Parvatibai Chowgule College of Arts and Science
(Autonomous)
Accredited by NAAC with Grade 'A+'
Best Affiliated College-Goa University Silver Jubilee Year Award

DEPARTMENT OF ZOOLOGY

SYLLABUS

FOR

UNDERGRADUATE PROGRAMME

THREE YEARS BACHELORS DEGREE IN ZOOLOGY/

FOUR YEARS HONOURS IN ZOOLOGY

COURSE STRUCTURE

COURSE STRUCTURE FOR STUDENTS REGISTERING FOR BSC ZOOLOGY PROGRAMME (NEP STRUCTURE)					
SEMESTER	**MAJORCORE**	**MINOR/ VOCATIONAL**	**MULTIDISCIPLINARY COURSE (MDC)**	**VALUE ADDED COURSES (VAC)**	**SKILL ENHANCEMENT COURSE (SEC)**
I	*UG-ZOO-101 Animal Diversity:Non-Chordates & Chordates	UG-ZOO-102 Introduction to Animal Diversity	UG-ZOO-MDC1 Nutrition & Diet Plans UG-ZOO-MDC4 Basics in Wildlife Photography	UG-ZOO-VAC1 Environment Protection Practices	UG-ZOO-SEC1 Waste Management Techniques
II	*UG-ZOO-103 Cell and Molecular Biology	UG-ZOO-104 Techniques Of Cell Study &Chemistry	UG-ZOO-MDC2 Techniques of Fish Preservation and Processing. UG-ZOO-MDC5 Zoonotic diseases of Public Health Importance	UG-ZOO-VAC2 Sustainable Development Goals- Life Below Water and On Land.	UG-ZOO-SEC2 BioEntrepreneurship
III	*UG-ZOO-201 Fundamentals of Animal and Human Genetics	UG-ZOO-203 Inheritance Pattern of Genetic traits and Diseases	UG-ZOO-MDC3 Aquarium maintenance :Freshwater and Marine fishes	--	UG-ZOO-SEC3 Biological Data Analysis
	UG-ZOO-202 Biochemistry and Metabolic Regulation	--	--	--	--
IV	UG-ZOO-204 Endocrinology & Assisted reproductive technologies	UG-ZOO-VOC1 Research methodology for Biological sciences	--	--	--
	UG-ZOO-205 Basic Microbiology and Fundamentals of Animal Biotechnology	--	--	--	--
	UG-ZOO-206 Immunology	--	--	--	--
	UG-ZOO-207 Techniques of Fish processing, Preservation s and Aquarium maintenance	--	--	--	--
V	UG-ZOO-301 Health & Nutrition	UG-ZOO-VOC2 Wildlife Photography	--	--	--

	UG-ZOO-302 Developmental Biology	--	--	--	--
	UG-ZOO-303 Ecology & Environmental Toxicology	--	--	--	--
	UG-ZOO-PRJ Project(a)	--	--	--	--
VI	UG-ZOO-304 Molecular genetics and Basics of Forensic Science	UG-ZOO-VOC3 Ecotourism	--	--	--
	UG-ZOO-305 Wildlife Biology and Ethology	--	--	--	--
	UG-ZOO-306 Human Physiology	--	--	--	--
	UG-ZOO-PRJ Project(b)	--	--	--	--
VII	UG-ZOO-401 Parasitology and vector borne diseases	UG-ZOO-VOC4 Techniques in Biological research	--	--	--
	UG-ZOO-402 Transgenic Animal Technology	--	--	--	--
	UG-ZOO-403 Techniques in Conservation Biology	--	--	--	--
	UG-ZOO-404 Animal Cell culture and Applications	--	--	--	--
VIII	UG-ZOO-405 Population Genetics	UG-ZOO-VOC5: Learner centric T-L-E pedagogies	--	--	--
	UG-ZOO-406 GIS in Wildlife Monitoring	--	--	--	--
	UG-ZOO-407 Economic zoology	--	--	--	--
	UG-ZOO-408 Tissue Engineering	--	--	--	--

