programme : B.Sc. Zoology
Course Code : ZOO-100
Title of the Course : Amazing World of Animals
Number of Credits : 04 (3T + 1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To outline the origin, diversity and distribution of Animals 2. To explain the resilience of animal life	
Content:	**MODULE I: Origin, diversity and distribution of Animals** Evolution of earth; the first living cell; Brief idea of geological time line and evolution of animals; outline classification of animal kingdom; major habitats associated animal diversity (desert, Savanna grassland, forest, cave, oceanic); Paleozoology as a tool to demonstrate evolution.	**15 hours**
	MODULE II: Role and Values of animals in the dynamics of the earth and drivers of species extinction Role of animals in ecosystem (as niche species, pollinators and seed dispersal by insect and birds, bioindicators); in human life; ethnozoology. Values of animals: Ethical, Ecological, Economic, Aesthetic, Scientific and Cultural. Threats to animals: Natural threats such as flood, Volcanic eruption, landslides, forest fires, tsunamis; habitat loss and fragmentation; Urbanization; Man and Wildlife conflict, threats of linear infrastructure, Zooanthroponosis, Global climate change.	**15 hours**
	MODULE III: Wonders of animal world Bioluminescence in animals, Echolocation in Bats and cetaceans, Pearl formation in Mollusca, Regeneration in animals, Mimicry in butterflies, Bird migration and Jatinga bird phenomenon, Breeding and parental care in animals (fishes, amphibia and mammals), Extreme survival adaptations in animals, Regeneration in animals, Animal cognition.	**15 hours**
	MODULE IV: Changing world and threats to animals • Study of Desert, Savanna grassland, Forest, Cave and oceanic animals (02 specimen each). • Mounting of Protozoans from Pond Water sample and identification of any two specimens. • Study of bioluminescent animals (any 2 examples). • Study of pearl formation through examination of Molluscan shellfish like Window pane Oyster/Rock Oyster. • Demonstration of regeneration of fin in fish (suitable specimen may be taken). • Study of 'Batesian and Mullerian' Mimicry in butterflies.	**30 Hours**

	• Camouflage as a protective mechanism in animals with reference to larvae of Common Mormon and Common Baron Butterfly. • Study of parental behaviour in animals (Arthropod (Potter Wasp, Scorpion), Fishes (Sea horse, cat fish), Amphibia (Midwife toad and Ichthyophis), Birds (Baya Weaver Bird, Common Crow). • Study of campus fauna: Butterflies (at least 4), Birds (at least 4), Amphibia (At least 2), Reptiles (At least 2). • Listing of Official State fauna of Goa and assessing their conservation threats. • Visit to a Zoo or an Aquarium to appreciate ex situ conservation approach.	
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. J. Z. Young, The Life of Vertebrates. Oxford University Press, 2004. 2. K. K. Chaki, G. Kundu, and S. Sarkar, Introduction to General Zoology: Volume I, 4th ed. India: New Central Book Agency, 2011. 3. M. P. Arora, Organic Evolution, 2nd ed. India: Himalaya Publishing House, 2000. 4. P. D. Sharma, Ecology and Environment, 13th Ed. Rastogi Publications, 2014. 5. P. R. Yadav, Understanding Zoology. India: Discovery Publishing Pvt. Ltd., 2010.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the origin, diversity and distribution of animals. 2. Summarize the role of animals in the dynamics of earth. 3. Discover the fascinating world of animals. 4. Relate to the factors important for sustenance of animals.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-111
Title of the Course : Understanding Applications of Zoology
Number of Credits : 04
Effective from AY : 2023-24

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To outline the history, scope and applications of Zoology in human health, trade, commerce and industry. 2. To explain the importance of animal conservation.	
Content:	**MODULE I: History, Milestones and Scope of Zoology** Genesis of Zoology as knowledge system, Rise of the Naturalist. Aristotle's Zoology. Major milestones in Zoology from 17th Century to present. Branches of Zoology.	**15 hours**
	MODULE II: Application of Zoology in Public Health Protozoans and Helminthes of public health importance; Protozoan causing intestinal amoebiasis and malaria. Helminths infestations- Tapeworm and Round worm. Mode of transmission, symptoms and prevention of Tuberculosis, Cholera, Tetanus, Rabies. Medical importance and control of disease-causing vectors: *Anopheles sp., Culex sp., Aedes sp.*	**15 hours**
	MODULE III: Application of Zoology in Trade, Commerce and Industry Bionomic Zoology: Apiculture, Lac culture, Sericulture, Mariculture (Mussel culture, Oyster culture). Introduction to Genetically Modified Organisms and Bioprospecting Introduction to Animal inspired designs.	**15 hours**
	MODULE IV: Conservation of Animal wealth Significance of conservation biology and global conservation efforts. *In-situ* and *Ex-situ* conservation strategies, conservation genetics, wildlife forensics (DNA fingerprinting). Centrally Sponsored Schemes for Wildlife Conservation (Project Tiger, Project Elephant, crocodile breeding project, Gir Lion project).	**15 Hours**
Pedagogy:	Lectures and class discussions to introduce basic principles and concepts. Use of ICT tools.	
References/ Readings:	1. K. K. Chaki, G. Kundu, and S. Sarkar, Introduction to General Zoology: Volume I, 4th ed. India: New Central Book Agency, 2011. 2. P. R. Yadav, Understanding Zoology. India: Discovery Publishing Pvt. Ltd., 2010. 3. R. L. Kotpal, Modern Textbook of Zoology: Invertebrates, 12th Ed. Rastogi Publications, 2020.	

	4. R. R. Prabhu Jayasurya, Economic Zoology. India: Saras Publications, 2013. 5. K.D. Chatterjee, Parasitology: Protozoology and Helminthology, 13th ed. India: CBS Publishers & Distributors, 2019. 6. P. Joshi, and P. Joshi, Textbook of Conservation Biology. India: Evincepub Publishing, 2020.
Course Outcomes:	At the end of the course, students will be able to: 1. Recall the history and scope of Zoology. 2. Appraise the role of Zoology in public health. 3. Discuss applications of Zoology in trade, commerce and industry. 4. Describe the importance of conservation of animals.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-131
Title of the Course : Food, Nutrition and Health
Number of Credits : 03
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To examine the impact of nutrition on health. 2. Understand the basic principles of nutrition and its role in human health. 3. To recognize the importance of managing Health and Wellness. 4. Identify the functions and sources of essential nutrients in the human diet.	
Content:	**MODULE I – Food and its constituents** Basic concept of Food, Nutrition and Nutrients. Classification of Nutrients: Macro and Micro nutrients. Dietary sources of Carbohydrates, Proteins, Lipids. Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source **(DEMO 1)** and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions. **(DEMO 2)** Water - Functions, daily requirements, Water balance. **Demo 1 –** Presence of Vitamin C in Packaged Orange Juice and Lime water **Demo 2** - Reading food labels and its importance	**15 hours**
	MODULE II – Human Nutrition Define Nutrition and Malnutrition. Concept of a Balanced Diet, BMR, Nutrient needs and Dietary pattern for various groups (adults, pregnant and nursing mothers, infants, school children, adolescents and elderly). Major nutritional Deficiency diseases Protein Energy Malnutrition (kwashiorkor and Marasmus). Vitamin deficiency disorders, Iron deficiency disorders - their causes, symptoms, treatment, prevention Demo 1 – Preparation of indigenous recipes (Ragi ladoo/ Khichdi/ Tizann (Millet porridge). Demo 2 – Planning and preparation of normal diets Demo 3- Preparation of Diet Plan / Healthy Eating Plate / Healthy Diet Plan	**15 hours**
	MODULE III – Management of Health and Wellness Importance of health and wellness Education. Factors affecting health and wellness. Sedentary lifestyle and its risk of disease. Stress, anxiety, and depression. Factors affecting mental health. Depression and Suicidal tendencies, Substance abuse (Drugs, Cigarette, Alcohol), de-addiction, counselling and rehabilitation. Spirituality and mental health. Role of sleep in maintenance of physical and mental health.	**15 Hours**

	Demo1: Role of Yoga, asanas and meditation in maintaining health and wellness.	
Pedagogy:	Lectures and class discussions to introduce basic principles and concepts. Use of ICT tools. Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. S. R. Mudambi, and M. V. Rajagopal, Fundamentals of Foods, Nutrition and Diet Therapy, 5th ed. New Age International Publishers, 2007. 2. B. Srilakshmi, Nutrition Science. New Age International (P)Ltd., 2002. 3. B. Srilakshmi, Food Science, 4th ed. New Age International (P)Ltd., 2007. 4. C. Bouchard, S. N. Blair, and W. L. Haskell Physical Activity and Health, 2nd ed. Human Kinetics, 2012. 5. S. Rodey, Food Science and Nutrition, 2nd ed. Oxford University Press, 2018.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the constituents of food. 2. List the components of a balanced diet, special nutritional requirements in various age groups and the diet related disorders in humans. 3. Plan a meal with ideal dietary requirements for various stages of life. 4. Demonstrate understanding of health and wellness.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-132
Title of the Course : Environmental Health
Number of Credits : 03
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Define and describe the key components, including genesis and spatial scales of environmental health. 2. Understand the interactions between environmental factors and human health 3. Bring out the link between environment and human health, in the light of contemporary climate change including Indian context. 4. Analyze the sources, pathways, and impacts of environmental contaminants on human health.	
Content:	**MODULE I: Introduction to Environment Health** Concept of ecology and ecological connectedness. Are humans exempted from ecological rules and limitations? A reflection. Earth's Carrying Capacity, ecosystem services, and ecological footprints. Consequences of replacing 'earth capital' with 'manufactured capital'. Scope and definition of Environmental Health. Changing context of Environmental Health concept: Ancient ages, age of industrialization, modern era of science and technology Brief idea of spatial scales of environmental health: Global, regional and local. Concise account of the drivers of environmental health.	**15 Hours**
	MODULE II: Environmental Links of Disease and Infirmity Brief idea of the following: Pollution induced diseases: Minamata disease, Itai Itai disease, Arsenicosis, Asthma, Allergy, Cancer, and disorders caused by Endocrine Disruptors Life style related diseases: Diabetes, Obesity, Hypertension, Stroke, Dietary deficiencies and excesses, depression and suicides Climate Change driven weather extremes and health: Heat strokes, Zoonotic spillover, Post-traumatic stress disorders following natural calamities, Water borne diseases: Hepatitis, Cholera, Poliomyelitis, Gastroenteritis, Vector borne diseases: Malaria, Filariasis, Chikunguniya, Dengue, Leishmaniasis. Parasitic Diseases: Amoebic Dysentery, Pinworm infection, Hookworm Infection.	**15 Hours**

	Impact of war and terrorism on health: Fall out of Nuclear weapons, Chemical agents, Biological agents, Gulf war Syndrome.	
	MODULE III: Practice of Environmental Health Precaution: A New Environmental Health Paradigm: Forecaring principle *(Vorsorgeprinzip*) and 'Polluter Pays' Principle Integrating environmental health concerns in Public Health Model: Case studies of '*Swachh Bharat Abhiyan'* and '**Mission *Indradhanush*'** **Clean Production and circular Economy** Brief idea of Environmental Health Indicators and Health Impact Assessment 'One Health'- Sustainable Development Goal 3.	**15 Hours**
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. E. Hutchinson, Environment, Health and Sustainable Development. Sari Kovats Publisher Open University Press, 2017. 2. F. R. Spellman, and R. M. Bieber, Environmental Health and Science Desk Reference. U.S.: Government Institutes Inc., 2012. 3. H. Frumkin, Environmental Health from global to local. John Wiley & Sons, Inc., 2005. 4. H. Koren, and M. Bisesi, Handbook of Environmental Health and Safety (2 Vols Set): Principles And Practices. Lewis Publishers, 2002. 5. J. Conant, and P. Fadem, A Community Guide to Environmental Health. Hesperian Foundation, 2008. 6. J. Selendy, *Water and Sanitation Related Diseases and the Environment: Challenges, Interventions and Preventive Measures.* Wiley Blackwell, 2011. 7. M. G. Robson, W. A. Toscano, Q. Meng, and D. A. Kaden, Risk Assessment for Environmental Health, 2nd ed. CRC Press, 2023. 8. N. Nandini, Environment & Public Health. Sapna Book House, 2018. 9. R. H. Friis, Essentials Of Environmental Health (Essential Public Health), 3rd ed. Jones and Bartlett Publishers, 2018. 10. S. K. Adhikari, A Textbook of Environmental Health. Samiksha Publication, 2019.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain and appreciate local regional and global Environmental Health issues. 2. Relate the contemporary health issues with extant environmental status. 3. Get an insight into environmental drivers of diseases. 4. Promote and practice environmental health to achieve SDG 3 on One Health.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-133
Title of the Course : Public Health and Hygiene
Number of Credits : 03
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Explain the importance of hygiene in maintaining public health. 2. Contrast between communicable and non-communicable diseases. 3. Analyze the factors influencing population health, including social determinants and environmental factors. 4. Identify the role of public health measures in disease prevention, health promotion, and community well-being.	
Content:	**MODULE I: Introduction to Public health and hygiene** History and Scope of public health system, Definition of health and components of public health, malnutrition and measures of malnutrition, over nutrition, Substance abuse and its control measures, Adulteration of food and its harmful effects, Hygiene-Definition, types (Personal and Social hygiene) and importance.	**15 hours**
	MODULE II: Communicable and Non-communicable diseases Definition; Causes, Symptoms and Control measures of common Food and Water Borne Diseases (Jaundice, Cholera, Traveller's diarrhoea, Typhoid), Sexually transmitted diseases and infections (HIV-AIDS, Genital herpes, Hepatitis-B, Syphilis, Gonorrhoea), Zoonotic and Vector borne diseases (COVID-19, Rabies; Malaria, Dengue), Lifestyle habits and their effects on health.	**15 hours**
	MODULE III: Community Health Prophylaxis through health education, Population control and Family welfare, Contraceptive methods. Consanguineous marriages - implications, mental health and common mental disorders, prevention and possible interventions, stress management, vaccination programs, Health indicators and National Health Care and hygiene Programmes.	**15 hours**
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. G. R. Seage, Essentials of Epidemiology in Public Health. Jones and Barlett publisher, 2018. 2. K. Dass, Public Health and Hygiene. Notion Publishers, 2021. 3. M. J. Schneider, Introduction to Public Health. Jones and Barlett Publisher, 2020. 4. R. L. Goldsteen, K. Goldsteen, and T. Dwelle, Introduction to Public Health: Promises and Practice. Springer Publishing Co inc., 2014.	

	5. W.C. C. Pares, The Science of Hygiene: A Textbook of Laboratory practise for Public Health Students, Forgotten Publisher, 2019.
Course Outcomes:	At the end of the course, students will be able to: 1. Discuss aspects of public health and hygiene. 2. Summarise information about various communicable and non-communicable diseases. 3. Describe personal and community prophylactic measures to combat various diseases. 4. Explain various aspects of community health.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-134
Title of the Course : Environmental Ethics
Number of Credits : 03
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Understand the fundamental principles and theories of environmental ethics. 2. Define ethics and describe its relationship with our environmental perspectives and actions. 3. Compare western and Indian environmental ethics and understand current trends. 4. Identify key ethical issues related to environmental conservation, sustainability, and resource management.	
Content:	**MODULE I** **Introduction to Ethics and ethical Theories** Meaning of Ethics World Views: Earth Wisdom & Planetary Management View Utilitarianism Rights Theory Divine Command Theory Natural Law Virtue Theory Moral Theory	**15 hours**
	MODULE II **Values in Environmental ethics** The Idea of Anthropocentrism Environmental Justice and Sustainability Ethics and Sentient Animals Ethical Biocentrism Holistic Ethics: Eco-centrism Holistic Ethics: Species Wildness Value Value-Pluralist Views Eco-feminism Environmental Pragmatism	**15 hours**
	MODULE III **Current trends, Western and Indian Eco-ethics** Environmental ethics links with other disciplines and technologies Environmental Ethics of restoration and climate change Ethics of Species preservation, assisted migration, and climate change Gaia Theory Deep Ecology	**15 Hours**

	Lynn White's critique of anthropocentric faith, and Theology with Ecological Perspective A reflection on Environmental ethics in Indian culture. Building an 'Earth Community'.	
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. A. S. Miller, Gaia Connections: An Introduction to Ecology, Ecoethics, and Economics, 2nd ed. Rowman & Littlefield Publishers, 2003. 2. Biodiversity Project, Ethics for a Small Planet: A Communications Handbook. Biodiversity Project, 2022. 3. C. Palmer, K. McShane, and R. Sandler, Environmental Ethics. Annual Review of Environment and Resources. 39:419–42, 2014. 4. D, Schmidtz, and D. C. Shahar, Environmental Ethics: What Really Matters, What Really Works, 3rd ed. Oxford University Press. 2018. 5. K. K. Smith, Exploring Environmental Ethics. Springer, 2018. 6. R. Sandler, Environmental Ethics: Theory in Practice. Oxford University Press, 2017.	
Course Outcomes:	At the end of the course, students will be able to: 1. Explain and appreciate philosophies of environmental ethics. 2. Evaluate the nuances of eco-ethical values. 3. Practice ethical obligations towards the planet earth, and promote sustainable lifestyles. 4. Assess the various theories of Ethics.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-141
Title of the Course : Skills for Zoologists
Number of Credits : 03 (1T +2P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Recognize skills of observation and data collection in field. 2. Develop fundamental skills required for zoological research and fieldwork. 3. Understand taxonomic methods for identifying and classifying animal species. 4. Teach protocols of handling hazardous waste, biomedical waste, and biological specimens.	
Content:	**MODULE I: Skills for Field Work and Laboratory** Introduction to the concept of 'field'. Rationale for the need to acquire field skills and Ethics of sustainable field work. Introduction to basic field instruments (Binoculars, Camera, Spotting-Scope, Range Finders, Hygro-thermometer, Lux meter, Anemometer) and Observational skills. Dress-code and conduct in the field. Use of taxonomic keys/ field guides/ maps. Animal handling, Record keeping and maintaining field diary. Principles and practices of Laboratory safety and conduct – Safety signages, hazards and precautions. Concept of Biosafety levels, Use of personal safety gears; animal/ microbial, chemical and hazardous material disposal. Handling and maintaining biological specimens. Laboratory instruments- Handling, care and applications of Microscopy, Colorimetry/ spectrophotometer, pH meter, Centrifuge, Chromatography, Electrophoresis. Systems of Units; CGS, FPS and MKS, Calculations and related conversions of Metric system- length (1 millimetre, 1 centimetre, 1 decimetre, 1 decametre, 1 hectometre, 1 kilometre, 1 inch, 1 foot, 1 angstrom, 1 fermi, 1 light year, 1 mile); Mass (1 milligram, 1 centigram, 0.01 gram, 1 decigram, 1 decagram, 10 gram, 1 hectogram, 1 kilogram, 1 stone, 1 pound, 1 ounce); Volume (1 milliliter, 1 centiliter, 1 deciliter, 1 decaliter, 1 hectoliter, 1 kiloliter, 1 cubic inch, 1 gallon, 1 cubic foot); Temperature(Celsius, Fahrenheit, Kelvin); Energy (1 BTU (British thermal unit), 1 erg, 1 foot-pound, 1 calorie, 1 kilowatt- hour, 1 electron volt, 1 liter atmosphere) Concentrations: (Percent solutions, ppt, ppm, ppb dilutions, Normality, Molarity and Molality).	**15 hours**

	MODULE II: Practicals Field: 1. Handling field instruments (at least four) 2. Use of taxonomic keys and field guides (for any two groups of animals). 3. Field survey methods to be demonstrated in field (Sample Area Count, Line Transects, Quadrate Sampling, Point Count and Random survey). 4. Collection and preservation of specimens/ samples. 5. Data collection methods – cards/ diary, dictaphone, imagery, and maintenance of Field Diary. Laboratory: 1. Safety and conduct in a laboratory (Interpretation of safety symbols) 2. Sterilization and handling of laboratory glassware/ fluids/ reagents/ media (dry heat, wet heat, filtration, radiation (UV)) 3. Preparation of solutions. 4. Handling laboratory instruments (at least four) 5. Study of parts of microscope and their functions; types, handling,and use. 6. Types of staining techniques (Simple, Differential, Vital and Negative) 7. Demonstration of microtomy (Tissue fixing, Block making, Ribbon cutting). 8. Chromatography (Paper and TLC) and Gel Electrophoresis (demonstration).	**60 hours**
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Practicals to enhance the theoretical knowledge.	
References/ Readings:	• A. Upadhyay, K. Upadhyay, and N. Nath, Biophysical Chemistry Principles & Techniques Handbook. Himalaya Publishing House, 2003. • D. M. Harmening, Laboratory Management, Principles and Processes, 3rd ed. D.H. Publishing & Consulting Inc., 2012. • I. H. Segel, Biochemical Calculations, 2nd ed. New York: John Wiley and Sons, 1997. • R. H. Linville, and H. A. Kelly, A Guide for Laboratory and Field Work in Zoology, Boston: Ginn & Co., 2019. • S. S. Lal, Practical Zoology: Vertebrate. Rastogi Publication, 2019.	
Course Outcomes:	At the end of the course, students will be able to: 1. Demonstrate skills for observations of specimen in the field. 2. Use the common/ basic field and laboratory equipment. 3. Develop strategies to work effectively in 'field' and biological laboratory. 4. Plan safety protocols for 'field' and laboratory work.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-142
Title of the Course : Vermitechnology
Number of Credits : 03 (1T + 2P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Explain Vermitechnology as a sustainable bio-enterprise. 2. Understand the principles and applications of vermitechnology in waste management and soil health. 3. Analyze the biology and ecology of earthworms and their role in decomposition and nutrient cycling. 4. Create skills to compost organic waste into organic manure.	
Content:	**MODULE I: Vermitechnology** Definition, History, Growth and development of Vermitechnology in India. Significance of Vermitechnology as against chemical fertilizers. Vermicast to Vermicompost. Vermiculture: definition, scope and importance. Techniques of Vermicomposting: indoor, pit and commercial. Vermiwash: preparation and application Vermimeal and its nutritive value. Future perspective of Vermitechnology. Crop nutritive value of Vermicompost. Biology of Earthworms: Morphology and anatomy, reproductive system and life cycle. Earthworm candidates for Vermicomposting. Habitat ecology- epegeic, endogeic and anecic species. Role of earthworms in soil aeration, water retention and decomposing.	**15 hours**
	MODULE II: Practicals 1. Study of common earthworm species used in 2. Vermitechnology(specimens and digitalsources). 3. Visit to vermicomposting farm. 4. Study of life stages and development of *Eisenia fetida* (Digital). 5. Preparing for vermicomposting setup (material gathering). 6. Study of Vermicompost equipments and bed preparations. 7. Hands on training of Vermicomposting. 8. Segregation of Vermicompost and earthworms. 9. Air drying, sieving, packaging and storage of vermicompost. 10. Preparation of Vermiwash 11. Field application of compost and Vermisaline and study its effect on plant growth. 12. Estimation of phosphate content from Vermicompost. 13. Estimation of moisture content from Vermicompost. 14. Setting up of a mini Vermicomposting unit. 15. Study of earthworm diseases and enemies.	**60 Hours**

Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.
References/ Readings:	1. E. L. Jordan, and P. S. Verma, Invertebrate Zoology. Chand and Company, 2009. 2. H. Panda, The Complete Technology Book on Vermiculture and Vermicompost (Earthworm) with manufacturing Process, machinery equipment details & plant Layout. Asia Pacific Business Press Inc, 2022. 3. K. Singh, G. Nath, R. C. Shukla, and D. K. Bhartia, A Textbook of Vermicompost: Vermiwash and Biopesticides. Astral International, 2014. 4. R. K. Bhatnakar, and R. K. Palta, Earthworm: Vermiculture and Vermicomposting. Kalyani publishers, 2007. 5. S. A. Ismail, The Earthworm Book. India Press, 2005.
Course Outcomes:	At the end of the course, students will be able to: 1. Explain the biology of earthworms. 2. Identify earthworms used in Vermicomposting. 3. Build a Vermicompost unit. 4. Formulate various Vermiproducts.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-143
Title of the Course : Aquarium Fish Keeping
Number of Credits : 03 (1T + 2P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Understand the basic principles of aquarium fish keeping, including water quality, filtration, and habitat requirements. 2. Outline the techniques of rearing /maintaining fishes in an aquarium. 3. Identify the requirements for an Aquarium fabrication. 4. Examine strategies for disease prevention, quarantine procedures, and treatment options for sick fish.	
Content:	**MODULE I: Introduction and Biology of Aquarium Fishes and Plants** Introduction: Definition of an Ornamental fish, aquarium, Aquariculture and Aquarists. Benefits of Aquarium Fish Keeping,(1L). Types of Aquarium fishes (Exotic, Endemic and indigenous species; Fresh water& Marine water aquarium fishes; Surface feeders, Column feeders, Bottomfeeders; Carnivores, Omnivores, Herbivores with two examples of each type(2L). Importance of Aquarium Plants (1L). Types of Aquaria (1L). Factors need to consider when selecting Aquarium Fish: Water and Water parameters required; Size of the fish and thefish tank; compatibility(water conditions, behavioural patterns, food requirements and feeding habits; Health of the fish, Aquarium equipment) (1L). Ornamental fish transportation(1L). Types of fish feed (Artificial and Live) (2L) Common aquarium fish diseases (2L). Important points to be considered while choosing a place for aquarium set up : Sunlight, Accessibility, Noise, Visibility, Electrical Sockets, etc. (1L). The potential scope of Aquarium Fish Industry as a Cottage Industry and budget for setting up an Aquarium Fish Farm as a Cottage Industry(3L).	**15 Hours**
	MODULE II: Practicals 1. Study (Origin, Habits, habitat, common characters and colour pattern, Feed and feeding behaviour, Sexual dimorphism and breeding behaviour) of common Aquarium fishes such as- Guppy, Molly, Sword tail, Gold fish, Angel fish, Anemone fish and Butterfly fish. (Specimens/ Pictures/ Photos)	**60 Hours**

	2. Study of aquarium plants: Ceratophyllum, Java Moss, Vallisneria , Hydrilla sp. (Specimens/ Pictures/ Photos) 3. Types of aquariums: Community aquarium, Planted aquarium, Fresh water aquarium, Marine water aquarium. (Pictures/ videos) 4. Types of Aquarium tanks: Stand alone, Cabinet aquarium, Aquarium stand, Wall aquarium, Floor aquarium and Public aquarium. (Pictures/ Photos). 5. Study of aquarium accessories: Aquarium Lights, Water filters, Water areator, Aquarium thermometer and heater, Aquarium substrates, Aquarium decors, etc (Specimens/ Pictures). 6. Identification of live feed organisms -Infusoria, Paramecium, Daphnia, Bloodworm , Black worm Tubifex and Artemia (Specimens/ Pictures/ Photos) and Culture of live feed organisms -Paramecium, Euglena and Infusoria any one. 7. Study of different types of formulated feed: Flakes, Crisps, Granules, Pellets, Discs and Vacation blocks. Frozen foods. (Specimens/ Pictures). 8. Formulation of feed by using Pearson square method and preparation of formulated feeds. 9. Study of Fish diseases: Fin rot, Swim bladder disease, Fluke, Dropsy and Ich. (Specimens/ Pictures). 10. Setting up of an aquarium. 11. Maintenance of Aquarium (Daily, Weekly and Monthly). 12. Aquarium water quality check up for pH, Ammonia, Nitrate, Nitrite by using test kit. 13. 10. Visit to Public aquarium/ Aquarium fish division ICAR complex Goa.	
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. A. V. G. Jhingran, Fish and Fisheries of India. Hindustan Publishing Co., 1991. 2. J. D. Jameson, and R. Santhanam. Manual of ornamental fisheries and farming technology. Fisheries College and Research Institute, Thoothukudi, 1996. 3. J. E. Baradach, J. H. Ryther, and W.O. McLarney, Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. NewYork: Wiley Interscience, 1972. 4. M. Beazley, The complete guide to tropical aquarium fish care. London: Read and Consumes Book Ltd., 1998. 5. R. K. Rath, Freshwater Aquaculture. India: Scientific Publishers, 2000.	

Course Outcomes:	At the end of the course, students will be able to: 1. Explain the biology of aquarium fishes, their nutritional requirements and care. 2. Identify the requirements for setting up and maintenance of an aquarium. 3. Evaluate aquarium fish diseases based on common symptoms. 4. Demonstrate construction of an aquarium set-up.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-144
Title of the Course : Value Added fish products
Number of Credits : 03 (1T + 2P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. To explain the various value-added fish products. 2. Understand the concept and significance of value-added fish products in the seafood industry. 3. Demonstrate skills for preparation of value-added fish products. 4. Analyze various methods and techniques used to add value to fish products, such as processing, packaging, and flavoring.	
Content:	**MODULE I: Introduction to value added fish products.** • Value added fish products: Concept and Purpose, scope, merits and demerits (2L). • Selection of fish candidates (fin and shell fishes) for value addition (1L). • Introduction to common marinaded, fermented, battered and breaded value added fish products: Fish/ Prawn Pickle,Fish/ Prawn Mole, Prawn Balchao, Fish Parra, Fish fingers, Fish balls, Fish Cutlets, Fish Sandwich, Fish Papad, Fish Soup powder, Fish Wafers, Fish Chakli, Fish sev Fish Samosa, Prawn Pakora, fish sausage, surimi and fish cake (Introductory information such as fishes or shell fishes used, storage & life span, packing and market availability only are to be discussed) (6L). • Processes of Mincing, Battering, Breading and equipment / common ingredients required (2L). • Schedule IX of Food Safety and Standards Act (FSS), 2006 (1L). • Registration and Licensing of Product (1L). • Fish product packaging and marketing (2L).	**15 hours**
	Module II: Practicals • Determination of quality of fish, using organoleptic tests and Fish cleaning Techniques (Fin fishes and Shell fishes) • Study of the common equipment/ ingredients used for mincing, Battering and Breading • Preparation of fish fingers and fish balls • Preparation of fish cutlets. • Preparation of fish pakora, and fish sandwich. • Preparation of fish shev and fish chakali. • Preparation of fish papad. • Preparation of fish and prawn pickle. • Preparation of Goan traditional fish product - Fish Parra. • Preparation of Fish and Prawn Balchao.	**60 hours**

	• Preparation of Fish and Prawn mole. • Study of packaging material and methods. • Visit to commercial value-added fish product.manufacturing unit/ Self-help group centre/ Entrepreneur.	
Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration. and visit to commercial manufacturing units.	
References/ Readings:	• K. Ratnakumar, and R. Kavya, Textbook on Fish Processing Technology. Delhi: Narendra Publishing House, 2022. • N. Akhter, Marketing of Fish and Fish Products. Random Publications, 2015. • N. P. Singh, Goan Seafood Recipes (ICAR-Goa). Golden Heart Emporium Books, 2016. • S. Balasundari, G. Raghu, and S. Felix, Fish products and Value Addition. Tamil Nadu Dr. Jayalalithaa Fisheries University, 2018.	
Course Outcomes:	At the end of the course, students will be able to: 1. Assess the quality of fish and cleaning techniques. 2. Demonstrate preparation of various local, commercial and homemade value added fish products. 3. Plan licencing and marketing strategies. 4. Create an ecosystem of Bio-entrepreneurship.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-161
Title of the Course : Dairy Technology
Number of Credits : 04 (01 T + 03 P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	1. Appraise dairy technology as a viable livelihood option. 2. Develop an understanding of cattle breeds. 3. Relate milk processing and yield with health care. 4. Highlight adulterants in milk.	
Content:	**MODULE I: Introduction to Dairy Technology** • Common Indian Buffalo breeds, Common Indian and exotic Cow breeds (Emphasis to be given on milk yield and regional suitability) • Cattle care: Nutritional needs, Feeding Management and healthcare of Dairy Animals, Concise information about common diseases in dairy cattle: Mastitis, Foot-and-mouth Disease, Brucellosis, Tuberculosis, Fasciolosis. • Milk and Milk processing: Definition of Milk and nutritive value of Milk; Methods of milking, Milk preservation technique (Pasteurisation). • Preparation of special milk: Toned, double toned, standardized, Homogenised Milk. • Traditional Indian dairy products: Cream, Dahi, Butter milk, Butter, Ghee, Paneer, Khova, Rabdi, Basundi. • Adulteration in milk and milk products.	**15 hours**
	MODULE II: Practicals • Identification of cattle breeds (Cows and buffalo Six each) with the help of pictures. • Tests for Milk Quality: Clot- on boiling test (COB), Alcohol Test, Acidity test, Measurement of Density of Milk by using Lactometer. • Preparation of Indian Milk products: Flavoured milk; Dahi (Curds); Yogurt; Lassi; Butter; Ghee; Butter milk; Paneer; Chakka; Shrikhand; Basundi; Rabadi; Khoa/ Mawa and Khoa based sweets (Burfi, Peda, Kalakand, Milk Cake); Mozzarella cheese. • Detection of common adulterants in Milk and milk products. – Detection of Added Water in Milk (Glass Plate Method). – Detection of Added Starch and Cereal Flours in Milk. – Detection of Added Cane Sugar (Sucrose) in Milk. – Detection of Neutralizers in Milk: Rosalic Acid Test. – Detection of Added Urea in Milk. – Detection of Detergents and Pulverized Soap in Milk. – Test for Skimmed Milk Powder in Natural Milk.	**90 hours**

	– Detection of Coloring Matter Metanil Yellow in Milk and Ghee. – Detection of Vanaspati/Hydrogenated Edible Fat In Ghee and Blotting Paper in Rabdi. – Detection of Thickeners in Milk Products (Cream, Dahi, Khoa, Butter, Ghee): Starch, Mashed Potato and Cereal flours. • Detection of Preservative added to Milk: Formalin (Leach Test) • Visit to Dairy farm to learn farm layout, daily routine management, feed management and health care of the dairy cattle. Submit report. • Visit to Goa dairy to understand platform tests, pasteurisation process, Storage and packing of milk and milk products. Submit report. • Visit to Animal husbandry department to gather information about cattle breeds, Sperm collection and storage techniques, Feed management, Cattle disease management and various schemes of the of Govt. of Goa. Submit report.	
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/ Readings:	1. A. K. Puniya, Fermented Milk and Dairy Products, CRC Press/Taylor and Francis (ISBN 9781466577978), 2015. 2. C. P. Anatakrishan, A. Q. Khan, and P. N. Padmanabhan, The Technology of Milk Processing, Shri Lakshmi Publications, 1993. 3. D. Sukumar, Outlines of Dairy Technology, Oxford University Press, 2011. 4. D. Sukumar, Outlines of Dairy Technology, Oxford University Press, 2019. 5. EIRI Board, Dairy Farming for Milk Production Technology, Engineers India Research Institute, ISBN: 9789380772097 6. FSSAI, Manual of simple methods of testing common adulterants in food, Food Safety and Standered Authority of India, New Delhi. 7. J. Prasad, Dairy products manufacturing technology. Kalyani Publishers, 2020. 8. M. R. Goyal, A. Kumar and A. K. Gupta (Eds.). 2018. Novel Dairy Processing Technologies: Techniques, Management, and Energy Conservation. CRC Press 9. Milk Industry Foundation, Analysis of Milk and Its Products: A Lab Manual, 2nd ed. Biotech Books, 2005. 10. NDDB, Handbook of Good Dairy Husbandry Practices, National Dairy Development Board, Anand Gujarat 11. R. K. Pandey, Production Processing and Marketing of Milk and Milk Products, Astral International, 2013. 12. S. Dixit, Food Adulteration Testing Manual. Consumer Guidance Society of India (CGSI), 14th Revised Edition, Mumbai, 2019.	

	13. S. Singh, Dairy Technology: Milk and Milk Processing, New India Publishing Agency, 2014. 14. Y. H. Hui, Dairy Science and Technology Handbook: Principles And Properties, John Wiley, 2014.
Course Outcomes:	At the end of the course, students will be able to: 1. Identify the various cow and buffalo breeds. 2. Assess the quality of milk and milk products. 3. Explain the various techniques of processing milk. 4. Prepare the various Indian traditional milk products. 5. Apply the technique of testing milk and milk products for detecting adulterants and preservatives.

Semester III & IV
Name of the Programme : Zoology
Course Code : ZOO-200
Title of the Course : Biology of Non-chordates
Number of Credits : 04 (3T + 1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Zoology	
Course Objectives:	1. Imparting understanding of the body organization and general characteristics of various invertebrate phyla. 2. Understand characteristics unique to non-chordate phyla. 3. Appreciate the diversity within the invertebrate phyla. 4. Examine evolutionary patterns and adaptations within non-chordate taxa.	
Content:	**MODULE I: Organization of Non-chordates** General characteristics of non-chordates. Body symmetry – asymmetry, radial, biradial and bilateral symmetry with suitable examples and significance. Body organization – protoplasmic, cellular, tissue and organ level of organization with suitable examples and significance. Diploblastic and triploblastic organisms. Coelom – acoelomate, pseudocoelomate and eucoelomate animals. Metamerism- pseudometamerism (strobilization), eumetamerism. Major and minor invertebrate phyla, protostomes and deuterostomes.	**15 hours**
	MODULE II: Non-Chordates I (Protozoa, Porifera, Ctenophora, Cnidaria, Platyhelminthes) Protozoa – General characteristics and classification upto classes, locomotion in Protozoa. *Paramecium (*structural organization), Porifera – General characteristics and classification upto classes; canal system in sponges. Cell types in Sponges. Cnidaria- General characteristics and classification upto classes; polymorphism in Cnidaria. Hydra (structural organization) Ctenophora – General characteristics and evolutionary significance Platyhelminthes- General characteristics and classification upto classes. Parasitic adaptations in Platyhelminthes. Planaria (structural organization) Superphylum Aschelminthes- General characteristics and classification. *Ascaris* (structural organization).	**15 hours**
	MODULE 3: Non- Chordates II (Annelida, Onycophora, Arthropoda, Mollusca, Echinodermata)	**15 hours**

	Annelida – General characteristics and classification upto classes; Feeding structures in Annelids. *Nereis* (structural organization) Arthropoda - – General characteristics and classification upto classes, respiration in Arthropoda. *Periplaneta* (structural organization) Onychophora - General characteristics and evolutionary significance. Mollusca - General characteristics and classification upto classes; shell types in Mollusca; nervous system in Mollusca. *Paphia* (structural organization) Echinodermata - General characteristics and classification upto classes; water vascular system in Asteroidea, symmetry in Echinoderms. *Asterias* (structural organization) Hemichordata- Current evolutionary status. *Balanoglossus* (Structural organization	
	Practicals 1. Study of T.S of Hydra, T.S of Sycon, T.S of Ascaris. 2. Phylum Protozoa (permanent slides) – Minimum one 3. specimen from each class 4. Phylum Porifera- minimum one specimen from each class 5. Phylum Cnidaria- minimum one specimen from each class 6. Phylum Ctenophora- minimum one specimen 7. Phylum Platyhelminthes – minimum one specimen from each class 8. Superphylum Aschelminthes - *Ascaris* 9. Annelida – minimum one specimen from each class 10. Mollusca- minimum one specimen from each class 11. Arthropoda – minimum one specimen from each class 12. Echinodermata – minimum one specimen from each class 13. Demonstration of digestive system of *Pila* 14. Demonstration of nervous system in *Pila* 15. Study of Crustacean larvae. 16. Dissection- Digestive system in Cockroach. 17. Dissection- Nervous system in Cockroach. 18. Mounting of spiracles of cockroach 19. Mounting trachea of Cockroach. 20. Field visit to an intertidal zone to explore the invertebrate 21. fauna 22. Visit to local fish market to get familiar with shell fish.	**30 hours**
Pedagogy:	Lectures, presentations, videos , assignments, use of various assessment tools.	
References/Readings:	1. E. E. Ruppert and R. D. Barnes, Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, 2006.	

	2. E.J.W. Barrington, *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson, 1979. 3. E.L. Jordan, and P.S. Verma, *Invertebrates Zoology.*, S. Chand and company, New Delhi, 2001. 4. L.A. Boradale, and E.A. Potts, *Invertebrates: A Manual for the use of Students.* Asia Publishing Home, 1961. 5. R. Bushbaum, *Animals without Backbones.* University of Chicago Press, 1964. 6. R.D. Barnes, *Invertebrate Zoology* VI Edition. Holt Saunders International Edition, 1982. 7. R.S.K. Barnes, P. Calow, , P.J.W. Olive, D.W. Golding, and J.I. Spicer, *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science, 2002.
Course Outcomes:	At the end of this course, students will be able to: 1. Explain the classification of Invertebrate phyla. 2. Discuss the body organization and general characters of different invertebrate phyla. 3. Understand the life cycles and reproductive strategies of non-chordate organisms. 4. Contrast the Habit and habitat of various invertebrates Recognise the diversity among non-chordates

Name of the Programme : Zoology
Course Code : ZOO-201
Title of the Course : Cell Biology & Genetics
Number of Credits : 04 (3T + 1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of zoology	
Course Objectives:	1. Imparting understanding of the cellular organisation. 2. Understanding the genetic basis of inheritance. 3. Analyze the structure and function of cells, organelles, and cellular components. 4. Gain practical experience in laboratory techniques used in cell biology and genetics research.	
Content:	**Module I** Generalised Prokaryotic cell, Extremophiles, PPLO. Eukaryotic cell: Plasma membrane, structure (Fluid mosaic Model), composition and functions (Passive and active transport). Cell organelles—Structure and functions of -Mitochondria, Endoplasmic reticulum, Golgi complex, Ribosomes, Lysosomes, Centriole, Cytoskeletal elements Nucleus- Interphase nucleus- Nuclear envelope (structure including the pore complex), Chromatin (heterochromatin and Euchromatin), Nucleolus (structure and function) Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.	**15 hours**
	Module II Prokaryotic chromosome organisation, Eukaryotic Chromosome organisation (nucleosome to metaphasic chromosome) Cell division: -Mitosis -stages and significance, Meiosis -stages and significance Giant chromosomes—Lampbrush chromosome and Polytene chromosome Mutation—gene and chromosomal mutations, Mutagens (radiations and chemicals) Benign and Malignant neoplasms, Characteristics of a cancer cell	**15 hours**
	Module III Monohybrid, Dihybrid crosses and Mendel's Laws Epistatic interactions (9:7, 12:3:1, 13:3, 15:1) Multiple Alleles (Rabbit coat colour), Multiple genes (skin colour in humans). Sex linked, Sex limited and Sex influenced inheritance.	**15 hours**

	Symbols and rules of construction of a pedigree chart (one example each of an autosomal dominant trait, autosomal recessive trait and an X linked recessive trait) Sex determination----Chromosomal---*Drosophila* (genic balance theory), Humans, Fowl, Grasshopper, Honeybee. Environmental basis of sex determination in *Bonelia viridis* and Turtles. Cytoplasmic inheritance ---Kappa particles in Paramoecium The role of Mitochondria in Maternal inheritance in Humans	
	Practicals 1. Gram staining to observe bacteria from curd/ tartar. 2. Use of a suitable staining technique to mount buccal epithelial cells. 3. Temporary mount of onion root tip cells to study mitotic stages. 4. Use of photomicrographs /permanent slides to study the meiotic stages. 5. Study of Polytene Chromosome 6. Study of cell organelles—Mitochondria, Endoplasmic reticulum, Golgi complex using Electron micrographs 7. Study of Human Karyotype- Normal male, 8. Study of Human Karyotype- Normal female 9. Study of Human Karyotype- Down's syndrome 10. Study of Human Karyotype- Turner's Syndrome 11. Study of Human Karyotype- Cri-du-chat syndrome - Karyotype studies to be undertaken with printed material 12. Preparation of Pedigree chart of tongue rolling, hitch hikers thumb, Widows peak, folding of arms, clasping of hands, attached/free ear lobes. 13. Problems on Mendelian monohybrid and dihybrid crosses using beads. 14. Problems on Multiple genes 15. Human blood grouping---(Rh and ABO)	**30 hours**
Pedagogy:	Lectures, presentations, videos , assignments, use of various assessment tools.	
References/Readings:	1. B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter, Molecular Biology of the Cell (6th edn), Garland Science, 2014. 2. C.B. Powar, Cell biology, Himalaya Publishing House, 2010. 3. C.B. Powar, Genetics –Vol.1 Himalaya Publishing House, 2010. 4. E.J. Gardner, M.J. Simmons, D.P. Snustad, Principles of Genetics (8th Edition), Wiley, 2006. 5. J. Hardin, G. Bertoni, L. Kleinsmith, Beckers World of the Cell (8th Edition) Pearson Benjamin Cummins Publishing House, 2014. 6. P.S. Verma and V.K. Agarwal, Genetics 9th edition, S.Chand Publications, 2010.	