SEMESTER I

*UG-ZOO-101 Animal Diversity: Non-Chordates & Chordates
UG-ZOO-102 Introduction to Animal Diversity
UG-ZOO-MDC1 Nutrition & Diet Plans
UG-ZOO-MDC4 Basics in Wildlife Photography
UG-ZOO-VAC1 Environment Protection Practices
UG-ZOO-SEC1 Waste Management Techniques

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE:ANIMALDIVERSITY:NON-CHORDATES &CHORDATES

Course Code: UG-ZOO-101

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will give insight to be familiar with the different non-chordate and chordate phyla, know the general and distinguishing characters of each of them, study how the different systems evolved in their complexity and enable students to compare and contrasts the life processes in chordates and non-chordates.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Identify and classify Non-Chordates up to the class level, including major phyla like Porifera and Cnidaria.
CLO2: Analyze the classification and characteristics of higher Non-Chordates and foundational concepts of Phylum Chordata.
CLO3: Explain the classification of Protochordata and Agnatha, and classify vertebrates within Superclass Pisces and Tetrapoda.
CLO4: Utilize taxonomic keys to accurately identify and classify Non-Chordates and Chordates.

Content:

Module I: INTRODUCTION TO DIVERSITY AND CLASSIFICATION OF LOWER NON-CHORDATES **[Contact Hours 15]**
UNIT1: Introduction to Non-Chordates:Characteristics and Concepts
UNIT 2: Taxonomical Hierarchy and Nomenclature of animals
UNIT 3: General characters of Phyla and classification up to class level for the following: Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida and Onycophora

Module II: DIVERSITY OF HIGHER NON-CHORDATES & INTRODUCTION TO PHYLUM CHORDATA AND ITS CLASSIFICATION **[Contact Hours 15]**

UNIT 4: General characters of Phyla and classification up to class level for the following: Arthropoda, Mollusca, Echinodermata and Hemichordata
UNIT 5: Introduction to Chordates: Characteristics and outline classification
UNIT6: Protochordata: General characters and classification upto class level
UNIT7: Division Agnatha: Ostracodermi and Cyclostomata

Module III: DIVERSITY OF VERTEBRATES AND CLASSIFICATION UP TO ORDER LEVEL **[Contact Hours 15]**
UNIT 8: General characters and classification up to Order level for the following: Superclass Pisces: Chondrichthyes and Osteichthyes
UNIT 9: General characters and classification up to Order level for the following: Class Amphibia, class Reptilia, Class Aves and Class Mammalia

Practicals **[Contact Hours 30]**

1. Identification of representative organisms of Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Onycophora, Arthropoda, Mollusca, Echinodermata and Hemichordata**[08 hours]**
2. Identification of representative organisms of protochordates to Mammalia(local sps) **[08 hours]**
3. Mountings/Observation: Prawn appendages, mouthparts of cockroach, scales and chromatophores in fishes, nests in birds **[04 hours]**
4. Field trip to terrestrial / Aquatic habitat/wildlife sanctuary to study the animal diversity in their natural habitats **[04 hours]**
5. Practical assessments **[06 hours]**

Reference books:

1. *RuppertEE,FoxRS,BarnesRD.(2019).Invertebrate Zoology.Thomson Press India Ltd 7thEdition.*
2. *Jordan,E.L.andVerma,P.S.(2022).Invertebrate Zoology. S.Chand&Co.Pvt.Ltd. NewDelhi.*
3. *PechenikJ.A.(2015).Biologyoftheinvertebrates.TataMcGrawhillPublishingcompanylimited, NewDelhi.*
4. *Jordan,E.L.andVerma,P.S.(2022).ChordateZoology.S.Chand&Co.Pvt.Ltd.NewDelhi.*
5. *ClevelandHJ,LarryR,KeenS,LarsonAandEisenhourD(2020).AnimalDiversity.McGrawHillScience.*
6. *SinhaAK,AdhikariSandGangulyBB(2022).BiologyofAnimalsVolumeII.NewCentralBookAgency*
7. *LalSS(2019).PracticalZoology.RastogiPublications,NewDehli.*
8. *LalSS(2022).PracticalZoologyForB.Sc.FirstYear.Rastogipublications,MeerutIndia.*
9. *LalS.S.(2019)Atextbookofpractical zoologyvertebrate.Rastogipublications,MeerutIndia.*
10. *SinhaAK,AdhikariSandGangulyBB(2022).BiologyofAnimalsVolumeII.NewCentralBook Agency*
11. *VermaPS(2022).AManualofPracticalZoology:ChordatesS.Chand&Co.Pvt.Ltd.NewDelhi*