Course Outcomes:	At the end of the course, students will be able to 1. Explain the cellular organisation. 2. Distinguish between prokaryotic and eukaryotic cell 3. Interpret the transmission of traits based on the laws of inheritance. 4. Predict the outcome of monohybrid and dihybrid genetic crosses

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-211
Title of the Course : Vector-borne Diseases
Number of Credits : 04
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Zoology	
Course Objectives:	1. Acquainting with common tropical vector-borne diseases and vector control strategies. 2. Understanding the host-pathogen interaction, transmission, symptoms of vector borne diseases. 3. Introduction of various Insect vectors to the Learners. 4. Develop competencies in responding to vector borne diseases.	
Content	**Module I: Introduction to Vectors and Vector-borne diseases (VBDs):** Vectors-definition, Types of vectors, Vector-borne diseases, Disease transmission-horizontal and vertical transmission of vectors, Epidemiology of Vector-Borne Diseases and control Strategies, Emerging and Re-emerging Vector Borne diseases. **Insects as Vectors:** Features of insect orders (having vectors) – Diptera, Siphonoptera, Siphunculata and Hemiptera. Salient features of Dipteran vectors – Mosquitoes, Sand fly and Housefly Mosquito-borne diseases – Malaria, Dengue, Filariasis- causative agent, it's lifecycle and symptoms. Sandfly-borne diseases – Leishmaniasis- causative agent, it's lifecycle and symptoms. Housefly transferred diseases- Shigellosis, Diarrhoea, Typhoid - causative agent, it's lifecycle and symptoms, Control of Mosquitoes, Sand flies and House fly.	**15 Hours**
	Module II: Siphonaptera as Disease Vectors: Fleas: Fleas and flea-borne diseases: Plague causative agent, it's lifecycle and symptoms. Control of Fleas. Siphunculata as Disease Vectors: Human body louse as important insect vectors. Human body louse disease: Epidemic typhus causative agent, it's lifecycle and symptoms. Control of human louse Hemiptera as Disease Vectors: Bugs as insect vectors- Blood-sucking bugs	**15 hours**

	Triatomine Bugs transferred diseases: Chagas disease- causative agent, it's lifecycle and symptoms. Bed bugs as mechanical vectors, Control, and preventive measures. Other Arthropod vectors: Ixodid ticks as vectors Ixodid ticks disease- Lyme disease: causative agent, it's lifecycle and symptoms. Preventive measures of ticks.	
	Module III: Molluscs as Vectors: Snail-borne parasitic diseases (SBPDs) Gastropod: Bulinus sp. Disease: Schistosomiasis (bilharziasis)- causative agent, it's lifecycle and symptoms. Hippeutis sp. Disease: Fasciolopsiasis- causative agent, it's lifecycle and symptoms. Snail control. Rodent Vectors: Diseases transmitted by Rats: Leptospirosis Rodent control	**15 hours**
	Module IV: Practicals 1. Identification of the following specimens: Mosquito, Housefly, rat Flea, Head Louse, Bed bug, Tick and House Rat. 2. Study of Life cycle of some Vectors representing Order: Diptera, Siphonoptera, Siphunculata and Hemiptera. 3. Study of mouth parts of vectors representing Orders: Diptera, Siphonoptera, Siphunculata and Hemiptera. 4. Understanding incidence of prominent Vector borne diseases in India from secondary data of VCRC-ICMR /WHO resources. 5. Design a Vector control program for the following vector-borne diseases (any two): a. Malaria b. Schistosomiasis c. Lyme's Disease d. Plague 6. Identify signs, indicating the species and extent of a rodent infestation. Plan a community rodent control program. 7. Rearing of any suitable mosquito species of Goa, from egg to adult in laboratory. 8. Study of different larvivorous fish found in Goa.	**30 hours**
References/Readings	1. C.K. Paniker, *Textbook of Medical Parasitology.* New Delhi: Jaypee Brothers medical Publishers (P) ltd., 2007. 2. D. Despommier, D. Griffin, R. Gwadz, P. Hotez and C. Knirsch, C. *Parasitic Diseases.* (6th Ed). New York: Parasites without borders, 2017.	

	3. D.J. Gubler, The Global Threat of Emergent/Re-emergent Vector-Borne Diseases. *Vector Biology, Ecology and Control*, 39–62. https://doi.org/10.1007/978-90-481-2458, 2010. 4. G. Mullen and L. Durden, *Medical and Veterinary entomology*, Academic press, London, 2009. 5. L. Roberts and J. Janovy, *Gerald D Schmidt & Larry S Roberts' Foundations of Parasitology.* New York: The McGraw hill Companies, 2009. 6. M.W. Service *Medical Entomology for students*. Chapman & Hall, London, 1996. 7. P. Chakraborty, *Textbook of Medical Parasitology.* Kolkata: New Central Book Agency (P) Ltd., 2010. 8. W.C. Marquardt, *Biology of disease vectors* (2nd Edition). Doody Enterprises, Inc. USA, 2005. 9. World Health Organization, *Malaria vector control and personal protection*. World Health Organization Technical Report Series, nº 936, Geneva, Switzerland. 62 pp., 2006. 10. World Health Organization, Vector-Borne diseases in India. Report of a Brainstorming session. 9 Nov. 2006. WHO/SEARO & Govt. of India pp1 -7-9, 2006. Web references: 1. https://www.cdc.gov/ncezid/dvbd 2. https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases
Course outcome	At the end of the course, the student will be able to 1. List the various major vector-borne diseases. 2. Describe the symptoms of the major vector-borne diseases and control measures of the vectors. 3. Choose effective responses against vector borne diseases. 4. Assess the severity of vector borne disease outbreaks.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-231
Title of the Course : Standard First Aid
Number of Credits : 03
Effective from AY : 2024-25

Prerequisite for the Course:	Basic knowledge of first aid	
Objectives:	1. Acquire basic knowledge and skills for providing first aid. 2. Understanding the first aid intervention needed for various emergencies. 3. Familiarizing the principles and operational aspect of a first aid response. 4. Analyze common medical emergencies and appropriate first aid responses.	
Content:	**MODULE I** Basic First Aid- Aims of first aid & First aid and the law, Dealing with an emergency, Resuscitation (basic CPR), Recovery position, Initial top to toe assessment. Hand washing and Hygiene, Types and Content of a First aid Kit. First aid Technique- Dressings and Bandages, Fast evacuation techniques (single rescuer), Transport techniques. Symbols associated with First aid Shock- Principles and first aid intervention in: a. shock due to injury. b. shock due to allergic reactions. c. Appropriate assessment and first aid treatment of a victim who has fainted. Bleeding a. Types of bleeding including arterial, venous, capillary, external, and internal. b. The principles and performance of bleeding control interventions including direct pressure, pressure points, elevation, and pressure bandaging. the principles of wound care including infection precautions, wounds requiring medical attention, and the need for tetanus prophylaxis	**15 hours**
	Module II: Musculoskeletal Injuries- Principles and first aid intervention in: a. open fractures, closed fractures, and splinting. b. dislocations, especially the methods of joint dislocations of the upper extremity. The importance of differentiating dislocations from fractures. c. joint sprains. d. muscle strains, contusions, and cramps. e. head, neck, back, and spinal injuries. Medical emergencies- principles and first aid intervention of:	**15 hours**

	Heart attacks, strokes, asthma attacks, diabetic emergencies including diabetic coma, insulin shock, hyperglycemia, and hypoglycemia, Seizures -Importance of not putting gags in mouth. pregnancy including the appropriate care of any abdominal injury or vaginal bleeding. Burns - First aid related with Burns- assessing the severity of the burn including first degree, second degree, and third-degree burns. Differentiating between the types of third-degree burns (thermal, electrical, and chemical) and their specific interventions. (Particular attention should be focused upon chemical burns, and the use of specific chemicals in the workplace which may cause them).	
	Module III: Temperature Extremes- Principles and first aid intervention of: a. exposure to cold including frostbite and hypothermia. b. exposure to heat including heat cramps, heat exhaustion, and heat stroke Bites and stings- principles and first aid intervention in: a. human and animal (especially dog and snake) bites. b. bites and stings from insects (spiders, ticks, scorpions, hornets and wasps). Interventions should include responses to anaphylactic shock; other allergic manifestations; rabies and tetanus prophylaxis. Site of Injury- Principles and first aid intervention of injuries to the following sites**:** Head and Neck • Including skull fractures, concussions, and mental status assessments with particular attention to temporary loss of consciousness and the need for referral to a physician. • Including the appropriate approach to the management of the individual who has suffered a potential neck injury or fracture. • Eye • foreign bodies, corneal abrasions and lacerations. • chemical burns and the importance of flushing out the eye. • the importance of not applying antibiotics without physician supervision. • Nose • nose injuries and nose bleeds. • Mouth and Teeth • oral injuries, lip and tongue injuries, and broken and removed teeth. The importance of preventing inhalation of blood and teeth. • Chest	**15 hours**

	• rib fractures, flail chest, and penetrating wounds. • Abdomen • blunt injuries, penetrating injuries, and protruding organs. • Hand, Finger, and Foot Injuries • finger/toe nail hematoma, lacerations, splinters, finger nail avulsion, ring removal, and foreign bodies. • the importance of identifying amputation care hospitals in the area. When an amputation occurs, appropriate handling of amputated fingers, hands, and feet during the immediate transportation of the victim and body part to the hospital.	
Pedagogy:	Lectures/tutorials/Videos/ demonstrations.	
References/ Readings	1. L. Gupta, A. Gupta, Manual of first aid : Management of general injuries, sports injuries and common ailments, New Delhi Jaypee Brothers, 1995. 2. M. Flegel, Sport First Aid, Human kinetics USA, 2004.	
Course Outcome:	By the end of this course, students will be able to 1. Explain the first aid interventions needed for various emergencies. 2. Apply the principles of first aid management in managing emergency situations. 3. Differentiate between various injuries. 4. Assess the seriousness of the emergency scene/situations to take appropriate action.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-241
Name of the Course : Value Added Fish Products
Number of Credits : 3 (1T + 2P)
Effective from AY : 2024-25

Prerequisite for the Course:	Basic knowledge of zoology	
Course Objectives:	1. Explain the various value added fish products. 2. Demonstrate skills for preparation of value-added fish product	
Content:	**MODULE I: Introduction to value added fish products.** 1. Value added fish products: Concept and Purpose, scope, merits and demerits. 2. Selection of fish candidates (fin and shell fishes) for value addition. 3. Introduction to common marinaded, fermented, battered and braided value added fish products: Fish/ Prawn Pickle, Fish/Prawn Mole, Prawn Balchao, Fish Parra, Fish fingers, Fish balls, Fish Cutlets, Fish Sandwich, Fish Papad, Fish Soup powder, Fish Wafers, Fish Chakli, Fish sev Fish Samosa, Prawn Pakora, fish sausage, surimi and fish cake (Introductory information such as fishes or shell fishes used, storage & life span,packing and market availability only are to be discussed) 4. Processes of Mincing, Battering, Breading and equipment / common ingredients required 5. Schedule IX of Food Safety and Standards Act (FSS), 2006(1L) 6. Registration and Licensing of Product 7. Fish product packaging and marketing	**15 hours**
	MODULE II: Practicals 1. Determination of quality of fish, using organoleptic tests and Fish cleaning Techniques (Fin fishes and Shell fishes) 2. Study of the common equipment/ ingredients used for mincing, Battering and Breading 3. Preparation of Fish fingers and Fish balls 4. Preparation of Fish cutlets. 5. Preparation of Fish Pakora, and Fish sandwich, 6. Preparation of Fish Shev and fish Chakali 7. Preparation of fish Papad 8. Preparation of fish and prawn pickle, 9. Preparation of Goan traditional fish product - Fish Parra, 10. Preparation of Fish and Prawn Balchao, 11. Preparation of Fish and Prawn mole 12. Study of packaging material and methods. 13. Visit to commercial value-added fish product manufacturing unit/ Self-help group centre/ Entrepreneur.	**60 hours**

Pedagogy:	• Lectures and class discussions to introduce basic principles and concepts. • Use of ICT tools. • Fundamental theoretical concepts will be explained by practical demonstration and visit to commercial manufacturing units
References/ Readings	1. D.P. Sen, Technology of Fishery Products, Fishing Chimes, 2009. 2. G.M. Hall, Text book of Fish Processing Technology, ICAR Publication, 1992 3. https://mpeda.gov.in/ 4. ICAR, Goan Seafood Recipes. Broadway Publishing House, Goa. ISBN 9789384298388, 2016. 5. K. Gopakumar, Text book of Fish Processing Technology. Indian Council of Agricultural Research, New Delhi, 2002. 6. K. Ratnakumar, R. Kavya, Textbook on Fish Processing Technology. Narendra Publishing House, Delhi, 2022. 7. K.K. Balachandran, Post-harvest technology of fish and fish products. Daya Publishing House, New Delhi, 2001. 8. N. Akhter, Marketing of Fish and Fish Products. Random Publications. ISBN: 9789351116158., 2015. 9. S. Balasundari, G. Raghu, S. Felix, Fish products and Value addition. Tamil Nadu Dr. Jayalalithaa Fisheries University. ISBN 9789351249351, 2018. 10. T.K. Govindan, Fish processing technology. Exford& IBH Publishing Co. Pvt. Ltd., New Delhi., 1985.
Course Outcome:	At the end of the course, students will be able to: 1. Assess the quality of fish and cleaning techniques. 2. Demonstrate preparation of various local, commercial and homemade value added fish products. 3. Plan licencing and marketing strategie. 4. Create an ecosystem of Bio-entrepreneurship

Name of the Programme : Zoology
Course Code : ZOO-242
Name of the Course : Wildlife and Ecotourism
Number of Credits : 3 (1T + 2P)
Effective from AY : 2024-25

Prerequisite for the Course:	Basic knowledge of Zoology	
Course Objectives:	1. Acquaint the learner with India's rich wildlife, conservation challenges 2. Understanding the alternatives to mass tourism	
Content:	**Module I** **Introduction to Wildlife and Current Scenario** Meaning, Values, Biogeographic zonation and wildlife endowments of India, Causes of decline in diversity and density of Indian Wildlife and challenges to conservation of wildlife in India **Endemicity, Extinction of wildlife & Conservation Categories** North East and Western Ghats; as 'Centers of Endemicity', Extinct Species, Drivers of Extinction & Extinction Threshold, IUCN Conservation categories with relevant examples Basis of IWPA 1972, Schedules, with emphasis on Schedule-I species (Mammals, Birds and Reptiles). **Wildlife Conservation-Objectives & Methods** Ex-situ & In-situ methods of wildlife Conservation Centrally Sponsored Schemes for Wildlife Conservation (Project Tiger, Project Elephant, Reintroduction of Cheetah in India: An evaluation). **Wildlife as sustainable Tourism option in India** Ecotourism vs Mass tourism, Wildlife Tourism: Advantages (Sustainability of enterprise, Assured backflow of profits to local communities, Upholding conservation ethos), Impacts (Altered landscape, Impact of roads on wildlife habitats, Tourism generated litter, Transference of Invasive species, zoonosis and zooanthroponosis), Concept of 'Visitors Carrying Capacity'. **Brief idea of Visitor Planning, Management & Monitoring** Visitor Management: Zoning, Visitor Communication & Education Regulating Visitor numbers. Interpretation: Role of interpretation and Major interpretation techniques (Publication & Websites, Visitor Centres, Self-guided Trails, Guided Tours Visitor Monitoring: Monitoring rationale and Techniques (Counting visitors, Questionnaires & Interviews, indirect methods like Camera, Counting devices , Self registration)	**15 hours**
	MODULE II: Practicals 1. Use of Maps to understand Goa's Protected Areas Network (PAN).	**60 hours**

	2. Prepare an Inventory of state's Wildlife Resources (Forest Types, Carnivores, Wild Ungulates, Endemic and Sch I Birds) from secondary sources and classify them under them IUCN conservation categories & IWPA Schedules 3. Visit to a state WPA to understand and prepare Report on the management and conservation. 4. To prepare an inventory of your Taluk's existing /potential Ecotourism sites with special reference to willdlife. Evaluate any one extant ecotourism site with reference to: A. Visitor's Carrying Capacity B. Visitor Education &Interpretation C. Visitor Facility 5. Carnivore Pug Biometry by analysis of Printed Pug Marks Tracings 6. Whisker Spot study in Asiatic Lion (Lion Head sketches with Reference Rows & Identification Rows of Whisker Spots to be provided) 7. Population enumeration by Lincoln & Peterson's Index Method (Simulation using Coloured Beads to represent marked to unmarked individuals)	
Pedagogy:	Lectures/tutorials/Videos/ demonstrations.	
References/ Readings	1. W.J. Sutherland, L.V. Dicks, N. Ockendon, and R.K. Smith, What works in conservation. Open Book Publishers, UK, 2015. 2. S.K. Singh Text Book of wildlife Management International Book Distributing Company, Lucknow, 2010. 3. P. Porob, R. Kulkarni and V. Giri, Biodiversity of Goa. Pug Marks Art Gallery, Kolhapur, 2014 4. Goa State Biodiversity Board Island Biodiversity, Goa: Biological Treasure of Chorao, Divar and St Jacinto Island. National Biodiversity Authority, 2014. 5. R. Grimmet, T. Inskipp, Birds of Southern India. Om Books International, 2005. 6. I. Kehimkar, The Book of Indian Butterflies. Oxford, 2011. 7. L. Boitani and R. Powell, Carnivore Ecology and Conservation. Oxford University Press, 2012. 8. R. Whitaker and A. Captain, Snakes of India. Draco Books Tamil Nadu, 2008. 9. A.R. Rehmani, Threatened Birds of India. Oxford University Press, 2012. 10. R. Chauhan, Ecotourism Trends & Challenges. Vista International Publishing House Delhi, 2006. 11. D. Newsome, S. Moore and R.K. Dowling, Natural Area Tourism Ecology, Impacts and Management. Viva Books Pvt Ltd Ac Delhi, 2006. 12. The Wildlife (Protection) Act, Natraj Publishers, 1972.	

Course Outcome:	By the end of this course, students will be able to 1. Appreciate wildlife as soft sustainable alternative to tourism. 2. Understand the nuances of conservation and wildlife tourism management. 3. Gain practical experience in field techniques used in wildlife monitoring and ecotourism operations. 4. Communicate the principles of responsible wildlife tourism to tourists, guides, and local communities.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-202
Title of the Course : Biology of Chordates
Number of Credits : 04 (3T + 1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of zoology	
Course Objectives:	1. Acquaint the learner with Chordate body organization. 2. Appreciate the diversity within the chordates. 3. Evaluate the evolutionary relationships and adaptations within chordates. 4. Examine the diversity of chordate life histories, including reproduction and development.	
Content:	**Module I: Introduction to Chordates and Protochordates.** Characteristics of Chordates. Ancestry of Chordata. General characteristics and outline classification of Cephalochordata and Urochordata. study of larval forms of protochordates. Retrogressive metamorphosis in Urochordata. Branchiostoma, *Simple Ascidian* (Structural organization)	**15 hours**
	Module II: Chordates I Agnatha: Salient features and biological significance of ostracoderms. General characteristics and outline classification of cyclostomes; features of Petromyzontia and Myxinoidea Petromyzon (Structural organization) Gnathostomes- General characteristics Latimeria- Evolutionary significance Pisces: General characteristics and outline classification of Chondrichthyes and Osteichthyes.; types of caudal fins in fishes, types of accessory respiratory organs in fishes. Introduction to Tetrapoda. Amphibia- General characteristics and classification of Amphibia, neoteny and paedogenesis. *Ichthyophis* (Structural organization)	**15 hours**
	Module 3: Chordates II Reptilia- General characteristics and outline classification, temporal fossae in reptiles, poison apparatus, venomous and non- venomous snakes, Mesozoic reptiles (Dinosaurs). Aves- General characteristics and outline classification, flight adaptations in birds; types of beak and feet in birds, flightless birds. Mammalia: General characteristics and outline classification, Prototheria and Metatheria, placenta as a foetal- maternal connect. Dentition in mammals	**15 hours**
	Practicals:	**30 hours**

	Study of Classification, habit, habitat and structural organization of the following: 1. Ascidian tadpole larva 2. Protochordates- Branchiostoma, Simple Ascidian. 3. Petromyzon and Myxine 4. Shark, Trygon, Mackerel. 5. 3 specimen each from Class Pisces, Amphibia, Reptilia and Mammalia (necessarily local specimen) 6. Types of Caudal fins in fishes. 7. Axolotl larva 8. Type of beaks in birds 9. Type of feet in birds 10. Types of teeth in mammals Field visits: 1. Field visit to any ephemeral pond(s) to study amphibia. 2. Field visit to study wetland birds	
Pedagogy:	Lectures, presentations, videos , assignments, use of various assessment tools.	
References/Readings:	1. J.Z. Young, *The Life of Vertebrates*. III Edition. Oxford university Press, 2004. 2. H. Pough, W.E. Bemis, B.A. McGuire, C.M. Janis, *Vertebrate life,* 11th Edition, Pearson International, 2022. 3. P.J. Darlington, *The Geographical Distribution of Animals*, Academic Publishers, 2017 4. B.K. Hall and B. Hallgrimsson *Strickberger's Evolution*. IV Edition, Jones and Bartlett Publishers Inc., 2008.	
Course Outcomes:	At the end of this course the student will be able to: 1. Explain the classification of Chordates. 2. Describe the unique characters of protochordates, Pisces, Amphibia, Reptiles, Aves & mammals. 3. Distinguish the various Chordate classes. 4. Recognise the diversity among chordates.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-203
Title of the Course : Biochemistry
Number of Credits : 04 (3 + 1)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of zoology	
Course Objectives:	1. Understand the fundamental principles and concepts of biochemistry. 2. Imparting understanding of structure of biomolecules, the basic building blocks of living organisms 3. Understanding the biological roles of the various biomolecules. 4. Examine the principles of enzyme kinetics and catalysis in biochemical reactions.	
Content:	**Module I: Carbohydrates** Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates. Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important monosaccharide derivatives, oxidation of sugars. Formation of disaccharides, reducing and non- reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides	**15 hours**
	Module II: Lipids Classification of Lipids. Building blocks of lipids - fatty acids (Physiologically important saturated and unsaturated fatty acids), glycerol, ceramide. Storage lipids - triacylglycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Derived lipids- cholesterol & its importance.	**15 hours**
	Module III: Proteins & Enzymes Classification, structure & physico-chemical properties of amino acids (amphoteric molecules, ionisation, zwitterions, pk_a values, isoelectric point), Physiological importance of essential and non-essential α-amino acids. Peptide bond, Proteins- simple, conjugated and derived. Fibrous and globular**,** bond stabilizing protein structure. Classification of Enzymes; Cofactors, Co-enzymes, Zymogens, Iso-enzymes, Specificity of enzyme action, Factors affecting rate of enzyme-catalyzed reactions, Concept of Michaelis-Menten equation, Significance of Km, Lineweaver-Burk plot for enzyme inhibition- (competitive and non-competitive)	**15 hours**
	Practicals: 1. Qualitative tests for reducing and non-reducing sugars.	**60 Hours**