MINOR CORE COURSE

COURSE TITLE: INTRODUCTION TO ANIMAL DIVERSITY

Course Code: UG-ZOO-102

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will give insight to the diversity of non-chordate and chordates. It will also enable students to know the general and distinguishing characters of classes of organisms and understand how the evolutionary process progressed from simple to complex forms.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Describe fundamental concepts of the animal kingdom, including taxonomy and nomenclature.
CLO2: Identify and classify Non-Chordates and Chordates, focusing on distinguishing characteristics at the class level.
CLO3: Analyze the distinguishing features of various animal classes to enhance understanding of their diversity.
CLO4: Apply taxonomic keys effectively to identify Non-Chordates and Chordates through practical observations and assessments.

Content:

Module I:INTRODUCTION TO NON-CHORDATES AND STUDY OF ITS DIVERSITY **[Contact Hours 15]**
UNIT 1: Introduction to Animal Diversity-Concepts in Animal Kingdom, Characters of Non-Chordates, Binomial nomenclature and Taxonomic Hierarchy.
UNIT 2: General characters of and brief classification (upto class) of: Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida and Onycophora
UNIT 3: General characters of and classification (upto class) of: Arthropoda, Mollusca, Echinodermata and Hemichordata
UNIT 4: Deeper understanding of classification through activities (E- Posters on classes of above-mentioned Phyla/ Presentations)

Module II: DIVERSITY OFHIGHER NON-CHORDATES& INTRODUCTION TO PHYLUM CHORDATA AND ITS CLASSIFICATION **[Contact Hours 15]**
UNIT 5: Introduction to Chordates: General Characters and overview of classification
UNIT 6: General characters and brief classification up to class level: Protochordates, Agnathans; Superclass Pisces: General characters of Chondrichthyes and Osteichthyes
UNIT 7: Superclass Tetrapoda: General characters of Class Amphibia, class Reptilia, Class Aves and Class Mammalia
UNIT 8: Deeper understanding of classification through activities (E- Posters on classes of above-mentioned Phyla/ Presentations)

Module III: FASCINATING PHENOMENA IN THE ANIMAL WORLD **[Contact Hours 15]**

UNIT 9: Coral reefs, Symbiosis and Mutualism, Courtship and Mating rituals in animals, Bioluminescence in animals, Mimicry and Camouflage in animals, Pearl formation in Mollusca, Regeneration in animals, Venom and Poison, Animal Migration, Echolocation in Bats and Cetaceans, Breeding and parental care in animals, Extreme adaptations in animals, Animal Cognition and Communication.

Practicals **[Contact Hours 30]**

1. Identification of representative organisms of Non-Chordates **[08 hours]**
2. Identification of representative organisms of Chordates (local sps) **[08 hours]**
3. Observation: Prawn appendages, mouthparts of cockroach, scales and chromatophores in fishes, nests in birds **[04 hours]**
4. Fieldtriptoterrestrial/Aquatichabit/wildlifesanctuarytostudytheanimal diversity in their natural habitats **[04 hours]**
5. Practical assessments **[06 hours]**

Reference books:

1. *RuppertEE,FoxRS,BarnesRD.(2019).InvertebrateZoology.ThomsonPressIndiaLtd7thEdition.*
2. *Jordan,E.L.andVerma,P.S.(2022).InvertebrateZoology.S.Chand&Co.Pvt.Ltd.NewDelhi.*
3. *PechenikJ.A.(2015).Biologyoftheinvertebrates.TataMcGrawhillPublishingcompanylimited, NewDelhi.*
4. *Jordan,E.L.andVerma,P.S.(2022).ChordateZoology.S.Chand&Co.Pvt.Ltd.NewDelhi.*
5. *ClevelandHJ,Larry R,Kee nS,Larson A and EisenhourD(2020). AnimalDiversity. McGrawHill Science.*
6. *SinhaAK,AdhikariSandGangulyBB(2022).BiologyofAnimalsVolumeII.NewCentral BookAgency*
7. *LalSS(2019).Practical Zoology. RastogiPublications,New Dehli.*
8. *LalSS(2022).PracticalZoologyForB.Sc.FirstYear.Rastogipublications,MeerutIndia.*
9. *LalS.S.(2019)Atextbookofpractical zoologyvertebrate.Rastogipublications,MeerutIndia.*
10. *SinhaAK,AdhikariSandGangulyBB(2022).BiologyofAnimalsVolumeII.NewCentral Book Agency*
11. VermaPS(2022).*AManualofPracticalZoology:ChordatesS.Chand&Co.Pvt.Ltd.NewDelhi.*

MULTIDISCIPLINARY COURSE

COURSE TITLE: NUTRITION AND DIET PLANS

Course Code: UG-ZOO-MDC1

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will give an insight into the nutritional requirements of human and diseases associated with nutrient deficiency or order-dose. It will also help to understand food labels and diet plans for different age groups.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Explain the nutritional requirements of humans, including macronutrients and micronutrients.
CLO2: Correlate dietary choices with diseases related to nutrient deficiencies and excesses
CLO3: Perform tests to assess food quality and detect adulteration and analyze their nutritional labels.

Content:

Module I:INTRODUCTION TO FOOD AND NUTRITIONALREQUIREMENTS **[Contact Hours 15]**

UNIT 1: Overview of health and nutrition: Definition, Scope of nutrition, food as a source of nutrients, Nutrients and energy, Adequate, optimum and balanced diet, Malnutrition and health.
UNIT 2: Macronutrients: Definition, Classification and properties and dietary sources of carbohydrates, lipids and proteins
UNIT 3: Micronutrients-Vitamins and minerals and their properties and dietary sources.

Module II: DIET RELATED DISEASES **[Contact Hours 15]**

UNIT 4: Major nutritional deficiency diseases- protein energy malnutrition, Vitamin A, B complex, C, D, E and K deficiency, iron deficiency anaemia, iodine deficiency disorders (causes, symptoms, treatment, prevention).
UNIT 5:Food and water borne diseases, Life style related diseases -obesity, hypertension, diabetes mellitus, polycystic ovarian disease(PCOD/PCOS) (causes and prevention through dietary/lifestyle modifications).
UNIT 6: Nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition; interpreting Nutrient labels. Brief account of food spoilage: Causes and preventive measures.

Practicals **[Contact Hours 30]**

1. To detect adulteration in a)Ghee b)Sugars c)Tea leaves d)Turmeric e)Honey **[06 hours]**
2. Qualitative test: lactose in milk **[04 hours]**
3. Qualitative test: Ascorbic acid in food **[04 hours]**
4. Observation of any two pests of grains **[02 hours]**
5. Project based Practical :
    a. Study of Nutritional value of foods of any local festival.**[04 hours**
    b. Study of Nutrient labels of selected foods **[04 hours]**
6. Practical assessments **[06 hours]**

Reference books:

1) *Rangnath, R. (2020). Fundamentals of nutrition and diet therapy. Jaypee Brothers Medical Publishers.*
2) *Ghosh, S., & Ray, S. (2019). Nutrition and health: A comprehensive guide. New India Publishing Agency.*
3) *Sharma, R. (2021). Health and nutrition: Concepts and applications. Academic Publishers.*
4) *Kumar, P., & Gupta, R. (2020). Nutritional science and health. CBS Publishers & Distributors.*
5) *Bansal, R., & Singh, A. (2019). Public health nutrition in India. Springer India. Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; Mc Graw Hill.*
6) *Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.*

MULTIDISCIPLINARY COURSE

COURSE TITLE: BASICS IN WILDLIFE PHOTOGRAPHY

Course Code: UG-ZOO-MDC4

Marks: 75 [50–: Theory;25-Practicals]

Credits:03 [02 –Theory; 01- Practical]

Contact Hours:

Theory: 30 hours (02 lec/week)

Practicals: 30 hours (01 practical/week)

Course Objectives:

This course will equip students with a fundamental understanding of photography, covering both principles of general photography and specialized wildlife photography techniques.