	2. Estimating sugar in fruit juices and soft drinks using refractometer. 3. Estimation of Glycogen from liver tissue. 4. Estimation of total protein from a suitable tissue 5. Fatty acid estimation from oil 6. Effect of pH on salivary amylase activity. 7. Effect of temperature on the action of salivary amylase. 8. Calculating the K_m for Amylase enzyme. 9. Effect of inhibitor (any suitable) on salivary amylase activity 10. Cholesterol estimation from blood serum.	
Pedagogy:	Lectures, presentations, videos , assignments, use of various assessment tools.	
References/Readings:	1. J.M. Berg, J.L. Tymoczko, and L. Stryer, L. *Biochemistry*. VI Edition. W.H Freeman and Co., 2006. 2. R.K. *Murray, D. Granner, P. Mayes, V. Rodwell, Harper's*. Illustrated *Biochemistry* (LANGE medical book) 26th edition., McGraw-Hill Education, 2003. 3. M.N. Chatterjea, R. Shinde, *Textbook of Medical Biochemistry.,* Jaypee Brothers Medical Publishers, 2012. 4. D.L. Nelson, M.M. Cox, Lehninger *Principles of Biochemistry*. 7th Edition. W.H. Freeman and Co., 2017. 5. *P. Naik*, Essentials of *Biochemistry*. Jaypee Brothers Medical Publishers., New Delhi., 2023 6. R.A. Joshi, M. Saraswat, A Text Book of Practical Biochemistry., B Jain Publishers Pvt Ltd; First Edition, 2021. 7. Ranjna Chawla, Practical Clinical Biochemistry Methods And Interpretations, Jaypee Brothers Medical publishers (P) Ltd. New Delhi 8. R.J.P. Williams and J.J.R.F. da Silva, Bringing chemistry to life: from matter to man, Oxford University Press., 1999. 9. U. Satyanarayana, U. Chakrapani, Biochemistry, Elsevier India Pvt. Ltd, Co published by Allied Books, 2020. 10. W. Pickering, C. Smith and E.J. Wood, Life, Chemistry and Molecular Biology", pub. Portland Press., 1997.	
Course Outcomes:	At the end of the course, students will be able to 1. Impart understanding of structure of biomolecules, the basic building blocks of living organisms. 2. Understand the biological roles of the various biomolecules. 3. Analyze the structure and function of biomolecules such as proteins, carbohydrates, lipids, and nucleic acids. 4. Examine the kinetics and catalytic properties of enzymes in biochemical reactions.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-204
Name of the Course : Vertebrate Anatomy
Number of Credits : 4 (3+1)
Effective from AY : 2024-25

Pre-requisites for the course	Basic knowledge of Zoology	
Course Objectives:	1. Understand the basic principles of vertebrate anatomy and its significance in biology. 2. Preparing learners for understanding the structural and functional body system of the vertebrates. 3. Introducing the anatomy of different systems in vertebrates. 4. Analysing the structural modifications in anatomy of different groups vertebrates.	
Content:	**MODULE I: Integumentary System Skeleton System and Digestive system** Integument: • Basic structure and prominent functions of Vertebrate Integument . • Functions of derivatives of integument- Epidermal derivatives (Mucous glands and Mammary glands), Dermal derivatives (Scales in fishes; Claws In reptiles and birds: Nails in mammals) Skeleton system: Overview of axial and appendicular skeleton: Atlas and Axis vertebrae (Fish and Rat), Pectoral and Pelvic girdles (Frog and Fowl) Digestive System • Study of Monogastric, Avian and Ruminant vertebrates Digestive system and digestive glands	**15 hours**
	MODULE II: Circulatory System, Respiratory System and Nervous system Circulatory System: • Outline of the Single circulation two chambered heart and aortic arches - (Shark) • Outline of the Double circulation three chambered heart and aortic arches of Amphibian. • Outline of the Double circulation four chambered Avian and mammalian hearts and aortic arches. • Respiratory system • Septal gills of Shark and Opercular gills of teleost • Cutaneous respiratory organs • Gross anatomy of the mammalian respiratory system Nervous System	**15 hours**

	• Outline of the Brain of the Non-mammalians vertebrates (Fish , Reptile and Bird) and Mammalian vertebrates (Rat) • Overview of types and functions of sense organs. Types according to the source of stimuli: Types according to location of stimulus; Somatic and visceral receptors	
	MODULE III: Urinogenital System , and reproductive system • Overview of the structure of Pronephros, Mesonephros and Metanephros Kidneys • Overview of the Urinogenital systems in anamniotes (Bony fish) and in amniotes (Reptiles) • Outline of male and female reproductive systems in mammals (Rat/ humans)	**15 Hours**
	Module IV: Practicals 1. Study of integumentary systems - V. S. of Skin of mammal (Using permanent micro slides, Printed Picture/Photo micrograph/ model) 2. Identification of disarticulated Atlas and Axis vertebrae (Fish and Rat), Pectoral and Pelvic girdles (Frog and Fowl) 3. Mounting of scales in fishes (Cycloid, Ctenoid and Placoid. 4. Study of types of feathers in birds. 5. Study of structure and functions of any four sense organs in vertebrates (video recording/ Models/ Printed picture) 6. Mounting of Brain of bony fish from preserved heads of the fishes 7. Study of Brain of frog, Bird and Mammals with the help of models/ hand charts / museum preserved specimen 8. Study of human kidney with the help of Model/chart/ printed picture 9. study of human lung with the help of Model/chart/ printed picture 10. Dissection of bony fish - to study heart and anterior arterial system 11. Dissection of Digestive system of bony fish 12. Dissection of Urinogenital system in bony fish (demonstration)	**30 Hours**
Pedagogy:	Lectures and class discussions to introduce basic principles and concepts. Use of ICT tools. Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. G.C. Kent, R. K. Carr, *Comparative anatomy of the vertebrates*, IX Edition. The McGraw-Hill companies, 2000. 2. H.E. Walter, L.P. Sayles, *Biology of vertebrates*, New York, Macmillan Co, 1949. 3. J.Z. Young, The Life of Vertebrates, Oxford Universtiy Press, 2004. 4. K.V. Kardong, *Vertebrates comparative anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education, 2005.	

	5. M. Hilgerbrand, G.E. Gaslow, *Analysis of Vertebrate structure*, John Wiley and Sons, 2001. 6. P.S. Verma, *Chordate Zoology*, S. Chand Publishing, 2010. 7. R.C. Gupta, G. Chopra, *Comparative anatomy of chordates,* R. Chand & Co., 1999. 8. R.K. Saxena, Comparative Anatomy of Vertebrates, Viva books, 2019. 9. R.L. Kotpal, *Modern Textbook of Zoology* Vertebrates, 2009.
Course Outcomes:	At the end of the course, the student will be able to: 1. Explain structural and functional diversity of chordates 2. Understand anatomical structures and their functions in vertebrates including humans 3. Analyze the modifications and anatomical relationship among the vertebrates which will help them to have better understanding of physiological processes and evolution. 4. Take up research in biological sciences in the field of anatomy, physiology and evolutionary relationship amongst vertebrates

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-205
Name of the Course : Basic Entomology
Number of Credits : 02
Effective from AY : 2024-25

Pre-requisites for the course	Basic knowledge of zoology	
Course Objectives:	1. Understanding the scope and importance of Entomology 2. Familiarize Insect classification and collecting and preservation techniques. 3. Introduction of various Insect vectors to the Learners. 4. Develop competencies in responding to vector borne diseases.	
Content:	**Module I: Introduction to Entomology, Classification, collection and preservation** Definition, History, Scope and importance of Entomology. Insect diversity, General anatomy of insects (in brief)- Digestive, Respiratory, Circulatory, Excretory, Nervous, and Reproductive system. Classification of Insects (Principles of classification, Taxonomic hierarchy), Introduction to major insect orders. Methods of Insect collection, preservation techniques. Digital sources for identification of insects.	**15 Hours**
	Module II: Interesting aspects of Insect life Insect Pollination, metamorphosis & ecdysis (Moulting), Aposematism (Warning Coloration), Insect Communication, insect migration, silk production in Insects, Eusociality in Hymenoptera (Ants, Bees, Wasps), Insect Mimicry, Parasitoidism in insects.	**15 Hours**
Pedagogy:	Lectures and class discussions to introduce basic principles and concepts. Use of ICT tools. Fundamental theoretical concepts will be explained by practical demonstration.	
References/ Readings:	1. R.L. Metcalf, W.H. Luckmann, Introduction to Insect Pest Management, 3rd edn, Wiley India Pvt Ltd, 2011. 2. C.L. Metcalf, W.P. Flint, Destructive and Useful Insects, Agri North press, 2018. 3. S.W. Frost, General Entomology, Narendra Publishing House, 1994.	
Course Outcomes:	At the end of the course, the student will be able to: 1. Explain the importance and scope of Entomology.. 2. Classify Insects. 3. Discuss the various methods for collecting and preserving insects. 4. Recall the various interesting aspects of insect life.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-221
Name of the Course : Bioinstrumentation
Number of Credits : 4 (3T + 1 P)
Effective from AY : 2024-25

Prerequisite for the Course:	Basic knowledge of cell biology and genetics.	
Objectives:	1. Understanding the principles, working mechanisms. 2. Applications of various Bio-instruments. 3. Familiarising the principles, operation, and applications of Imaging, separation and spectrophotometric techniques 4. Imparting hands-on experience with instruments.	
Content:	**Module I: Imaging and related techniques:** Principles of microscopy; Light microscopy; Fluorescence microscopy; Electron Microscopy (a) Flow cytometry (b) Applications of fluorescence microscopy: Chromosome banding, FISH, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, freeze fracture, freeze etching.	**15 hours**
	Module II: **pH and Centrifugation**: pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. **Spectrophotometry**: Principle involved in Spectrophotometer; Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers),	**15 hours**
	Module III: Separation techniques: Chromatography: Chromatographic techniques: Principle and applications – Column - thin layer –paper, affinity and gas chromatography - Gel filtration - Ion exchange and High performance liquid chromatography techniques– Examples of application for each chromatographic system - Basic principles of electrophoresis. Sonication.	**15 hours**
	Module IV: Practicals 1. Beer-Lambert's Law verification using spectrophotometry / colorimetry. 2. Study of absorption spectra over UV and visible range with an appropriate sample. 3. Preparation of burette and syringe chromatographic columns (Silica/ cellulose column) 4. Demonstration of PAGE assembly and electrophoretic run for the separation of proteins. 5. Demonstration of separation of DNA using Agarose Gel Electrophoresis.	**30 hours**

	6. Study of different types of centrifuge rotors. 7. Study of different centrifuges. 8. Study of pH meter assembly. 9. Calibration of pH meters. 10. Calibration of analytical weighing balance. 11. Study of different microscopes- Simple, monocular, binocular compound, inverted and phase contrast. 12. Calibration of micropipettes.	
Pedagogy:	Lectures/tutorials/Videos/ demonstrations.	
References	1. A.J. Ninfa, D.P. Ballou, Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald science press, Inc., 2009. 2. B. Notting, Methods in Modern Biophysics, Springer Verlag Berlin Heidelberg New York, 2009. 3. G.G. Hammes, Spectroscopy for the Biological Sciences, John Wiley & Sons Inc. 2005. 4. J.D. Enderle, Bioinstrumentation. Morgan & Claypool Publishers, 2006. 5. J.G. Webster, Bioinstrumentation. John Wiley & Sons, 2008. 6. K. Wilson, J. Walker, Principles and Techniques of Biochemistry and Molecular Biology, (6th edition), Cambridge University Press, 2018. 7. L. Veerakumari, Bioinstrumentation. PHI Learning Pvt. Ltd., 2019. 8. N. Arumugam, V. Kumaresan, Biophysics and Bioinstrumentation. Anuradha Agencies, 2015. 9. P. Narayanan, Essentials of Biophysics, New Age Int. Pub. New Delhi, 2010. 10. R.F. Venn, Principles and Practice of Bioanalysis, , Taylor and Francis, 2008. 11. R.K. Scopes, Protein Purification Principles and Practice, (3rd edition), , Spring International,1994.	
Course Outcome:	At the end of this course, students will be able to 1. Understand the importance of instrumentation in biological research. 2. Explain the principles and applications of spectroscopic techniques and microscopy. 3. Apply a range of spectroscopic, chromatographic, electrophoretic, and microscopic techniques to analyze and characterize biomolecules, demonstrating a foundation in bioanalytical methods. 4. Critically evaluate experimental setups, troubleshoot potential issues, and adapt bioinstrumentation techniques to address specific research questions.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-261
Title of the Course : Poultry Technology
Number of Credits : 04 (01 T + 03 P)
Effective from AY : 2024-25

Pre-requisites for the Course:	H.S.S.C. in Science discipline.	
Course Objectives:	1. Appraise poultry technology as a viable livelihood option. 2. Develop an understanding of poultry breeds. 3. Understand chick management and health care. 4. Explain poultry products.	
Content:	**MODULE I: Introduction to Poultry Farming.** • Present & future status of Poultry Industry, Importance of Poultry industry in India; Poultry development programmes in India; Classification of Exotic breeds of Fowl (American, English, Mediterranean); Layers & Broilers; Selection of breed for egg production. • Chick management- Deep litter system & Cage system of Housing. Natural & Artificial brooding, Management of Brooder house. Poultry equipments - Brooders, Feeders, Waterers. Layer management & Broiler management (Floor space, feeding space, watering space in deep litter system).	**15 hours**
	MODULE II: Practicals • External Morphology of Chicken & Comb patterns. • Study of poultry birds (Any 4) (ducks, quails, turkeys, Guinea fowls, Chickens). • Study of Chicken breeds- Indigenous (Any 4), Exotic (Any 4) • Study of Poultry diseases. • Study of Ectoparasites & Endoparasites of poultry. • Study of commercial poultry equipments- Brooders, Feeders, Waterers. • Study of structure of egg. • Candling & handling of eggs. • Quality Assessment of eggs. • Study of grading of eggs to meet AGMARK standards. • Study of different types of poultry feed. • Economics of Poultry Farming for 1000/2000 broilers. • Visit to a local Poultry Farm to study management practices (Feed, Water, collection of eggs). • Visit to a local Poultry Farm to study debeaking & vaccination program.	**90 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/ Readings:	1. D. Pandey, Handbook of Poultry and Technology, Agrotech Press Publishers, 2017.	

	2. J. Prasad, Poultry Production and Management, Kalyani Publishers, 2000. 3. M. A. Jull, Successful Poultry Management, Biotech Books, 2003. 4. P. C. Panda; Egg and Poultry Technology, Vikas Publishing House,1995. 5. R. P. Sharma, R. N. Chatterjee, S. V. RamaRao and S.R. Sharma, Poultry Production in India. Indian Council of Agri. Research, New Delhi, 2008. 6. V. Nanda, Meat, Egg and Poultry Science and Technology, I.K. International Publishing House, New Delhi, 2014.
Course Outcomes:	At the end of the course, students will be able to: 1. Identify the various poultry breeds. 2. Assess the quality of poultry products. 3. Explain the various techniques of poultry management. 4. Summarize the importance of poultry technology.

Semester V & VI
Name of the Programme : B.Sc. Zoology
Course Code : ZOO-300
Title of the Course : Molecular Biology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Cell Biology, Genetics and Biochemistry.	
Course Objectives:	1. Acquaint students with basic molecular biology knowledge. 2. Provide the learners with the process of replication of DNA. 3. Understand the processes of transcription and translation in eukaryotes and prokaryotes. 4. Provide the learners with basic skills in molecular biology and handling DNA.	
Content:	**MODULE I: Nucleic Acids and Replication** Discovery of nucleic acids. Nucleic acids (DNA, RNA and their components), B- DNA, A-DNA, Z-DNA. Mechanism of Eukaryotic DNA replication—Initiation, elongation and termination. Concepts of semi-conservative, bi-directional and semi-discontinuous replication, End replication problems and the role of telomerases, overview of DNA repair mechanisms. Differences between prokaryotic and eukaryotic DNA replication.	**15 hours**
	MODULE II: Transcription and Post-Transcriptional Modifications Mechanism of transcription in Eukaryotes—initiation, elongation and termination, steps in the synthesis of the primary messenger RNA transcript. Eukaryotic RNA Polymerases and their role in rRNA and tRNA synthesis. Differences between prokaryotic and eukaryotic DNA transcription. Post transcriptional modifications and processing of eukaryotic RNA-split genes, splicing mechanisms, RNA editing.	**15 hours**
	MODULE III: Translation and Regulation of Gene Expression Genetic code (coding dictionary, degeneracy of code and Wobble hypothesis). Ribosome in Prokaryotes and Eukaryotes. Aminoacyl tRNA synthetases and charging of tRNA. Translation steps of initiation, elongation and termination in eukaryotes. Differences between prokaryotic and eukaryotic translation. Transcription regulation in prokaryotes—principles with examples of *lac* operon and *trp* operon. Transcription regulation in eukaryotes—activators, repressors, enhancers, silencer elements, Genomic methylation, acetylation.	**15 hours**
	MODULE IV: Practicals ● Study and interpretation of DNA replication— using Electron micrographs	**30 hours**

	● Study and interpretation of transcription — using Electron micrographs ● Study and interpretation of translation — using Electron micrographs ● Study and interpretation of split genes— using Electron micrographs ● Study and interpretation of ribosomes (prokaryotic and eukaryotic) using photographs ● Identification and description of B-DNA, Z-DNA and A-DNA using suitable models/Photographs ● Isolation and estimation of DNA from a suitable eukaryotic tissue. ● Isolation and estimation of plasmid DNA from bacteria. ● Isolation of bacterial chromosomal DNA. ● Quantitative Estimation of RNA from eukaryotic cells. ● Determination of molecular weight of DNA (fragments) with the help of DNA ladder by using gel electrophoresis.	
Pedagogy:	● Lectures and class discussions to introduce basic principles and concepts. ● Use of ICT tools.	
References/Readings:	1. B. Alberts, R. Heald, A. Johnson, D. Morgan, M. Raff, K. Roberts, and P. Walter, Molecular Biology of the Cell, 7th Edition, WW Norton & Co, 2022. 2. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, M. Kelsey, K. C. Martin, M. Yaffe, and A. Amon. Molecular Cell Biology, 9th Edition, W. H. Freeman, 2020. 3. P. S. Verma, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand Limited, 2004. 4. R. C. Dubey, A textbook of Biotechnology, 5th Ed. S. Chand & Co. Pvt. Ltd. New Delhi, 2014. 5. R. C. Dubey, and D. K. Maheswari, Practical Microbiology, S. Chand & Co. Ltd, 2007. 6. S. B. Primrose, and R. M. Twyman, Principles of Gene Manipulation and Genomics - 7th Edition. Blackwell Publishing Company, 2006.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the role of Molecular Biology in modern times. 2. Appreciate the role of the genetic material in cells. 3. Explain the various steps of replication, transcription and translation. 4. Perform the basic techniques in molecular biology.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-301
Title of the Course : Human Physiology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Animal Biology.	
Course Objectives:	1. Understanding the physiology of the human body. 2. Familiarising with internal milieu fixity in humans. 3. Develop an understanding of the mechanisms behind physiological processes. 4. Evaluate physiological wellbeing from experimental data.	
Content:	**MODULE I: Digestive system and Muscle Physiology** Organisation and functions of alimentary canal, tongue, pharynx, oesophagus, stomach, small intestine, large intestine. Location and functions of glands associated with digestion- pancreas, liver, and gall bladder, salivary glands. Peristaltic movement of the alimentary canal and its control, control and coordination of secretions of saliva, gastric juice, pancreas. Digestion and absorption of carbohydrates, lipids and proteins. Types of muscles, microscopic and electron microscopic structure of striated, smooth and cardiac muscles. The sarco-tubular system. Properties of muscle, excitability and contractility, all or none law, summation of stimuli, summation of contractions; effects of repeated stimuli; genesis of tetany, onset of fatigue; refractory period, tonicity, contractility, extensibility and elasticity. Muscle proteins, mechanism of muscle contraction and relaxation (Huxley's Sliding filament theory). isometric and isotonic contractions, Electro-myography, Muscle autoimmune disease- Myasthenia gravis	**15 hours**
	MODULE II: Respiratory and Circulatory system Organisation of respiratory system. Mechanism of ventilation, Lung Compliance, elasticity and elastic recoil. Tidal volume, inspiratory and expiratory reserve volumes, residual volume, vital capacity, functional residual capacity, maximum breathing capacity. Ventilation-perfusion ratio. Partial pressure and percentage of respiratory gases in inspired, expired and alveolar air and in blood. Transport of O_2 and CO_2 in blood, O_2 dissociation curve, CO_2 dissociation curve. Regulation of respiration. Hypoxia, asphyxia, dyspnoea, asthma, Lung function test. General pattern of circulation. Hemodynamics- volume, viscosity and stasis, Structure of heart, Origin of heartbeat, Conduction of heartbeat, Cardiac cycle, cardiac output, stroke volume. Regulation of heart function. Blood pressure- systolic, diastolic, mean arterial & pulse pressure, factors controlling	**15 hours**

	blood pressure. Regulation of blood pressure. Ischemia, angiography and angioplasty.	
	MODULE III: Excretory & Reproductive system Organization of urinary system. Gross structure of kidney, Role of kidney in acid base balance and osmoregulation. Structure of nephron and its working, Juxtaglomerular apparatus, Mechanism of formation of urine. Concept of ultrafiltration, glomerular filtration rate. Passive and active tubular transport. Counter-current exchanger and counter multiplier. Regulation of kidney function, Dialysis. Puberty and its control. Ovary: Structure of ovary, Functions of ovary (including hormonal), Folliculogenesis and ovulation, Hormonal control of ovarian functions. Menstrual cycle and its hormonal control. Formation, function and fate of corpus luteum. Testis: Structure of testis, Functions of testis (including hormonal) seminiferous tubules and interstitial tissue of Leydig. Hormonal control of testicular function. Spermatogenesis, spermiogenesis. Eunuchoidism, Cryptorchidism. Pregnancy and Lactation: Pregnancy changes and their hormonal control. Pregnancy tests. Stages of Parturition, Hormonal control of lactation and milk ejection.	**15 hours**
	MODULE IV: Practicals ● To study the pneumographic effects of normal breathing, hyperventilation, talking, laughing, coughing. ● Spirometric measurement of vital capacity of lungs ● Measurement of some common anthropometric parameters - stature, eye height, shoulder height, elbow height, shoulder-elbow length, shoulder breadth, head breadth, head circumference, waist-hip ratio. Calculation of body surface area (BSA) and Body Mass Index from anthropometric measurements ● Determination of muscular efficiency/ fatigue by Ergography. ● Measurement of blood pressure, heart rate, pulse and effect of posture ● Determination of normal and abnormal constituents in urine ● Estimation of serum Creatinine ● Calculate of eGFR. ● Superficial (Plantar/ Abdominal reflexes), Deep (Knee-Jerk/ Biceps and triceps jerk) reflexes ● Determination of muscle strength and endurance by Handgrip Dynamometer ● Determination of VO2 max by Queens College Step test. ● Determination of BMR using predictive equation. ● Demonstration of Blind spot	**30 hours**