Course Learning Outcomes:

CLO 1: Demonstrate understanding of core concepts of photography and types of cameras

CLO 2: Implement effective strategies for capturing images in varying lighting and diverse environmental conditions.

CLO3: Demonstrate proficiency in applying technical skills to capture images in the wild

Content:

MODULE 1: INTRODUCTION TO PHOTOGRAPHY [Contact hours: 15]

UNIT 1: Principles of photography, types of cameras (SLR, DSLR, Mirrorless, Smartphone), Parts of a camera, Basics of camera operation, Structure and Functioning of DSLR and Mirrorless Cameras

UNIT 2: Camera settings: Aperture (f-stop), Shutter Speed, ISO, Metering Mode, Exposure Compensation, Camera Exposure Mode: depth of field, Automatic, Manual, Aperture Priority, Shutter Priority, Dynamic Range

UNIT 3: Composition & Framing Techniques: Symmetrical Composition, Diagonal composition, Rule of thirds, leading lines, and symmetry, Framing and negative space, Perspective and angles (high, low, eye- level)

MODULE 2: WILDLIFE PHOTOGRAPHY [Contact hours: 15]

UNIT 4: Understanding lenses and lighting: Prime vs. Zoom lenses ,Wide-angle, standard, and telephoto lenses, Controlling background blur (Bokeh effect), types of lighting in wildlife photography; Natural, Artificial light sources, Golden Hour & Blue Hour photography, shadows and highlights, Night photography

UNIT 5: Photography in the Wild: Understanding animal behaviour, safety; Use of devices to capture: drones, camera traps; Geo tagging wildlife locations; Capturing images of animals in motion; Processing raw images: colour adjustments, cropping and reframing etc.

UNIT 6: Photographic Accessories: Memory Cards, Batteries and Chargers; Stabilization; Flashes and Lighting; Hard Drives; tripods and gimbal; weather protection; Ethical considerations in wildlife photography; Careers in wildlife photography.

PRACTICALS : [Contact Hours -30]

1. Parts of a camera (SLR, DSLR& smartphone) 02 hours
2. Field activity in the campus- 04 hours
   a) Capture images of still objects
   b) Capture images of moving objects at different shutter speeds
3. Techniques of processing raw images using applications-02 hours
4. Interaction with a wildlife photographer 02 hours
5. Field activity: capture images of animals to record their behaviour (feeding, sitting) 04 hours
6. Project based practical: 10 hours
   a. Photograph wildlife in your backyard using different techniques of photography
   b. Photograph wildlife in any one ecosystem (beaches, forest)
7. Practical assessment 06 hours

REFERENCES

1. Sartore, J. (2012). Fundamentals of photography. The Teaching Company.
2. Kelby, S. (2020). The digital photography book: The step-by-step secrets for how to make your photos look like the pros! (Vol. 1). Rocky Nook.
3. Langford, M., Fox, A., &Sawdon Smith, R. (2010). Langford's basic photography: The guide for serious photographers (9th ed.). Focal Press.
4. Dyer, R. (2019). The art of wildlife photography: A practical guide. Crowood Press.
5. Shaw, J. (2017). Close-ups in nature: Capturing the beauty of the natural world. Amphoto Books.
6. Tipling, D. (2012). The art of wildlife photography: Tips and techniques for capturing the natural world. Amphoto Books.

VALUE ADDED COURSE

COURSE TITLE: ENVIRONMENT PROTECTION PRACTICES

Course Code: UG-ZOO-VAC 1

Marks: 50[50–Theory]

Credits: 02 [02 –Theory]

Contact Hours: Theory: 30 hours (02 lec/week)

Course Objectives:

This course aims at familiarizing the students with the duties and responsibilities of an individual in adopting certain good practices for protection of environment.