Pedagogy:	● Lectures and class discussions to introduce basic principles and concepts. ● Use of ICT tools.
References/Readings:	1. A. C. Guyton, and J. H. Hall, Textbook of Medical Physiology 12th Edn., Saunders/ Elsevier, 2011. 2. A. P. Krishna, Text book of Medical Physiology, Scientific publication, New Delhi, 2015. 3. H. A. Harper, Review of Physiological Chemistry, Marusan Co, 2010. 4. K. E. Barrett, S. M. Barman, S. Boitano, and H. Brooks, Ganong's Review of Medical Physiology, 24th Edition, McGraw-Hill Education, 2011. 5. N. A. John, CC Chatterjee's Human Physiology, 14th Edition, CBS publishers and Distributors, 2022. 6. O. P. Tandon, and Y. Tripathi, Best and Taylor's Physiological Basis of Medical Practices, 13th Edition, Wolters Kluwer (India) Pvt. Ltd, 2011. 7. R. Rhoades, and R. G. Pflanzer, Human Physiology, Saunder College Publishing, 1992. 8. S. Subrahmanian, K. Madhavankutty, and H. D. Singh, Text Book of Human Physiology. S. Chand, 2010.
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the role of different organ systems in the human body. 2. Explain the various physiological processes. 3. Appreciate the working of the human body. 4. Understand the various physiological mechanisms in the human body.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-302
Title of the Course : Histology and Endocrinology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Acquaint the learners with mechanisms of physiological homeostasis. 2. Provide the learners with understanding of the neuroendocrine-target organ communication. 3. Understand the importance of hormones 4. Outline the disorders of endocrine glands.	
Content:	**MODULE I: Evolutionary Significance of endocrine system, Hypothalamus-Hypophysis unit- Histology, Hormones, Physiological Effects, and Disorders** • Homeostasis: Role of endocrine system in maintaining 'fixity of internal milieu' (Maintenance of normal Glycemia, electrolytes balance and calcium) • Types of hormones and mechanisms of hormone action. • Hypothalamo-Hypophysial-Target Organ axis and feedback mechanisms. • Hypothalamic Neurohormones (Hypophysiotropic Hormones) and their sources, communication between hypothalamus and Pituitary (Adenohypophysis and Neurohypophysis), angioarchitecture of hypophysial portal system and its significance. • Divisions of Pituitary and Histology of Adenohypophysial Pars distalis (Tinctorial affinity, Immuno-histochemical typing, Ultrastructural signatures, Immuno-electron microscopy) • Trophic hormones of anterior Pituitary and their targets • Hormones stored and released by Neurohypophysis and their functions. • Disorders caused by excess and deficit of Pituitary hormones: Dwarfism, Gigantism and Acromegaly, Prolactinomas, Diabetes insipidus.	**15 hours**
	MODULE II: Thyroid, Parathyroid and Adrenal Glands: Histology, hormones, Functions and disorders. • Location and Histology of Thyroid Gland • Hormones of the Thyroid gland Tri-iodo-thyroxine (T3) and Tetra-iodo-thyroxine (T4) • Neuro-endocrine mechanism for control of Thyroid function. • Hyperthyroidism and hypothyroidism, Hashimoto's Thyroiditis, Grave's Disease.	**15 hours**

	• Histology of Parathyroid gland (Chief cells and Oxyphil cells and their functions) • Disorders of Parathyroid: Hyperparathyroidism and hypoparathyroidism • Location and histology of Adrenal Gland • Hypothalamic-Pituitary-Adrenal (HPA) Axis • Adreno-cortical hormone secretions (Mineralocorticoids, Glucocorticoids, and sex Hormones) • Adreno-medullary Hormones/ Neurotransmitters (Epinephrine and Norepinephrine) and their functions. • Disorders of Adrenal: Addison's Disease and Cushing's Syndrome.	
	MODULE III: Gonads, Gonadal Hormones and Disorders. • Location, histology, and hypothalamic control of Testes with special reference to endocrine cellular components (Interstitial Cells of Leydig) and their secretion and gametogenic function. • Disorders of Hypogaonadism/ 'low T': Infertility, Gynaecomastia and Erectile Dysfunction • Location, histology and hypothalamic control of Ovaries, Graafian Follicle, its cells and their secretions and gametogenic function. • Endocrine control of Ovulation and Luteinisation. Corpus luteum, Corpus haemorrhagicus and Corpus albicans • Disorders: Amenorrhea (Primary & Secondary), Stein-Leventhal Syndrome, Infertility, Progesterone deficit and miscarriage.	**15 hours**
	MODULE IV: Practicals • Observing histology of - Pituitary Gland - Thyroid Gland - Parathyroid Gland - Adrenal Gland - Testes - Ovaries • Study of location of endocrine gland in a mammalian model • Checking FSL, PPSL, and RSL using a Glucometer • Conducting a Pregnancy Test on a Urine sample • Preparation of permanent slides of endocrine glands (Adrenal and Testes) using Microtomy and staining techniques. • To understand protocols and procedures for surgical ablation of Endocrine glands (adrenalectomy) through videos • In situ study of fish pituitary in any commercial species.	**30 hours**

Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.
References/Readings:	1. A. J. Zeleznik, and T. M. Plant, Knobil and Neill's Physiology of Reproduction, Vol I & II, Raven Press, New York, 2015. 2. C. D. Turner, and J. T. Bagnara, General Endocrinology, Saunders Press, 2012. 3. D. O. Norris, Vertebrate Endocrinology, 5th Edition, Academic Press Inc., 2013. 4. E. J. W. Barington, Hormones and Evolution, Vol I & II Academic Press, New York, 1979. 5. J. F. Laycock, and P. H. Wise, Essential Endocrinology, Oxford University Press, 1996. 6. M. E. Hadley, and J. E. Levine, Endocrinology, 6th Edition. Pearson Education Inc., New Jersey, 2009. 7. S. Melmed, K. S. Polonsky, P. R. Larsen, and H. M. Kronenberg, Williams Textbook of Endocrinology, Saunders Press, London, 2011. 8. S. Nussey, and S. Whitehead, Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers, 2001.
Course Outcomes:	At the end of this course, students will be able to: 1. Appreciate the role of endocrine system in homeostasis. 2. Explain the location and role of major endocrine glands. 3. Analyse the various endocrine disorders. 4. Demonstrate the techniques involved in histology.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-303
Title of the Course : Bio-entrepreneurship
Number of Credits : 02
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Biology.	
Course Objectives:	1. Provide the basics of Bio- entrepreneur skills. 2. Introduce the learners with setting up of a successful Bio-enterprise. 3. Expose the learners with the various schemes/ support provided by Government agencies for setting up of a Bio-enterprise. 4. Develop the knowledge to create a startup plan.	
Content:	**MODULE I:** Concept, nature, scope and philosophy of entrepreneurship- Distinction between self-employment and entrepreneurship. Importance of entrepreneurship and self-employment in India. Bio-entrepreneurship, Process of Entrepreneurship. Competencies of an Entrepreneur, Types of Entrepreneurs, Advantages and Disadvantages of Entrepreneurship. Entrepreneurship in the context of Animal Sciences. Entrepreneurial Opportunity, Perceiving and Sensing Opportunities, Problem Identification, Idea generation, innovation. Funding opportunities for businesses, Central and Sate Government support for establishment of self-employment and entrepreneurial ventures in Life Sciences (fisheries, animal husbandry, mushrooms, poultry, and medicinal gardens).	**15 hours**
	MODULE II: Concept of various Types of business organization - sole proprietorship, partnership, cooperation society, private and public limited companies. Organizational structure & Management; Capital Management; Product innovation and management; Government schemes for commercialization of technology (Biotech Consortium) Intellectual property rights – Patents, Trademarks, Copyrights, Industrial Designs, Geographical Indications, Integrated Circuits, Plant Varieties & Farmers Rights, Trade Secrets Making a business plan for availing financial assistance (loan).	**15 hours**
Pedagogy:	● Lectures and class discussions to introduce basic principles and concepts. ● Use of ICT tools.	
References/Readings:	1. Biotech Consortium India Limited, Bio-entrepreneurship Development-A Resource Book, Biotech Consortium India Limited, 2018 2. C. D. Shimasaki, The Business of Biosciences – What goes into making a Biotechnology Product, Springer-Verlag New York Inc., 2009.	

	3. Entrepreneurship, A study by National Knowledge Commission, 2008. 4. M. J. Ahn, and M. Meeks, Building a conducive environment for life science–based entrepreneurship and industry clusters. Journal of Commercial Biotechnology. Vol 14. No 1. 20–30, 2008. 5. N. Agarwal, India is the nesting ground for young entrepreneurs and new start-ups, International Journal of Applied Research, 1(7): 578-582, 2015. 6. Startup India Action Plan https://www.startupindia.gov.in/actionplan.php
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the basic requirements for setting up of a Bio-enterprise. 2. Ideate plans for bio-entrepreneurship. 3. Evaluate the competencies of an Entrepreneur. 4. Enlist funding opportunities for bio-entrepreneurship in India. 5. Appreciate the protection provided by IPR laws.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-304
Title of the Course : Concepts in Genetic Engineering
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2025-2026

Pre-requisites for the Course:	Basic knowledge of Biochemistry and Molecular Biology.	
Course Objectives:	1. Acquainting students about the role of biotechnology in modern times. 2. Providing students the basic knowledge in the field of Genetic engineering. 3. Providing the learners with basic skills of microbiology and molecular biology. 4. Perform basic experiments in biotechnology.	
Content:	**MODULE I: Introduction to Biotechnology, Prokaryotes and Genetic Engineering** Introduction to Biotechnology: Concept, History, Disciplines, Importance and Scope of Biotechnology. Introduction to microbes, Classification of bacteria, Structure of bacterial cell, Nutritional requirements, Culturing bacteria (media), Bacteria in Biotechnology. E.coli as a model organism for Biotechnology. Genetic Engineering- History and scope. Overview of the steps of Genetic Engineering. Cloning vectors: Plasmids, Cosmids, Phagemids, Shuttle Vectors, Lambda Bacteriophage, M13, BAC, YAC, MAC, pBR, pUC, SV40 and Expression vectors (characteristics).	**15 hours**
	MODULE II: Enzymes of Genetic Engineering, labelling DNA, DNA library, blotting and Screening techniques Restriction enzymes: Nucleases (Endonucleases, Exonucleases, Nomenclature, recognition sites, sequences, cleavage patterns), DNA ligases, Polymerases, Polynucleotide Kinases, Alkaline Phosphatase and Nucleotidyl Transferase. CRISPR technology. Radioactive and non-radioactive Labeling of DNA, Nick translation. Construction of genomic & cDNA libraries. Colony hybridization, Plaque hybridization, Blotting techniques for RNA, DNA and Proteins.	**15 hours**
	MODULE III: DNA sequencing, Finger printing, DNA transfer techniques, Genetically modified organisms PCR technique, Sanger's and Maxam Gilbert method of DNA sequencing, automated sequencing, Human Genome Project (HGP) – an overview of the project, major scientific strategies & approaches used in HGP, benefits of the project, DNA Fingerprinting technique. Transfer of DNA- natural and artificial methods. Genetically modified organisms, Transgenics. Concept of gene therapy and Xenotransplantation.	**15 hours**

	MODULE IV: Practicals • Sterilization techniques. • Gram staining and Negative staining of bacteria. • Preparation of media for cell culture (agar plate, slants, deep). • Isolation and enumeration of bacteria (spread plate and streak plate method). • Methods for preservation of bacterial culture- Glycerol stock culture and stabs. • Biochemical tests: IMViC. • Restriction digestion of suitable DNA sample (plasmid or lambda DNA) by any restriction enzyme followed by gel electrophoresis. • Ligating suitable DNA sample (Restriction digest) followed by gel electrophoresis. • DNA sequencing through charts (Sanger's method).	**30 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. B. Alberts, R. Heald, A. Johnson, D. Morgan, M. Raff, K. Roberts, and P. Walter, Molecular Biology of the Cell. 7th Edition, W.W. Norton & Co., 2022. 2. R. C. Dubey, A textbook of Biotechnology, 5th Ed. S. Chand & Co. Pvt. Ltd. New Delhi, 2014. 3. R. C. Dubey, and D. K. Maheswari, Practical Microbiology, S. Chand & Co. Ltd, 2007. 4. S. B. Primrose, and R. M. Twyman, Principles of Gene Manipulation and Genomics - 7th Edition. Blackwell Publishing Company, 2006. 5. T. A. Brown, Gene Cloning- an Introduction, VNR International Publications, 1990.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the role of Biotechnology in modern times. 2. Appreciate the role of microbes in Biotechnology. 3. Explain the various steps of Genetic Engineering technique 4. Perform the basic techniques in microbiology and molecular biology.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-305
Title of the Course : Evolution
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Understand the principles of evolutionary biology and its application to the diversity and adaptation of animal species. 2. Develop an understanding of genetic variability, isolating mechanisms and natural selection within a population. 3. Learn how changes in the gene pool leads to evolution of species. 4. Understand the Geo-biological history of earth and evolution of horse and man.	
Content:	**MODULE I: Origin of earth and life, Concept and Theories of Evolution** • Origin of earth: Nebular hypothesis and Planetesimal hypothesis; Atmosphere and Energy Sources on Primitive earth. • Origin of Life on Earth (Biopoiesis): • Theory of Special Creation, Theory of Catastrophism, Cosmozoic Theory, Theory of Abiogenesis and Theory of Biogenesis. • Chemogeny; Biogeny; Cognogeny. • Definitions of Evolution, Organic evolution and Evolutionary Biology. Importance of Evolution. • Concise information about- - Pre-Darwinian theories of organic evolution: Francis Bacon's theory, Erasmus Darwin's theory and Lamarck's Theory of inheritance of Acquired Characters - Evolutionary theories since Darwin: Charles Darwin's Theory of Natural Selection, Weismann's theory of continuity of Germplasm, De Vries Theory of Mutation and Modern synthetic theory of evolution (Neo-Darwinism).	**15 hours**
	MODULE II: Mechanisms of Evolution: Variability and Mutations, Natural selection, Isolation, Adaptations, Speciation and Population genetics • Variations: Definition; Nature, kind and sources of variations; Role of variability in evolution. • Natural selection: Definition; Types, nature and working of natural selection; Role of natural selection in evolution. • Isolation: Definition, Brief explanation about isolating mechanism; Role of isolations in evolution. • Adaptations (Brief explanation about all types), Significance in evolution. • Basic Pattern of evolution: Microevolution, Macroevolution and Megaevolution; Convergent and Divergent evolution; Monophyletic & Polyphyletic evolution; Anagenesis,	**15 hours**

	Cladogenesis and Stasigenesis; Bradytelic, Tachytelic and Horotelic mode of evolution. • Speciation: Definition of species and sub species category, Allopatric, Sympatric and Parapatric speciation. • Population genetics: Gene pool, Allele frequency, Genotype frequency, Genetic drift and Hardy- Weinberg equilibrium.	
	MODULE III: Study of Fossils, Geological time scale, Evolution of Horse, Evolution of Man, Mass extinctions • Study of Fossils: Definition; types; formation; determination of age of fossils (Stratigraphy and radioactive clock method); interpretation of fossil records and significance of study of fossils. • Concept of "ontogeny recapitulates phylogeny". • Introduction to Geological time scale: Palaeozoic, Mesozoic and Coenozoic Era. • Evolution of Horse: Place and time of origin, Characteristic features of Dawn horse and Modern horse and Evolutionary trends. Successive stages of horses in Eocene, Oligocene, Miocene Pliocene and Pleistocene periods. • Evolution of Man: Time and place of origin of Man; Characteristic features of Primates; Characteristic features of Ape and Man; Evolutionary trends (Ape like form to Man); Compelling causes of evolution of man. • Common ancestors of apes and man in Oligocene, Miocene and Pliocene: Propliopithecus, Proconsul, Dryopithecus, Ramapithecus, Sahelanthropus tchadensis. • Pleistocene: Australopithecus, Homo habilis, Homo erectus (Java man and Peking Man), Homo sapiens (Neanderthal man, Rhodesian man, Cro-Magnon Man) and Homo sapiens sapiens. • Brief explanation about Mass extinctions: Names of five major extinctions and causes; Role of extinction in evolution.	**15 hours**
	MODULE IV: Practicals • Study of fossils (models/ pictures)-Trilobite, Ammonite, Ostrea, Graptolite, Archaeopteryx (Any four). • To understand evolutionary significance of Homologous organs (Using models/ pictures/Specimens). • To understand evolutionary significance of Analogous organs (Using Models/ Pictures/Specimens). • An exercise to illustrate the concepts of Genetic drift. • Demonstration of role of natural selection in changing allele frequencies using simulation studies. • Study of Prehuman ancestors: Proconsul, Dryopithecus, Ramapithecus and Human ancestors: Australopithecus, Homo habilis, Homo erectus (Java man/ Peking Man), Homo	**30 hours**

	sapiens (Neanderthal man/ Cro-Magnon Man) and Homo sapiens sapiens with the help of models/ pictures. • Study of Macroevolution using Darwin finches (Pictures/ Printed material). • Study of successive stages of evolution of horse with the help of pictures with special reference to limb digits, dentition, brain size and skull: Eohippus, Mesohippus, Merychippus, Pliohippus and Equus. • Problems on Phenotype frequency, Allele frequencies and Genotype frequencies. • Study and verification of "Hardy-Weinberg Law of equilibrium" by Chi-square analysis. • Study of extinct species: Trilobites, Eurypterids and Dinosaurs (with the help of Models/ Pictures). • Study of vestigial organs as evidence of evolution (with the help of models/pictures).	
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. M. P. Arora, Evolutionary Biology, Himalaya Publishing House, Mumbai, 2015. 2. M. P. Arora, and H. Arora, A Text Book of Organic Evolution, Himalaya Publishing House, Mumbai, 2013. 3. T. Dobzhansky, Genetics and Origin of Species, Columbia University Press, 1982. 4. B. K. Hall, and B. Hallgrimsson, Strickberger's Evolution, 5th Edition. Jones and Bartlett Publishers, 2013. 5. A. P. Jha, Genes and Evolution, Macmillan Publishing Company Inc. 2000, 6. R. Mathur, B. S. Tomar, and S. P. Singh, Evolution and Behaviour, Rastogi Publication, 2017. 7. Rastogi VB (2018). Organic Evolution (Evolutionary biology). 13th Edition. MedTech, New Delhi. 8. V. B. Rastogi, Organic Evolution, 3rd Edition, MedTech, 2018. 9. M. Ridley, Evolution, 3rd Edition, Blackwell Publishing, 2004. 10. P. S. Verma, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand Limited, 2004.	
Course Outcomes:	At the end of this course, students will be able to: 1. Gain insights into the origin of life and will analyse and critically view the different theories of evolution. 2. Demonstrate a comprehensive understanding of evolutionary biology, , and the ability to critically evaluate and explain evolutionary processes and patterns. 3. Explain the Geo-biological history of earth. 4. Evaluate the patterns of evolution of horse and human.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-306
Title of the Course : Biochemistry of Metabolic Processes
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Biochemistry and Physiology.	
Course Objectives:	1. Acquaint students about metabolic processes 2. Provide students the basic knowledge of carbohydrate, protein and lipid metabolism. 3. Understand the basic concepts of energy and its production. 4. Perform basic experiments to estimate biomolecules in samples.	
Content:	**MODULE I: Overview of Metabolism and Bioenergetics** Metabolism, Stages of catabolism, Sub divisions of Metabolism, Catabolism vs. Anabolism, regulation of Metabolic pathways, Shuttle systems and membrane transporters. Bioenergetics- Concept of Energy, Laws of Thermodynamics, Free energy, Nucleotides as energy carriers, ATP as "energy currency" of the cell.	**15 hours**
	MODULE II: Carbohydrate Metabolism and Respiratory Chain Sequence of Reactions and Regulation of Glycolysis, Pentose phosphate pathway, Oxidative decarboxylation, Citric acid cycle, Gluconeogenesis, Glycogenolysis and Glycogenesis, Mitochondrial respiratory Chain, Theories of oxidative phosphorylation mechanisms.	**15 hours**
	MODULE III: Catabolism of amino acids: Transamination, Deamination, Urea Cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids, inborn errors of Amino acid catabolism (Albinism, Alkaptonuria, Phenylketonuria). Beta-oxidation of fatty acids – a. Palmitic acid {saturated (C 16:0) b. Linoleic acid {unsaturated (C 18:2) Alpha and Omega oxidation of fatty acids, ketogenesis- Ketogenic and Antiketogenic substances, Regulation of ketogenesis.	**15 hours**
	MODULE IV: Practicals • Estimation of concentration of plasma glucose in the given sample by colorimetric / spectrophotometric method. • Estimation of fatty acids from the given oil/ fat samples by titration method. • Estimation of cholesterol concentration in the given blood sample. • Separation of lipids by thin layer chromatographic method of the given sample. • Separation of amino acids by paper chromatography. • Estimation of glycogen in the given sample by colorimetric / Spectrophotometric method. • Determination of saponification value of oil.	**30 hours**

	• Determination of iodine number of oil. • Detection of SGOT in serum/ tissue. • Estimation of amino acids by Ninhydrin method.	
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. D. Hames, and N. Hooper, BIOS Instant Notes in Biochemistry, 4th Edition, Taylor & Francis, 2011. 2. J. L. Jain, S. Jain, and N. Jain, Fundamentals of Biochemistry, 7th Edition, S. Chand and Co. Ltd., New Delhi, 2016. 3. J. M. Berg, J. L. Tymoczko, G. J. Gatto, and L. Stryer, Biochemistry, 8th Edition, W.H. Freeman and Co., New York, 2015. 4. M. M. Cox, and D. L. Nelson, Lehninger Principles of Biochemistry, 7th Edition, W.H. Freeman and Co., New York, 2017. 5. P. J. Kennelly, K. M. Botham, O. McGuinness, V. W. Rowell, and P. A. Weil, Harper's Illustrated Biochemistry, 32nd Edition, McGraw-Hill Education, 2022.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the intricacies of Biochemistry and Its role in metabolic processes. 2. Analyse and appreciate the energy transduction in biological systems. 3. Correlate the relationship between different biochemical pathways. 4. Perform the basic techniques in estimating important biomolecules from biological material.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-321
Title of the Course : Biostatistics and Data Analytics
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Biology	
Course Objectives:	1. Learn the fundamental concepts of data and methods of data collection. 2. Acquaint the learners with the basic principles of biostatistics and data analytics. 3. Perform and interpret statistical analysis. 4. Provide skills to the learners for the analysis of data.	
Content:	**MODULE I: Introduction to data, its collection, distribution, dispersion in Biological Sciences** Relevance of statistics in biological investigations. Introduction to data, data sets and structure of data sets. Primary, Secondary and Tertiary Data. Methods of Data Collection. Measures of Central Tendency and Location – Mean, Median, Mode and Measures of Location of data- Quartiles, Quintiles, Deciles and Percentiles. Measures of Dispersion – Range Deviation, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Introduction to big data in Zoology (WHO world Datasets, Global Biodiversity Information Facility, eBird).	**15 hours**
	MODULE II: Sampling methods and Data Representation in Biological Sciences Sources of data collection (primary, secondary and tertiary) Census vs. Survey/Sampling. Sampling Designs – Probability (simple, stratified, systematic, cluster, multi-stage) vs Non-Probability Design (convenience, judgmental, quota, and snowball sampling). Sample Size Estimation, Errors in data collection – Sampling vs non-sampling errors with examples. Design of Experiments and Importance of Controls. Types of data distribution and relevance for biological data sets, Frequency Distribution- types, tables, graphs, curves. Techniques of Data Summarisation – Data as text, table (structure of a balanced table) and Graphs (scatter, line, multi-line, bar, multi-column, pie).	**15 hours**
	MODULE III: Data Analytics The meaning of P value and relevance in biostatistics. Concept of parametric and non-parametric tests, Statistical Inference- Null and Alternative Hypotheses, Chi-square tests, Student's t – test, Z-test and F-test, Analysis of variance (ANOVA). Coefficient of Variation- Karl Pearson's Coefficients, Correlation and Concepts of Regression. Introduction to R, Microsoft Excel and SPSS for data analysis (using Biological examples).	**15 hours**

	MODULE IV: Practicals • Data collection using probability and non-probability sampling. (simple, stratified, systematic, cluster, multi-stage, convenience, judgmental, quota). • Finding Mean, Median, Mode of the collected data. • Measuring location of data- Quartiles, Quintiles, Deciles and Percentiles. • Calculating Variance, Standard Deviation of the collected data. • Creating Frequency distribution tables using appropriate data. • Representing frequency distribution of quantitative data. graphically- Bar graphs, Histograms, Pie chart, Frequency polygon • Use of null and alternate hypothesis in Chi square tests- test for independence, goodness of fit. • Use of Student's t-test to compare the means of two groups. • Use of ANOVA. • Use of Z score to compare a sample and population. **Practicals to be conducted using Microsoft Excel or other analytical software.**	**30 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. A. P. Gore, and S. A. Paranjpe, A course on Mathematical and Statistical Ecology, Kluwer Academic Publishers, 2001. 2. C.R. Kothari, Research Methodology: Methods and Techniques, 2nd Edition, New Age International Publishers, 2004. 3. J. H. Zar, Biostatistical Analysis, Pearson Education India, 1999. 4. N. Gurumani, Research Methodology for Biological Sciences, MJP Publishers, 2008. 5. P. Legendre, and L. Legendre, Numerical Ecology - 3rd Edition. Elsevier, 2012.	
Course Outcomes:	At the end of this course, students will be able to: 1. Gain insights into types of data and data collection. 2. Collect valid data for the purpose of stated research questions and testing hypothesis. 3. Identify appropriate sampling and data representation methods.. 4. Apply appropriate statistical tools for data analysis.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-322
Title of the Course : Environmental Impact Assessment
Number of Credits : 04 (03T+01P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Environmental Sciences.	
Course Objectives:	1. Acquaint the learners with an understanding and appreciation of impacts on the environment of developmental activities. 2. Familiarize with the impact appraisal methods and mitigation approach relevant to our country. 3. Understand the working of different organizations / groups involved in EIA. 4. Invest in future environment-friendly citizenry.	
Content:	**MODULE I: Introduction to Environmental Impact Assessment** • Link between Environmental Impact Assessment (EIA) and Sustainable Development. • Global overview of genesis, history, and progression of EIA. • Evolution of EIA in India, purpose, and principles of EIA. • EIA Notification 2006 and Institutional Framework for conduct of EIA in India: • Constitution and role of • Expert Appraisal Committee (EAC), Ministry of Environment Forests and Climate Change, Govt. of India (MoEFCC, GoI). • State Environmental Impact Assessment Authority (SEIAA). • State Experts Appraisal Committee (SEAC). • Project Categories. • Public Participation / Consultations in key stages of EIA and benefits thereof. • Salient features of Draft EIA notification 2020.	**15 hours**
	MODULE II: EIA process and Environmental Clearance (EC) • Flowchart of a Generalized EIA process. • Application for EC, project profile and feasibility report. • Screening: Purpose and screening methods. • Scoping: Role and purpose of Scoping in EIA, Guiding principles, and objectives of scoping. • Standard Terms of References (ToR). • Brief idea of Types of Environmental Impact Assessments (Rapid EIA, Comprehensive EIA, Cumulative Impact Assessment, Strategic EIA, Regional and Sectoral EIA, Project level EIA and Life Cycle Assessment). • Identification and consideration of alternatives. • Environmental Impact Assessment Methods by Checklists, Matrices, Networks, Map Overlays and Geographic information system (GIS). • Procedure for Public Consultation and participation.	**15 hours**

	• Appraisal by EAC/SEAC. • Grant or Rejection of Environmental Clearance (EC) • Cancelation, validity, and transfer of Environmental Clearance. • Environmental Management Plan (EMP). • Post EC Monitoring. • The convention of Environmental Impact Assessment in a Trans-boundary Context.	
	MODULE III: Functional Areas in EIA and capacity building for quality appraisal and accreditation of EIA consultants • A brief idea of the 12 Functional Areas in EIA and scope of work in baseline data collection, Impact assessment and mitigation. • Land use, Air pollution monitoring, prevention, and control, Meteorology, air quality modelling and prediction, Water pollution monitoring, prevention and control, Ecology and biodiversity, Noise and vibration, Socioeconomics, Hydrology, Ground water and water conservation, Geology, Soil conservation, Risk assessment and hazard management. • QCI-NABET as an Accreditation agency for EIA Consultants and its role in fair and transparent EIA. • Brief idea of accreditation process, and cycles. • Requirements of accreditation and Key persons in an EIA Consultancy (EIA Coordinator, Associate EIA Coordinator, Functional Area Experts, Functional Area Associates, Team members and Mentors). • Fraudulent data, the confidentiality clause and punitive action for misconduct by EIA Consultants. • A Critical Evaluation of Environmental Impact Assessments: A Case Study of Goa Mines, India.	**15 hours**
	MODULE IV: Practicals • Measuring the sound levels in control and noisy sites especially during the festive season using portable digital Sound Level Meter/ Decibel Meters. The sound levels shall be compared with prescribed dB level limits. • Measuring the wind Speed and Direction using Portable Anemometer. • To quantify SPM (Surface Particulate Matter) using Wash-Off method on Leaves of any three road side trees. • Testing water for Hardness, pH, TDS, and *E. coli*. • Preparing an inventory of local tree Species for Green Belt Plantation in the following sectors. • Mining • Common Municipal Solid Waste Treatment Facility	**30 hours**

	• Calculating Density, Frequency & Abundance of flora in a plot using Quadrate sampling (For assessment during examination, compiled data be provided). • Determining of Important Value Index (IVI) of different plant species in a forest /garden plot. • Prepare a Concise Wildlife Conservation Plan for any two IWPA Schedule I mammalian species found in Goa. • Critical analysis of EIA Report of any B1 category Project from any sector (Report can be accessed from public domain). • Visit to any NABET accredited EIA consultancy firm in Goa/ to get acquainted with EIA process and submission of report (in absence of EIA Consultancy firm, a Virtual session be organised).	
Pedagogy:	• Lectures, Videos, Laboratory Assignments, Field Work, Visits to EIA Consultancy Organisation. . • Use of ICT tools.	
References/Readings:	1. B. Marriott, Environmental impact assessment: a Practical Guide, McGraw-Hill, 1997. 2. C. H. Eccleston, Environmental Impact Assessment: A Guide to Best Professional Practices, CBS Publications, New Delhi, 2011. 3. G. Colombo, Environmental Impact Assessment, Springer, New York, 1992. 4. N. S. Raman, A. R. Gajbhiye, and S. R. Khandeshwar, Environmental Impact Assessment, I. K. International Publishing, 2014. 5. N. S. Raman, A. R. Gajbhiye, and S. R. Khandeshwar, Environmental Impact Assessment, L. K. Intl. Publ. House, New Delhi, 2014. 6. P. Morris, and R. Therivel, Methods of Environmental Impact Assessment, 3rd Edition, Routledge, 2001. 7. P. R. Trivedi, Environmental Impact Assessment, APH Publ. Corp., New Delhi, 2012. 8. R. K. Morgan, Environmental Impact Assessment: A Methodological Perspective, Chapman and Hall, 1999. 9. R. Therivel, and G. Wood, Methods of Environmental and Social Impact Assessment, 4th Edition, Routledge, Taylor and Francis Group, New York, 2017.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand relevance of EIA to India's fast pace of development. 2. Acquire applied knowledge of EIA and contribute effectively to appraisal of developmental projects. 3. Gain hands-on experience in conducting environmental risk assessments. 4. Appreciate EIA proceedings.	

Semester VII & VIII
Name of the Programme : B.Sc. Zoology
Course Code : ZOO-400
Title of the Course : Developmental Biology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Cell Biology, Genetics and Biochemistry.	
Course Objectives:	1. Provide a comprehensive understanding of the concepts of early animal development 2. Compare and contrast various events that occur during gametogenesis, cleavage formation and fertilization. 3. Critically assess the current scientific literature on topics related to developmental biology. 4. Understand embryological processes through direct observation of chicken eggs.	
Content:	**MODULE I: Basic concepts of Developmental Biology** Gametogenesis: Spermatogenesis, Oogenesis; Types of Eggs and patterns of cleavage. Fertilization: Definition, activation and Amphimixis. Prevention of polyspermy: Fast block and slow block to polyspermy. Types of Fertilization, Significance of Fertilization. Blastulation, Gastrulation, Fate of Germ Layers and Fate maps.	**15 hours**
	MODULE II: Early Embryogenesis Embryonic induction: Types, Concept of primary organizer, Experiments by Brachets, Spemann, and Mangold, Characteristics of an organizer, Neural induction mechanism-Surface interaction and chemical interaction, Gradient theory of neural induction; Secondary, Tertiary and Quaternary organizers, Eye as an example of sequential induction. Structure of hen's egg, Development of chick embryo up to 3 days of incubation. Extra-embryonic membranes of chick (structure and functions of yolk sac, Amnion, Chorion and Allantois); Major structural types and functions of placenta in mammals.	**15 hours**
	MODULE III: Regeneration, teratogens and Assisted Reproductive technologies (ART) Regeneration: Definition and types, Regeneration in invertebrates (Stentor) and vertebrates (Newt), Mechanism of regeneration, Polarity in regeneration. Apoptosis. Concept of Teratogens and stage sensitivity of foetus, twins – Identical, fraternal, and conjoined - equal and unequal. Infertility, Artificial Insemination, ART (Assisted Reproductive Technologies): Surrogacy, IVF (In vitro Fertilization) and Test tube babies, GIFT (Gamete Intra-Fallopian Transfer) ZIFT (Zygote Intra-Fallopian Transfer) ICSI (Intra-Cytoplasmic Sperm Injection).	**15 hours**

	MODULE IV: Practicals • Observation of developmental stages of frog's egg: cleavage, blastula, gastrula (from permanent slides). • Study of morphogenetic movements in hen's egg using vital staining technique. • In vitro observation of the different extra embryonic membranes in a 6 days old chick embryo. • Mounting of eye vesicle and limb buds of a 6-day old chick embryo. • Preparation and observation of permanent slides of chick embryo (24 hrs, 36 hrs, 48 hrs, 72 hrs). • To study the regenerative ability in vertebrates (fish fin). • Effect of retinoic acid in early development of chick embryo (*in vivo*).	**30 hours**
Pedagogy:	3. Lectures and class discussions to introduce basic principles and concepts. 4. Use of ICT tools.	
References/Readings:	1. B.M. Carlson, Patten's Foundation of Embryology, McGraw Hill Inc., USA, 2014. 2. J. M. W. Slack, Essential Developmental Biology, Wiley Publication, USA, 2012. 3. L. Wolpert, C. Tickle and A.M. Arias, Principles of Development, Oxford University Press, 2019. 4. M. Barresi, and S. F. Gilbert, Developmental Biology, 13th Edition, Oxford University Press, U.K., 2023. 5. S.A. Moody, Principles of Developmental Genetics, Academic Press., New York, 2015. 6. S.F. Gilbert, Developmental Biology, 10th Edition, Sinauer Associates Inc., 2016. 7. S.F. Gilbert, Developmental Biology, 8th Edition, Sinauer Associates Inc., 2006. 8. S.F. Gilbert, Developmental Biology, 5th Edition, Sinauer Associates Inc., 2003.	
Course Outcomes:	At the end of this course, students will be able to: 1. Compare and contrast various events that occur during gametogenesis, cleavage and fertilization. 2. Understand the stages early animal development. 3. Analyse the role of organiser and embryonic induction. 4. Evaluate the process of regeneration, teratogens and assisted reproductive technologies.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-401
Title of the Course : Haematology and Immunology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Cell Biology and Genetics.	
Course Objectives:	1. Comprehend haematological concepts and immune system fundamentals for medical, veterinary or research careers. 2. Understand the mechanisms of action of various immune cells. 3. Provide immune system knowledge for better healthcare and research. 4. Attain proficiency in immunology and hematology laboratory skills.	
Content:	**MODULE I: Haematology** Composition and functions of Blood- Formed Elements and Plasma. Composition of Plasma- Inorganic and Organic content. RBCs, WBCs, platelets- functions and clinical significance of complete blood count (including differential count). Erythropoiesis, Leucopoiesis, thrombopoiesis, Mechanism of blood clotting and the factors affecting it, Clotting time, bleeding time, Erythrocyte Sedimentation Rate (ESR). Blood volume: Total quantity and regulation; haemorrhage, bleeding disorders- Haemophilia and purpura.	**15 hours**
	MODULE II: Immunology Innate immunity - Definition, factors affecting innate immunity, Mechanisms of innate immunity - First line of defence - physical and chemical barriers; Second line of defence - phagocytosis, inflammatory responses and fever, complement system- Classical and alternative pathways. Adaptive or Acquired immunity- Antibody mediated and cell mediated immunity; Active Acquired immunity - Natural and Artificial; Passive Acquired immunity - Natural and Artificial. Organs of immune system - Primary: Thymus and bone marrow Secondary: Lymph nodes and spleen. Cells of immune system - B cells, T cells, null cells, macrophages, natural killer cells, dendritic cells and mast cells, Antigens: Definition and properties, haptens, Antibodies: basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE.	**15 hours**
	MODULE III: Haemotological Abnormalities and Immunological Responses Abnormalities in the structure of RBC (Hemoglobinopathies, Cytoskeletal abnormalities, Enzymopathies), Anaemia – types, Haemoglobin: Structure, formation and degradation; variants of haemoglobin (foetal, adult). General features of antigen-antibody interaction, Hypersensitivity- types, Immune Deficiencies: Introduction, primary and secondary deficiencies. T-cell, B-cell and combined	**15 hours**

	immunodeficiencies, Compliment system deficiency. Acquired Immunodeficiency Syndrome, Severe Combined Immunodeficiency (SCID). Auto immunity: Introduction, Auto recognition, classes of auto immuno diseases. (Thyrotoxicosis, Systemic Lupus Erythematosus, Rheumatoid Arthritis).	
	MODULE IV: Practicals • RBC count using hemocytometer. • Total WBC count using hemocytometer. • WBC Differential count. • Erythrocyte Sedimentation Rate (ESR). • Packed Cell Volume (PCV). • Estimation of Haemoglobin (Hb) using Sahli's method. • Mean Cell Haemoglobin and Mean Cell RBC volume. • Colour Index and Volume Index of RBC. • Osmotic fragility of RBC. • Immunodiffusion. • Single Radial Immunodiffusion. • Ouchterlony double diffusion. • Detection of Human Chorionic Gonadotropin (HCG). • Haemagglutination tests for identification of human blood groups.	**30 hours**
Pedagogy:	5. Lectures and class discussions to introduce basic principles and concepts. 6. Use of ICT tools.	
References/Readings:	1. A. K. Abbas, A. H. Lichtman, and S. Pillai, Basic Immunology: Functions and Disorders of the Immune System, Elsevier, 2018. 2. A. V. Hoffbrand, and P. A. H. Moss, Essential Haematology, Wiley-Blackwell, 2015. 3. C. D. Stevens, Clinical Immunology and Serology: A Laboratory Perspective, F.A. Davis Company, 2017. 4. D. Male, J. Brostoff, D. Roth, and I. Roitt, Immunology, Elsevier, 2017. 5. E. D. Hsi, and C. B. Tornóczky, Hematopathology: A Volume in the Series: Foundations in Diagnostic Pathology, Elsevier, 2017. 6. E. M. Keohane, L, Smith, and J. M. Walenga, Rodak's Hematology: Clinical Principles and Applications, Elsevier, 2019. 7. I. M. Roitt, P. J. Delves, and S. J. Martin, Essential Immunology. Wiley-Blackwell, 2017. 8. J. Owen, J. Punt, and S. Stranford, Kuby's Immunology, W.H. Freeman & Company, 2019. 9. K. Murphy, C. Weaver, and A. Mowat, Janeway's Immunobiology, Garland Science, 2017. 10. M. L. Turgeon, Clinical Hematology: Theory and Procedures, Lippincott Williams & Wilkins, 2019. 11. R. Coico, G. Sunshine, and E. Benjamini, Immunology: A Short Course, Wiley, 2014.	