Course Learning Outcomes:

Upon successful completion of the course, students should be able to:
CLO1: Articulate the fundamental rules and regulations governing environmental conservation and protection and Identify strategies for waste reduction and resource conservation
CLO2: Evaluate individual actions that contribute to water and energy conservation, as well as pollution prevention.

Content:

Module I: INTRODUCTION TO ENVIRONMENTAL CHALLENGES AND SUSTAINABLE PRACTICES **[Contact Hours 15]**

UNIT 1: Global and Local Environmental Issues (Climate change, Pollution, Biodiversity Loss, Waste Management, Water scarcity)
UNIT 2: Environment protection laws/policies and laws governing individual/societal responsibilities towards environment
UNIT 3: Individual efforts towards: Water conservation, Energy conservation, Preventing Air, water & land pollution, Conservation of Biodiversity
UNIT 4: Community Participation: Public Awareness, NGOs and their role in policy advocacy, Indigenous knowledge and conservation and Participatory Approach in Environment Management

Module II: PRACTICAL APPROACHES TO ENVIRONMENT PROTECTION

[Contact Hours 15]

UNIT 5: Principles of Waste Management, Techniques in waste reduction, Managing E-waste
UNIT 6: Techniques in Rain Water harvesting, Soil Conservation methods and water conservation strategies
UNIT 7: Techniques in habitat restoration and species conservation
UNIT 8: Brief idea on SDGs related to environment protection: SDG 6, 7, 11, 12, 13, 14 and 15.

Reference books:

1. *ChandrappaRandDasDB(2012).SolidWasteManagement:PrinciplesandPractic e.Springerpublishers.*
2. *TERI(2014).Wastetoresources–awasteManagementHandbook.TERIPress,Newdelhi.*
3. *GoodalJ(2022).Local Voices, Local Choices: The Tacare Approach to Community-LedConservation*
4. *HendonJ(2019).EnvironmentalConservationandManagement.SyrawoodPublishing House*

SKILL ENHANCEMENT COURSE

COURSE TITLE: WASTE MANAGEMENT TECHNIQUES

Course Code: UG-ZOO-SEC1

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course aims at familiarizing the students with the techniques of waste management, offering hands on experience on techniques of managing waste and helping students understand the importance of reducing, reusing and recycling.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:
CLO1: Analyze the types of waste and their management processes, including collection, transport, and disposal methods.
CLO2: Evaluate waste treatment methods and assess the laws governing waste management practices.
CLO3: Implement practical waste reduction techniques through hands-on activities such as composting and recycling.

Content:

Module I:INTRODUCTION TO WASTE MANAGEMENT **[Contact Hours 15]**

UNIT 1: Overview of types of waste, collection, transport, treatment and disposal of solid and liquid waste, overview of Regulations governing waste management.
UNIT 2: Methods of waste collection: Door-to-door, Community Bins, Centralized systems; waste segregation at source: Techniques and Importance.
UNIT 3:Need for Waste management and effect on the community.
UNIT 4: Waste treatment methods: Physicochemical Treatment of Solid and Hazardous Waste, Chemical treatment processes, Biological Treatment of Solid and Hazardous Waste, 3Rs-Reuse Reduce and Recycle.
UNIT 5: Integrated waste management strategies; Concepts of Zero waste and circular Economy; Role of Technology and Innovation in sustainable waste management.

Module II: WASTE MANAGEMENT TECHNIQUES **[Contact Hours 15]**
Unit 6: Medical waste management-Sources, measures and health effects; disposal options.
Unit7:Bioremediation:Ground water contamination and remediation; Landfill designing; Incineration.
Unit 8:Radioactive and E-waste management-Sources, measures and health effects.
Unit 9: Organic composting- Methods, Procedure, Micro organisms, materials used, design and maintenance, Biogas
Unit 10:Vermicomposting- Earthworms – biology- life cycle and feeding, predators/pathogen control, requirements of Vermi-composting, initiation and maintenance of Vermi-composting, analysis of compost.