	12. R. Hoffman, E. J. Benz Jr., L. E. Silberstein, Hematology: Basic Principles and Practice, Elsevier, 2018. 13. R. Nairn, and M. Helbert, Immunology for Medical Students. Churchill Livingstone, 2019. 14. R. R. Rich, T. A. Fleisher, W. T. Shearer, Clinical Immunology: Principles and Practice, Elsevier, 2019. 15. R. S. Geha, and L. D. Notarangelo, Case Studies in Immunology: A Clinical Companion, Garland Science, 2014. 16. S. B. McKenzie, L. Williams, and B. B. Frei, Clinical Laboratory Hematology, Pearson, 2019.
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the constituents and blood and immune system. 2. Analyse natural and acquired immune responses. 3. Distinguish between normal and abnormal haematological parameters. 4. Understand the haematological abnormalities and anomalies in immunological responses. 5. Perform precise lab procedures applicable to clinical, biotech, or research settings with efficiency.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-402
Title of the Course : Parasitology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Acquaint the learners with an understanding and appreciation of parasites of relevance to Indian subcontinent. 2. Identify parasites of relevance to the Indian subcontinent. 3. Impart knowledge of transmission dynamics of parasites. 4. Understand the health effects and prophylaxis of parasitic infections relevant to Indian subcontinent.	
Content:	**MODULE I: Introduction to Parasitology** • Parasitism as a kind of 'ecological relationship'. • Components of a 'Parasite-Host system': Parasite and types (Obligate, Facultative, Accidental, Ectoparasite, Endoparasite), Host and Vector, Brief idea of Zoonotic and Anthroponotic parasites. • Technical Glossary: Prevalence, Trophozoite, Infective Stage, Incubation period, Intermediate & Definitive Host, Paratenic host, Portal of transmission, Pathogenesis, Prognosis, Diagnosis, Prophylaxis. • Overview of parasitic adaptations: morphological investments, biochemical mechanisms for invasion, complex life cycles and transmission opportunities, immune evasion. • Summary of direct (mechanical injury, effect of toxins, spoliative effect) and indirect effects (immune reactions, reactive hyperplasia) of parasite on host. • Reflection on historical aspects of medical parasitology. • Factors that predispose to parasitic diseases (International Travel, Contamination of water and food, immigration from endemic areas, pets, immunosuppressive drugs and climate change). • Connect between poverty and parasites. • Portals of parasitic transmission: Peroral, Percutaneous, Vectors, Sexual, Transplacental, Airborne.	**15 hours**
	MODULE II: Protozoan Parasites of Medical Importance With reference to a) Epidemiology b) Vectors & Hosts c) Morphology of various stages and Life Cycle d) Portal of Transmission, Infective stage & Incubation Period e) Parasitic Pathogenesis & Clinical Presentation f) Diagnosis g) Prophylaxis h) Treatment	**15 hours**

	The following parasites shall be discussed. 1) *Entamoeba histolytica* 2) *Plasmodium vivax* 3) *Trichomonas vaginalis* 4) *Leishmania donovani* 5) *Toxoplasma gondii*	
	MODULE III: Helminth Parasites of Medical Importance **With reference to** a) Epidemiology b) Vectors & Hosts c) Morphology of various stages and Life Cycle d) Portal of Transmission, Infective stage & Incubation Period e) Parasitic Pathogenesis & Clinical Presentation f) Diagnosis g) Prophylaxis h) Treatment The following parasites shall be discussed. 1) *Taenia saginata* 2) *Ancylostoma duodenale* 3) *Enterobius vermicularis* 4) *Ascaris lumbricoides* 5) *Wuchereria bancrofti*	**15 hours**
	MODULE IV: Practicals • To study prevalence of isopod parasite *Norileca indica* infestations in Indian Mackerel. • To study protozoan parasites from the gut of American Roach *Periplaneta americana*. • Study morphology of Trophozoites and cysts of *Entamoeba histolytica* from permanent slide. • To observe microfilariae of *Wuchereria bancrofti* in blood smear of a permanent preparation. • Study of Malarial parasite in fixed blood smear. • Study sexual dimorphism in preserved specimen of *Ascaris lumbricoides*. • Study of Scolex and Proglottids in preserved specimen of *Taenia saginata*. • Survey of prevalence of parasitic diseases in your locality through consultations with local pathology laboratories. • Design and conduct awareness program towards community prophylaxis against parasitic infestations in your institute. • Survey of traditional deworming practices in local community. • Visit to a modern Pathology Laboratory to get familiar with routine procedures for diagnosing blood and gut parasites.	**30 hours**

Pedagogy:	1. Lectures, videos, Assignments, Community engagement, Pathology Laboratory visits. 2. Use of ICT tools.
References/Readings:	1. C. K. Jayaram Paniker, Text book of Medical Parasitology, 6th Edition, Jaypee Brothers Medical Publishers (P) Ltd, 2007. 2. F. E. G. Cox, Modern Parasitology: A Textbook of Parasitology, 2nd Edition, Blackwell Science Ltd., 1993. 3. K. D. Chatterjee, Parasitology Protozoology and Helminthology, 13th Edition, CBS Publishers & Distributors Private Limited, 2019. 4. L. S. Roberts, and J. Janovy, Foundations of Parasitology, 9th Edition, McGraw Hill, 2012. 5. S. S. Apurba, and S. Bhat, Essentials of Medical Microbiology, 3rd Edition, Jaypee Brothers Medical Publishers, 2020. 6. V. D. Suryawanshi, and D. S. Kharate, Advances in Parasitology Protozoology & Helminthology, Orange Books Publication, 2021.
Course Outcomes:	At the end of this course, students will be able to: 1. Identify and describe parasites as well as their life cycle relevant to the Indian subcontinent. 2. Understand basics and applied knowledge of tropical parasites. 3. Appreciate the impact of parasites on public health. 4. Put in place measures for personal and community prophylaxis against parasites of Indian subcontinent.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-403
Title of the Course : Environmental Biology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Cell Biology, Genetics and Biochemistry.	
Course Objectives:	1. Learn the concepts of Environmental Biology. 2. Acquaint learners with concepts of population and community dynamics. 3. Provide understanding on critical aspects of conservation biology. 4. Understand the health of the environment through basic field experiments.	
Content:	**MODULE I: Introduction to Environmental Biology & Natural Resources** Definition of ecology and Environmental Biology, brief concept of Ecological scales: levels of organizations (species to biosphere). Ecosystem structure & function. Introduction to natural resources, resource cycle, mineral resources (Distribution and classification of minerals, mineral wealth of India), Marine living resources, Energy resources (Renewable & Non-renewable), Nuclear energy (Uranium & Thorium), Forest resources, Soil erosion & soil conservation.	**15 hours**
	MODULE II: Population & Community Dynamics Introduction to population ecology, density, natality, mortality, fecundity, survivorship curves and life tables, age distribution of population, Age pyramids, Sex ratio, Biotic potential and Environmental resistance, Density maxima of a population, Growth forms and Growth rate of population. Population dispersion: Emigration, Immigration, Migration. Regulation of Population size. Community Succession- Introduction, Types of Succession, Hydrosere, Lithosere, Xerosere, Concept of Climax communities.	**15 hours**
	MODULE III: Conservation Biology History, scope and Global conservation efforts, India's Biodiversity: Megadiversity status and Biodiversity Hotspots, Concerns and conservation challenges (Proximate & Root causes of biodiversity loss), Global conservation priorities and IUCN Conservation categories, IUCN-Red Data Book, Drivers of Extinction, Extinct Indian species, Re-introduction of species: a case study of re-introduced Cheetah in India. In-situ and ex-situ conservation: wildlife protected Areas, Role of Government and NGOs in wildlife conservation. Strategic species concept: Keystone species, Indicator species, Umbrella species and Flagship species. Restoration Ecology: Scope and Application.	**15 hours**

	MODULE IV: Practicals • Determination of Hardness in given water sample. • Determination of Calcium in given water sample. • Estimation of Total Dissolved Solids in given water sample. • Determination of Dissolved Oxygen from given water sample. • Determination of Dissolved Carbon Dioxide from given water sample. • Estimation of inorganic phosphate in the given water sample by spectrophotometric method. • Identification & Characterization of any five common mineral resources of Goa. • Determination of species density (Sample Area Plot) and Richness (using Chao Estimators) by simulation (Printed sample data to be provided). • Tricho-taxonomical catalogue of captive wild ungulate mammalian species found in Goa. • Study of strategic species concept using photo images. • Visit to a sanctuary/Biodiversity park /Zoo / Community conserved area.	**30 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. H. D. Kumar, Modern Concepts of Ecology, 8th Edition, Vikas Publishing House Pvt. Ltd., Mumbai, 2014. 2. J. S. Singh, S. P. Singh, S.P., and S. R. Gupta, Ecology, Environmental Science & Conservation, S. Chand & Company Pvt. Ltd., New Delhi, 2014. 3. M. P. Arora, Ecology, Himalaya Publishing House, New Delhi, 2004. 4. P. D. Sharma, Ecology and Environment, 11th Edition, Rastogi Publications, Meeru, 2007. 5. P. S. Verma, and V. K. Agarwal, Environmental Biology (Principles of Ecology) S. Chand Publications, New Delhi, 2017.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the importance of natural resources. 2. Explain population & community dynamics. 3. Appreciate the importance of conservation biology. 4. Analyze data of physico-chemical parameters of the environment.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-404
Title of the Course : Research Methodology
Number of Credits : 04
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoological research.	
Course Objectives:	1. Learn the fundamental concepts of research methodology. 2. Understand the concepts of data collection. 3. Acquaint the learners with the basic principles of biostatistics and data analytics. 4. Provide skills to the learners for the analysis of data.	
Content:	**MODULE I: Introduction to research methodology** Research and Scientific Method, Types of Research, Significance of Research, Selecting a Research Problem, Research Design, Criteria of Good Research, defining and delimiting Research problem, Formulation of Hypothesis, Procedure for Hypothesis Testing, Null hypothesis, Literature review, research methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive.	**15 hours**
	MODULE II: Data and its Collection Sources of data: primary, secondary and tertiary, Types of data: Nominal and ordinal, Data collection: observation, field investigations, experimental observations, Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, types of sampling designs: Non-probability sampling, Probability sampling; Primary data, Secondary data, tools and methods of data collection, Sampling Distribution, data compilation, tools in data analysis, Descriptive Analysis and Inferential Analysis.	**15 hours**
	MODULE III: Statistical Analyses Descriptive statistics: Measurement Scales, Sources of error in measurement. Measures of central Tendency (Mean, medium, Mode), Measures of dispersion (range, mean deviation, standard deviation) Inferential statistics: Normal Probability Curve- Meaning, characteristics and applications. Standard error, Confidence Intervals, Type I and Type II errors, Pearson's Correlations, Significance of correlation, Concept of Variance, Analysis of Variance (ANOVA), Testing the Significance of difference between means ('t' test), Non-Parametric Statistics: Sign Test, Mann- Whitney U Test, Kruskall-Wallis test, Characteristics and applications.	**15 hours**
	MODULE IV: Scientific Writing Importance of effective communication, Interpretation of results; Graphical representation of Data, Processing of data, Types of Reports, Layout of a Research Paper, Writing Format and style, Literature review, Major findings, Discussion,	**30 hours**

	Conclusions and suggestions, Citation and styles of references and Bibliography, Ethics in writing and publishing, Scientific misconduct, Journal publication processes and Journal Metrics.	
Pedagogy:	1. Lectures, presentations, videos, assignments. 2. Use of ICT tools.	
References/Readings:	1. C.R. Kothari, Research Methodology: Methods and Techniques, 2nd ed. New Delhi: New Age International Publishers, 2004. 2. D.M. Hawkins, Biomeasurement: a student's guide to biological statistics, New York: Oxford University Press, 2009. 3. N. Gurumani, Research Methodology for Biological Sciences, New Delhi: MJP Publishers, 2008. 4. T. Greenfield, and S. Greener, Research Methods for Postgraduates, 3rd ed. John Wiley & Sons, Ltd., 2016	
Course Outcomes:	At the end of this course, students will be able to: 1. Perform research work in a scientific and organized manner and produce accurate results. 2. Analyze datasets of their research efficiently. 3. Interpret the results of statistical analyses. 4. Effectively communicate the results in a report / research paper.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-405
Title of the Course : Practical Entomology
Number of Credits : 02 (P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Providing the learners with the skills of collecting and preserving Insects. 2. Familiarize learner with the basic body plan of an Insect. 3. Acquaint the learner with anatomy of various body system of Insects. 4. Impart understanding of Insect habits.	
Content:	**MODULE I: Practicals** 1. Study of basic morphology of an Insect (Cockroach) 2. Study of (at least one) representatives of Insect Orders. 3. Study of diversity of mouth parts of Insects in relation to feeding habits. 4. Collection methods in Entomology. 5. Demonstration of preservation and display methods in Entomology. 6. Mimicry in Insects. 7. Study of Camouflage in Insects. 8. Study of agricultural pest (Any two) 9. Study of common ants of Goa. 10. Demonstration of digestive system of an Insect. 11. Demonstration of respiratory system of an Insect. 12. Demonstration of Nervous system of an Insect. 13. Demonstration of Reproductive system of an Insect. 14. Study of life cycle of Drosophila.	**60 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/ Readings:	1. R.L. Metcalf, W.H. Luckmann, Introduction to Insect Pest Management, 3rd edn, Wiley India Pvt Ltd, 2011. 2. C.L. Metcalf, W.P. Flint, Destructive and Useful Insects, Agri North press, 2018. 3. S.W. Frost, General Entomology, Narendra Publishing House, 1994.	
Course Outcomes:	At the end of the course, students will be able to: 1. Demonstrate the basic skills for collection and preservation of Insects. 2. Summarize the anatomy of various body system of Insects. 3. Explain the habits of Insects. 4. Identify Insect pests and stages of Insect life cycle.	

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-406
Title of the Course : Marine Zoology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Cell Biology, Genetics and Biochemistry.	
Course Objectives:	1. Learn the concepts in marine Ecology. 2. Develop insights into biological oceanography. 3. Provide learners with knowledge on marine animal diversity. 4. Understand the management of sensitive ecosystems such as mangoves and coral reefs.	
Content:	**MODULE I: Introduction to Oceanography and Biological Oceanography** • Sea as a biological environment. • Division of marine ecosystem: Pelagic realm and Benthic realm. • Vertical and Horizontal zonation of Pelagic realm; Vertical zonation according to the light availability; Zonation of Benthic realm according to depth; Zonation of intertidal zone; Substrate Types of Shores (Sandy shore, Muddy shore and Rocky shore). • Concepts of Bays, Lagoons, Estuaries, Sandy shore, Muddy shore, Rocky shore, Mangrove, Coral reefs and Deep sea. • Abiotic factors of Marine ecosystem: Light. Temperature, Salinity, Pressure, Currents, Tides, DO2, CO2, Salinity, Organic and Inorganic nutrients. • Benthopelagic nutrient coupling through upwelling. • Marine biotic diversity: Plankton, Nekton, Benthos.	**15 hours**
	MODULE II: Ecological adaptation, Defence mechanism, Animal Association • Marine Fauna Ecological adaptations: Planktons; Intertidal, oceanic and deep-sea communities. • Movement: Tidal drift and migration in marine fauna. • Defence mechanism: Schooling, concealment silhouette, Speed and maneuverability, Sharp spines and armored scales, Slime and mucus, Ink screens, Mimicry, Chemical based defences. • Animal association in marine environment- Commensalism and Types of commensal relationships (Endoecism, Inquilinism, Phoresis, Epizoism); Mutualism; Symbiosis; Parasitism.	**15 hours**
	MODULE III: Changing Scenario of Seas and Oceans • Impact of climate change. • Terrigenous nutrients, Eutrophication and threat of plastics. • Ballast water and marine bioinvasion.	**15 hours**

	• Violation of Exclusive Economic Zones (EEZ) and fish famines. • International treaties ('High Seas' Treaty and Ballast Water Management Convention 2004) for protecting integrity of marine environments. • Marine species of high conservation value (Olive Ridley turtle, Dugong, Humpback Whale).	
	MODULE IV: Practicals • Qualitative & Quantitative estimation of Zooplanktons using Sedgewick-Rafter. • Study of adaptations of rocky shore fauna. • Study of adaptations of sandy shore fauna. • Study of Foraminiferans from marine sediments. • Study of marine birds & their adaptations (Seagull, sandpipers). • Determination of Salinity of water sample. • Adaptations in planktons & nektons. • Study of threatened marine species (Any four species using pictures / photograph). • Study of commercially important estuarine fish (Grey Mullet, Red Snapper, Sea Bass, Pearl Spot, Whipfin silver-biddy). • Study of mangrove fauna (Mudskipper, Fiddler crabs, Telescopium, Mangrove Clam). • Visit to a turtle nesting site to get familiarized with conservation initiatives.	**30 hours**
Pedagogy:	1. Lectures and class discussions to introduce basic principles and concepts. 2. Use of ICT tools.	
References/Readings:	1. A. K. Upadhyay, and B. C. Joshi, Textbook of Marine Fisheries: Fisheries of World Oceans and India in Perspective, Biotech Books, 2014. 2. C. M. Lalli, Biological Oceanography, Butterworth-Heinemann Ltd, 1999. 3. D. V. Bal, and K. V. Rao, Marine Fisheries of India. Tata McGraw Hill Pub. Co., 1990. 4. H. U. Sverdrup, M. W. Johnson, R. H. Fleming, The Oceans: Their Physics, Chemistry, and General Biology, Prentice-Hall Inc., 1942. 5. K. P. Biswas, A text book of Fish, Fisheries and Technology, 2nd Edition, Narendra Publishing House, New Delhi, 1996. 6. K. Venkataraman, C. Satyanarayana, J. R. Alfred, and J. Wolstenholme, Handbook on Hard Corals of India, Zoological Survey of India, Kolkata, India, 2003. 7. M. B. Nair and D. M. Thampy, Textbook of Marine Ecology, Macmillan, Delhi, 1989. 8. R. Harris, P. Wiebe, J. Lenz, and H. R. Skjoktal, ICES Zooplankton Methodology Manual, Elsevier, 2000.	

Course Outcomes:	At the end of this course, students will be able to: 1. Understand the role of animals in marine ecology. 2. Appreciate the diversity of marine organisms. 3. Explain the various steps concepts on biological oceanography. 4. Understand the importance of mangroves and coral reefs.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-407
Title of the Course : Fish and Fisheries
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Provide students with theoretical and practical understanding of fish and fisheries. 2. Enable students to understand about aquaculture practices. 3. Develop preliminary understanding of fishing crafts & gears. 4. Familiarize with post-harvest technologies.	
Content:	**MODULE I: Introduction Fish and Fisheries** • Definition and Importance of fish and fisheries; Concise information about present status and future Scope for fisheries in India; Types of Fishes (Fin fishes and Shell fishes); Types of Fisheries; Morphology, morphometric and meristic characters of fishes for taxonomy; Classification of fishes based on feeding habit, habitat and reproductive strategies. • Exclusive Economic Zones (EEZ); Environmental factors (Temperature, Oxygen, Upwelling, Primary Production) influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal, Depletion of fishery resources, Concept of Mean Sustainable Yield (MSY) and Catch per Unit Effort (CPUE). Indian National Centre for Ocean Information Services (INCOIS) programme and Indian fisheries, Fish Finder Technology; Mesh size regulation and maritime ban on inshore fishing.	**15 hours**
	MODULE II: Capture Fisheries • Definition of Capture fisheries. Introduction to Fishing crafts (Traditional and Mechanised), Fishing Gears of Goa (Active and Passive) used and chief fishing methods- Trawling, Shore seine (Ramponn operation), Purse seining. • Introduction to fishery importance of marine fin fishes (Indian oil sardine, Mackerel, Pomfret, Bombay Duck, King fish, Shark) and shell fishes (Prawn, Crab, Oyster, Clams, Cuttle Fish) of west coast of India (Goa). • Important Inland fin Fishes: Indian major carps (Catla, Rohu, Mrugal). • Concise study of preservation and processing of harvested fish: Need of preservation and processing. • Preservation methods - Icing, Refrigeration, Deep Freezing, Quick freezing, Freeze-Drying, Salting, Smoking, Drying and Canning. • Processing methods (Preliminary information and usage to be discussed) - Fish meal, Fish body and liver oil, Fish Manure and Guano, Fish Flour and Fish Silage.	**15 hours**

	MODULE III: Culture Fisheries • Introduction: Aquaculture, Advantages and disadvantages of aquaculture. • Types of aquaculture: Freshwater, Brackish water and Mariculture; Extensive, Semi-intensive, Intensive, Super intensive aquaculture, Zero water exchange system; Mono culture, Monosex culture, Polyculture, Composite culture and integrated culture systems. • Pond culture: Site selection, Types of ponds, Preparation of ponds before stocking, Feeding and Water parameters. • Pen and cage culture; Raft culture (used for Green Mussel culture). • Brood stock management and induced breeding in Indian major carps. • Fish diseases: Lymphocystis, Fin Rot, Dropsy. Flukes disease, Ich, Branchiomycosis. • Scope of Fish in research: Transgenic fish, fish as model organism in research.	**15 hours**
	MODULE IV: Practicals • Study of fishes based on the feeding habit: Surface, Column and Bottom feeders (Using fresh/ preserved specimens or pictures/ photographs of fishes). • Study of Morphometric and meristic characteristics of fish and calculate Percentage body proportions of any five morphometric characters versus Total length (TL)/ Standard length (SL). • Study of marine fisheries: Fin fishes (Indian oil sardine, Indian Mackerel, Pomfret, Bombay Duck, King fish, Shark) and Shell fishes (Prawn, Crab, Oyster, Clams, Cuttle Fish) (Using fresh/ preserved specimens or pictures/ photographs). • Study of Indian major carps: Catla, Rohu, Mrigal (Using fresh/ preserved specimens or pictures/ photographs. • Study of fishing crafts used along west coast of India (Goa) by using models/ pictures. • Study of fishing gears used along west coast of India (Goa) by using models/ pictures. • Water quality criteria for Aquaculture: Assessment of pH, Conductivity, Total solids, Total dissolved solids. • Dose determination of Pituitary extract dose for Male and Female breeders for induced breeding in Indian major carp. • Demonstration of induced breeding and hatching of eggs in Indian major carp (video). • Demonstration of Ramponn (Beach seine) operation (video). • Visit to aquaculture unit / fish breeding unit/ Beach seine operation (Submit report).	**30 hours**
Pedagogy:	1. Lectures, presentations, videos, assignments.	

	2. Use of ICT tools.
References/Readings:	1. D. V. Bal, and K. V. Rao, Marine Fisheries of India. Tata McGraw Hill Pub. Co., 1990. 2. FAO. Manual of Seed Production of Carps. FAO Publ., 1992. 3. G. M. Hall, Fish Processing Technology, Springer Science, 1992. 4. I. J. Clucas, Fish Handling, Preservation and Processing in the Tropics. Parts I,II. FAO, 1981. 5. ICAR Aquaculture technologies for farmers, CIFA, Bhubaneswar, 2009. 6. ICAR Handbook of fisheries and Aquaculture, ICAR, 2006. 7. Jhingran V. G. 1991. Fish and Fisheries of India. Hindustan Publ. 8. K. Gopakumar, Text Book of Fish Processing Technology, ICAR, 2002. 9. K. K. Balachandran KK. Post-harvest Technology of Fish and Fish Products. Daya Publ., 2001. 10. P. C. Thomas, S. C. Rath, and K. D. Mohapatra, Breeding and Seed Production of Finfish and Shellfish, Daya Publ., 2003. 11. S. D. Tripathi, and B. K. Sharma, Integrated agriculture-aquaculture, FAO fisheries technical paper, FAO, 2001. 12. S. K. Gupta, and P. C. Gupta, General and applied ichthyology (Fish and Fisheries. S. Chand Company Ltd., New Delhi, 2008. 13. T. V. R. Pillay and M. N. Kutty, Aquaculture- Principles and Practices. Blackwell, 2005. 14. V. G. Jhingran, and R. S. V. Pullin, A hatchery manual for the Common, Chinese and Indian Major Carps. Asian Development Bank, International Center for Living Aquatic Resources Management, Philippines, 1997.
Course Outcomes:	At the end of this course, students will be able to: 1. Gain insights into fish and fisheries. 2. Understand classification of fishes based on feeding, reproductive behaviour and habitat. 3. Analyze the techniques used in capture fisheries. 4. Acquire knowledge on aquaculture and induced breeding of Indian major carps. 5. Apply the techniques used in post-harvest technology.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-408
Title of the Course : Animal Behaviour
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Acquaint the learners with an understanding and appreciation of mechanisms and manifestations of diverse animal behaviours. 2. Impart to the learners, knowledge of basic behavioural science and applications thereof. 3. Understanding complexity of behaviour in higher organisms. 4. Conduct basic experiments to understand behaviour.	
Content:	**MODULE I: Introduction to Science of Animal Behaviour** • From irritability to animal cognition: Evolution of behaviour through the taxonomic hierarchy. • Survival value of behaviour. • Approaches to study of behaviour: Psychological, Neurophysiological and Ethological. • Patterns of Behaviour: Stereotyped Behaviors - Orientation and Reflex. • Individual Behavioural patterns: Instinct and Learned Behaviour. • Associative learning, classical and operant conditioning, Habituation, Imprinting, Releasers /Signalling Devices. • Contributions of Karl Von Frisch, Konrad Lorenz, and Nikollas Tinbergen.	**15 hours**
	MODULE II: Interesting Animal senses and Behaviours • Diverse sensory capacities: a) Vision in ultraviolet band in insects & birds. b) Infrared 'eyes' in Pit Vipers. c) Ultrasonic perception in bats & moths. d) Lateral line organ in fish. e) Chemoreception in moths and Star-nosed mole. f) 'Supernormal' stimuli in Herring Gulls, Oystercatcher and Reed Warbler birds. g) Displacement behaviour in Black headed Gull. h) Vacuum behaviours & Fixed Action Pattern (FAP). i) Deception in animal signalling (Stotting in Thomson's Gazelle & 'Broken Wing' trick in Plovers). j) Mates that mimic food (Spider, Water Mite, Moth). k) Mullerian mimicry in hornet, Cinnabar moth, Gila Monster and Poison arrow frog. l) Food storing behaviour in Marsh Tit and European Nutcracker birds.	**15 hours**
	MODULE III: Behavioural complexity in higher animals • Decision making and motivation.	**15 hours**

	• Skinner Box. • Hormones and reproductive behaviour. • Higher Learning in animals: a) Captive Rook enacting the crow in Aesop's fables. b) Advanced tool use by Caledonian Crows. c) Curious case of 'Clever Hans' the horse that calculated. d) Foraging methods in Capuchin monkeys. e) Termite fishing and nut cracking in Chimpanzees. f) Food washing in Japanese macaques. g) Empathy and cooperation in Chimpanzee troops. h) Cooperation and altruism between non-relatives (Meerkat Sentinel and food donation in vampire bats). i) Siblicide (Egrets and raptors) and infanticide (Lions). j) Complexity of Primate Social Organisation.	
	MODULE IV: Practicals • To study chemotaxis using a laboratory cultured Paramecium. • To study phototaxis using an annelid model. • To demonstrate trail pheromones in food discovery behaviour by ants. • To demonstrate substrate selection behaviour by Crab Spiders. • To observe wing colouration in butterflies to understand mimicry. • To study foraging behaviour of common butterfly species. • To study 'righting response' in crabs. • To observe the construct of nests of Baya Weaver birds as a stereotype innate behaviour. • To study 'proxemics' in different bird species like pigeons, crows, and kites. • To study 'habituation' in spiders / crabs. • Collect abandoned nests/hives of wasps, honeybee for studying architecture. • To assess escaper behaviour in cockroach after ablation of anal cerci. • Study the activity budget of wall lizards. • To observe displacement behaviours in captive animals. • Documenting human facial expression and understanding their relevance in social behaviour. • Documenting bird calls of common species as bioacoustics signature. • Screen films on animal behaviour and have a group discussion on various behaviours seen. **Any 10 of the above can be performed**.	**30 hours**

Pedagogy:	1. Lectures, Videos, Assignments, Community engagement, Pathology Laboratory visits.
References/Readings:	1. J. Alcock, Animal Behaviour, Sinauer Associates Inc., USA, 2005. 2. J. P. Shukla, Fundamentals of animal behaviour. Atlantic, 2023. 3. L. C. Drickamer, Animal Behavior: Mechanisms, Ecology, Evolution, 5th Edition, McGraw-Hill Higher Education, 2001. 4. M. Arora, and H. Arora, Animal Behaviour, Himalayan Publishing House, 2009. 5. Manning, and M. Dawkins. An Introduction to Animal Behaviour. Cambridge University Press, 2015. 6. P. W. Sherman, and J. Alcock, Exploring Animal Behaviour, Sinauer Associates Inc., Massachusetts, USA, 2013. 7. R. Gadagkar, Experiments in Animal Behaviour Cutting-Edge Research at Trifling Cost, Indian Academy of Sciences, 2021.
Course Outcomes:	At the end of this course, students will be able to: 1. Identify the reasons behind various animal behaviours. 2. Understand and gain insights into the Science and applications of animal behaviour. 3. Classify and analyse behaviours of different species. 4. Acquire a deeper understanding of evolution of behaviour culminating in the complex human cognition.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-409
Title of the Course : Toxicology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology.	
Course Objectives:	1. Provide students with theoretical and practical understanding of Toxicology. 2. Enable students to understand about toxicants and their impact on environment and public health 3. Develop preliminary understanding of Xenobiotic translocation, Toxicity tests, Bioassays. 4. Understand the experiments in Environmental Impact Assessment and Risk assessment.	
Content:	**MODULE I: Introduction to Toxicology and Toxicants in Atmosphere** • Definition, Brief history, Branches of toxicology and importance of toxicology. • Toxicants and classification on the basis of sources, Physical state, characteristics and effects, Target organ/system, Use, Toxic effect. • Poisons and toxins: classification of poisons - On the basis mode of action, physical state, Toxico-analytical and Medico-legal classification of poisons (Homicidal, Suicidal, Accidental, Abortifacient and Stupefying poisons) Definition of toxins. • Toxicants in atmosphere- Sources and effects on public health (CO, NO, NO_x, NH_3, SO_2, H_2S, Hydrocarbons, Photochemical products - Peroxyacetyl Nitrate (PAN), and Particulate matter (mist, smoke, fumes and dusts).	**15 hours**
	MODULE II: Xenobiotic Translocation, Toxicity tests, Bioassays • Definitions of xenobiotic, xenobiotic translocation- Absorption, Distribution, Biotransformation (Metabolism), and Excretion. • Accumulation of xenobiotic: Bio-concentration, Bio-accumulation, Bio-magnification. • Toxicity and Toxicity tests: Definitions, Types (Single species, Multi species and Ecosystem tests; Single & Multiple dose tests; Acute toxicity tests (LC_{50}, LD_{50} and EC_{50} value: Definitions and Importance) and Chronic toxicity tests) and their significance in toxicology. • Bioassays: Definition, Types, Classification and significance in toxicology. .	**15 hours**
	MODULE III: Toxicants and radiations • Toxicants in Hydrosphere- Sources and effects on environment and public health: Domestic sewage, Industrial effluents, Detergents, Oils.	**15 hours**

	• Toxicity of heavy metals – Mercury (Minamata Disease), Arsenic (Arsenicosis) and Cadmium (Itai Itai disease). • Food toxicants and effects on public health- Direct and Indirect food additives (Antioxidants, Emulsifiers, Enzymes, Flavouring agents, Colour); Preservatives; Artificial sweetening agents (Saccharin and Urea derivatives) and Food contaminants. • Pesticides: Definition, Classification and toxic effects of pesticides on public health. • Sources of ionising radiations and their effects.	
	MODULE IV: Practicals • Effect of a toxicant on oxygen consumption in fish / bivalves. • Detection of preservatives: Formalin (Leach Test), and Hydrogen peroxide in milk sample. • Determination of LC_{50} / LD_{50} from given data using arithmetic method of Karber. • Determination of LC_{50} / LD_{50} from given data using graphical method (Miller and Tainter). • Tests for detection of Metanil yellow colour and washing soda in jaggery, foreign resin in asafoetida, Argemone oil in edible oils, mixing of other oils in Coconut oil. • Determination of silica in water sample. • Determination of lead in water sample. • Detection of methanol in spurious liquor. • Qualitative detection of heavy metals in Holi colours and Vermilion. • Estimation of chlorides from water sample. • Visit to Pharmacology departments of Pharmacy college or GMC and R & D departments of Pharma or Pesticide industries to get an outline idea of toxicological experiments/ studies undertaken.	**30 hours**
Pedagogy:	1. Lectures, presentations, videos , assignments . 2. Use of ICT tools.	
References/Readings:	1. A. H. Wallace, Principles and Methods of Toxicology, 5th Edition. Informa Healthcare Publication, USA, 2007. 2. A. K. Shukla, A. K., Dixit, and R. P. Sing, Detection of adulterants in edible oils, Journal of Oleo Science, Vol. 54, No. 6, 317-324, 2005. 3. B. Ballantyne, T. Mars, and P. Turner, General & Applied Toxicology, Vol I & II, Macmillan, Stockton Press, 1993. 4. B. Mali, and A. Verma, Comparative Study on Kum kum for Heavy Metal Detection., International Journal of Research Publication and Reviews, Vol 3, no 12, pp 1111-1117, 2022 5. C. Klaassen, and J. J. Watkins, Casarett & Doull's Essentials of Toxicology, 3rd Edition, McGraw-Hill Education, 2015. 6. E. Hodgson, A Textbook of Modern Toxicology, 4th Edition, Wiley Publication, 2010.	

	7. FSSAI, Manual of simple methods of testing common adulterants in food, Food Safety and Standards Authority of India, New Delhi, 2019. 8. G. Pandey, and Y. P. Sahani, Toxicological Laboratory Manual, International E-Publication, India, 2013. 9. J. Timbrell, Introduction to Toxicology, 3rd Edition, Taylor and Francis, 2002. 10. K. Pandey, J. P. Shukla, and S. P. Trivedi, Fundamentals of Toxicology. New Central Book Agency Pvt. Ltd. Pune, 2009. 11. K. Stine, and T. M. Brown, Principles of Toxicology. 3rd Edition, CRC Press, 2015. 12. M. Durrant, Handbook of Clinical Toxicology, Hayle Medical Publishers, 2019. 13. S. C. Gad, and C. P. Chengelis, Animal Models in Toxicology, CRC Press, 1998. 14. S. Dixit, Food Adulteration Testing Manual, Consumer Guidance Society of India (CGSI) 14th Revised Edition, Mumbai, 2019.
Course Outcomes:	At the end of this course, students will be able to: 1. Gain insights into the concepts of toxicology. 2. Understand classification of toxicants, poisons, toxicants in the atmosphere and hydrosphere and their effect on public health. 3. Analyze xenobiotic translocation, toxicity tests and bioassays 4. Acquire knowledge on food additives, radiations and their effect on public health.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-411
Title of the Course : Traditional Ecological Knowledge Systems
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Zoology and local folklore.	
Course Objectives:	1. Identify Traditional Ecological Knowledge (TEK) systems. 2. Explore, express and defend local views on everyday sustainable utilities and practices from the traditional Indian cultures. 3. Critically evaluate the efforts of various organizations in India that have adapted sustainable traditional ecological practices and analyse their impact on the environment. 4. Re-evaluate people's relationship with nature and inculcate the values of respect, responsibility, and reciprocity towards nature.	
Content:	**MODULE I: Introduction to Traditional Ecological Knowledge Systems (TEKS) and Documentation Methods** • Concept of 'Ethnosphere'. • Definition of Traditional Ecological Knowledge (TEK). • Origins of 'Traditional Ecological Knowledge' and its Development as a Field. • Comparison and Relationship between Traditional Ecological Knowledge systems and Western Science. • TEK: From controversy to collaboration. • Significance of Traditional Ecological Knowledge. • An overview of methods of collection of TEK: Ethnographic literature review, Semi-directive Ethnographic interview, Focus Groups, Participatory Culture Watching, Linguistics.	**15 hours**
	MODULE II: Ecological Learning from Indigenous People: Contemporary relevance of Native Knowledge • Indigenous Leadership/partnership in Resource Management, Ecology, Population Dynamics, Zooarchaeology. Morphology, Epidemiology. • Summary accounts of the following examples. 1. Closures of Dungeness Crab (*Metacarcinus magister*) fisheries under indigenous law in British Colombia. 2. Monitoring program for Grizzly bears (*Ursus arctos horribilis*) in coastal British Columbia, under customary law of the indigenous Haíłzaqv people. 3. Habitat models for Woodland Caribou (*Rangifer tarandus caribou*) based on indigenous knowledge from the Taku River. 4. Estimation of Northern Abalone (*Haliotis kamtschatkana*) abundance on the Pacific coast of Canada from the Holocene to the present.	**15 hours**

	5. Māori ancestral sayings that describe the pollination of 'harakeke' the New Zealand flax (*Phormium tenax*) by native 'kākā parrots' (*Nestor meridionalis*). 6. Enawene- Nawe knowledge of diversity and niche occupancy of stingless bees in meridian Amazon of Brazil. 7. Historical baselines in rockfish size based on hand gestures of indigenous people of Western Canada, a key proxy for fecundity and population growth. 8. Veterinary Disease Surveillance system based on indigenous livestock knowledge in eastern Africa. 9. Sacred Groves of Goa: Community Conserved Forests. 10. Crocodile Worship of Goa's agrarian communities: eco-theological basis of conserving an IUCN 'Vulnerable' category reptile. 11. Khejri (*Prosopis cineraria*) forests and the Bishnois of Rajasthan. 12. Knowledge of Soil typing and crop selection by Gonds and Korku tribes of Madhya Pradesh. 13. Perception of climate change by indigenous communities of Indian Himalayas.	
	MODULE III: Traditional Ecological Knowledge in Marine Environment, Protection of Biodiversity related IPR of communities in India • Indigenous people of coastal environments and their stewardship of seas and oceans. • 'Two -Eyed Seeing' approach towards integrating TEKS with Modern Science. • "Waiwai": Protecting Hawaii's Wealth of Coastal Resources. • Traditional knowledge of the fishermen community of Indian Sundarbans. • Ethnic knowledge and cultural dimensions of fisheries in Goa: Conservation of critically endangered Rhino Rays (Guitar fish and Wedge fish) in Goa, India based on traditional knowledge of Fisherfolks. • WWF Coastal communities Initiative. • Protection of Intellectual Property Rights of Locals concerning biodiversity related knowledge and practices under The Biological Diversity Act, 2002 and its amendment.	**15 hours**
	MODULE IV: Practicals • Study of Goa's folklore to list ecological reflections. • Linguistic analysis of Goa's traditional sayings (Mhanni) and Puzzles (Umanni/Parkhonnem) for TEKS. • Traditional indicators of climate change prevalent in Goa's indigenous communities. • Prepare a list of Goa's eco-centric festivals and reflect on their environmental contexts.	**30 hours**

	• Visit to a Sacred Grove to understand the dynamics of this community conserved area. • Visit and interact with members of any ethnic community in your neighbourhood to understand their TEKS. • Study of dietary restrictions and recommendation based on ethnic knowledge of Goa's indigenous communities (any two communities). • Study of 'Cult of Earth worship' in Goa. • Preparing a list of Totemic species of Goa. • Study of Pagan expressions in Goa's Feasts and Festivals. • Study of Goa's agrarian past, sustainable farming practices and implements (Visit to any ethnographic museum).	
Pedagogy:	Lectures, Videos, Assignments, Literature survey, Field Work, Visits to Tribal settlements of Goa.	
References/Readings:	1. A. Varghese, Conservation Through Sustainable Use: Lessons From India. Abingdon, United Kingdom, Taylor and Francis, 2022. 2. B. Singh, Protection of Traditional Knowledge in India. LAP LAMBERT Academic Publishing, 2015. 3. F. Berkes, Sacred Ecology. 4th Edition, Routledge, 2017. 4. K. Ketki, Sustainable Traditional Practices From an Indian Perspective: An Introduction to the Series. https://curiositysavestheplanet.com/sustainable-lessons-from-india-intro/, 8 Apr. 2021, curiositysavestheplanet.com/sustainable-lessons-from-india-intro. Accessed 9 Dec. 2022. 5. M. Nelson, and D. Shilling, Traditional Ecological Knowledge: Learning From Indigenous Practices for Environmental Sustainability. Cambridge, United Kingdom, 2018. 6. M. Verma, Environment, Development and Sustainability in India: Perspectives, Issues and Alternatives, Springer, 2022. 7. N. Krishna, Ecological traditions of Goa, CPR Environmental Education Centre, Chennai, 2010. 8. N. Nimbalkar, and M. Tapiawala, Environmental Dimensions of Tribal Sustainability. Sambhashan, Vol. 3, Mumbai University, 2022. 9. N. Sengupta, Traditional Knowledge in Modern India: Preservation, Promotion, Ethical Access and Benefit Sharing Mechanisms, Springer, 2019. 10. P. Phaldesai, Goa: Folklore Studies, Golden Heart Emporium Books, 2014. 11. R. Brears, Nature-Based Solutions to 21st Century Challenges, Routledge, 2020. 12. S. Mansoor, Bare Necessities. Penguin Random House India Pvt. Ltd, 2021. 13. S. Pal, Modern India Can Learn a Lot From These 20 Traditional Water Conservation Systems." The Better India, www.thebetterindia.com/61757/traditional-water-conservation-systems-india, 15 July 2016.	

	14. U.S. Fish and Wildlife Service. "Traditional Ecological Knowledge for Application by Service Scientists." https://www.fws.gov/media/traditional-ecological-knowledge-fact-sheet, www.fws.gov/media/traditional-ecological-knowledge-fact-sheet, 2011. 15. V. Shiva, and R. Cummins, Reclaiming the Commons: Biodiversity, Traditional Knowledge, and the Rights of Mother Earth, Synergetic Press, 2020. 16. WWF Coastal Communities' Initiative Impact Report 2020-2023 Scaling Toward a Healthy Ocean and Resilient Coastal Communities, 2023.
Course Outcomes:	At the end of this course, students will be able to: 1. Analyze and appreciate the indigenous communities for their experiential knowledge. 2. Appreciate and integrate TEKS with modern science for betterment of environment and for sustainable future. 3. Explore the cultural, spiritual, and ethical dimensions embedded within traditional ecological knowledge systems. 4. Examine the challenges and limitations faced by indigenous and local communities in maintaining and transmitting traditional ecological knowledge in the context of globalization, modernization, and climate change.

Name of the Programme : B.Sc. Zoology
Course Code : ZOO-412
Title of the Course : Wetland Ecology
Number of Credits : 04 (03 T + 01 P)
Effective from AY : 2024-2025

Pre-requisites for the Course:	Basic knowledge of Ecology.	
Course Objectives:	1. Acquaint the learners with an understanding and appreciation of Wetland ecosystem and its endowments. 2. Understand the threats to Wetland ecosystems. 3. Compare various conservation measures of Wetlands. 4. Invest in future environment-friendly citizenry.	
Content:	**MODULE I: Introduction to Wetlands** • Definition of Wetlands. • Major wetland areas on earth. • Brief idea of causal factors in wetland ecology (Flooding, Disturbance, and Nutrients). • Wetland Classification (Swamp, Marsh, Bog, Fen, Wet Meadow, Shallow Water). • Wetland Soils and processing of Carbon, Nitrogen, Phosphorus and Sulphur.	**15 hours**
	MODULE II: Ecology and importance of Wetlands • Wetland zonation and mechanisms of zonation. • Adaptation of flood tolerance of wetland biota. • Overview of wetland macrofaunal diversity: Fish, Birds, Reptiles and Mammals. • Ecological services of wetlands: De Groot approach. • Wetlands as Ecotourism Sites: Case studies of Goa and Kerala. • Role of Wetlands in regulating climate change.	**15 hours**
	MODULE III: Threats, Restoration and Conservation of Wetlands • Threats to Wetlands. • Wetland Restoration. • Ramsar Convention and India's Ramsar Sites. • National Wetland Conservation Program. • Wetlands (Conservation and Management Rules) 2017. • The Montreux Record.	**15 hours**
	MODULE IV: Practicals • To estimate Dissolved Oxygen levels of wetland water sample. • To estimate Dissolved Carbon-di-Oxide levels in wetland water sample. • To estimate Turbidity of wetland water sample. • To estimate pH and Organic Carbon of wetland sediments sample.	**30 hours**

	• To make an inventory of hydrophytic flora of a wetland and study their adaptations. • To make an inventory of Odonate diversity of any wetland near the college campus. • To make an inventory of Waterfowl diversity of a wetland. • To familiarise with distribution of wetlands in Goa using maps. • To get familiar with the Interactive 'Wetlands of India Portal' of MoEFCC, GoI. • To compile information on any one wetland of tourism importance in Goa. • Visit to a Ramsar Wetland of Goa.	
Pedagogy:	Lectures, Videos, Laboratory Assignments, Field Work, Visits to Wetland Authority of Goa.	
References/Readings:	1. APHA, Standard methods for examination of water and waste water, 20th Edition. American Public Health association (APHA), American Water Works Association, 1998. 2. B. Gopal, Environmental Flows, An introduction for water resource managers. National Institute of Ecology, New Delhi, 2013. 3. B. Gopal, Handbook of Wetland Management, World Wide Fund for Nature India, New Delhi, 1995. 4. D. Kar, Wetlands and Lakes of the World. Springer, 2013. 5. J. Krishnamurthy, S. Lele and R. Jayakumar. Hydrology and watershed services in the Western Ghats of India. Tata McGraw – Hill Publishing Company Limited. New Delhi, 2006. 6. L. H. Fraser, and P.A. Keddy, The World's Largest Wetlands: Ecology and Conservation. Cambridge University Press, 2005. 7. O. Springate-Baginski, D. Allen, and W. Darwall, An Integrated Wetland Assessment Toolkit, IUCN, 2001. 8. P. A. Keddy, Wetland Ecology: Principles and conservation, 2nd Edition. Cambridge University Press, 2014. 9. R. G. Wetzel, Lake and river ecosystems. Elseiver. Academic Press. USA, 2001. 10. R. G. Wetzel, Limnological Analysis, Springer Science, New York, 2010. 11. Ramsar Convention, Handbooks on Wetland Management by Convention on Biological Diversity, 2013. 12. W. K. Dodds, Freshwater Ecology. Concepts and Environmental Applications, Elseiver Science, Academic Press. California, 2002.	
Course Outcomes:	At the end of this course, students will be able to: 1. Understand the criteria of categorization of wetlands. 2. Understand the basics of wetland ecology, including types, formation, and functions 3. Assess the ecological services wetlands provide and their significance. 4. Evaluate human impacts on wetlands and strategies for conservation.	