Practicals **[Contact Hours 30]**

1. Documenting individual efforts towards waste reduction **[02 hours]**
2. Case study – Regulations governing waste management **[02 hours]**
3. Waste collection /Awareness drive **[02 hours]**
4. Leaf composting /Organic composting/Vermicomposting **[10 hours]**
5. Handmade Paper **[02 hours]**
6. Art from waste –Practicing Recycle, Reduce, Reuse **[04 hours]**
7. Visit to Sewage treatment plant/Waste disposal plant/ vermicomposting unit **[02 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1. *Chandrappa R and Das DB(2012). Solid Waste Management: Principles and Practice. Springer publishers*
2. *EdwardsCA,HendrixPandAranconN(2014)BiologyandEcologyofEarthworms,S pringerPublishers.*
3. *EdwardsCA(2021).Vermicompostingtechnology.1stedition,Taylor&FrancisLtd.*
4. *KaracaA(2011)SoilBiology:Biology of Earthworms. Springer Publishers.*
5. *ShermanR(2018).TheWormFarmer;shandbook.ChelseaGreenPublishingColtd.*
6. *TERI(2014).Wastetoresources –awasteManagementHandbook.TERIPress,Newdelhi.*

SEMESTER II

*UG-ZOO-103 Cell and Molecular Biology
UG-ZOO-104 Techniques Of Cell Study &Chemistry
UG-ZOO-MDC2 Techniques of Fish Preservation and Processing.
UG-ZOO-MDC5 Zoonotic Diseases of Public Health Importance
UG-ZOO-VAC2 Sustainable Development Goals- Life Below Water and On Land.
UG-ZOO-SEC2 BioEntrepreneurship

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE:CELL AND MOLECULAR BIOLOGY

Course Code: UG-ZOO-103

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will give firm and rigorous foundation in the principles of molecular and cellular biology. It discusses the fundamental processes that enable cells to grow, move and communicate and will cover topics such as cell architecture, cell chemistry, cell division, functions and cell cycle. Students will also learn current molecular biological techniques that are used to study cell biology. Laboratories will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in modern cell and molecular biology research.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:
CLO1: Identify microscopy techniques and cell study methods, including cell fractionation and chromatography, and describe the roles of micro molecules and macromolecules in cells.
CLO2: Analyze the structure and function of cellular membranes and organelles, focusing on membrane proteins in cell architecture.
CLO3: Explain cellular transport mechanisms, including transmembrane and vesicular transport, and the principles of cell signaling.
CLO4: Demonstrate proficiency in laboratory techniques such as pipetting, cytochemistry, membrane permeability studies, osmotic experiments, and preparing permanent slides, while following safety protocols.

Content:

Module I:TECHNIQUESOFCELLSTUDY ANDCELLCHEMISTRY **[Contact Hours 15]**
UNIT1:Microscopy: Light Microscopy, Electron Microscopy
UNIT 2: Cell Study Methods: Cell Fractionation, Chromatography and Electrophoresis.
UNIT 3: Molecules In Cell: Micro molecules in cells: Sugars, Fatty acids, amino acids, Nucleotides. Macromolecules in cells: Nucleicacids, proteins, Polysaccharides, glycogen, fats.
UNIT 4: Chemical Bonds In Biomolecules: Covalent bonds, ionicbonds, non covalent interactions

Module II: CELL ARCHITECTURE **[Contact Hours 15]**

UNIT 5: Structure of a bacterial cell and Eukaryotic Cell, Membrane structure; Lipid bilayer – composition and structural organization; Membrane Proteins – structure and function (transmembrane proteins, peripheral membrane proteins): Phospholipids, sphingolipids, Cholesterol in cell membrane; Carbohydrates in membrane.

UNIT 6: Ultra structure And Function of Organelles: Nucleus, Mitochondria, Endoplasmic Reticulum, Golgi Complex, Ribosomes, Lysosomes, Cytoskeleton and Cell matrix.

Module III:CELLULARTRANSPORTOF PROTEINS AND VESICLES **[Contact Hours 15]**

UNIT 8: Transport across cell membranes: Principle of transmembrane transport (transporters and channels, active and passive transport,osmosis); Transporters and their function- passive transporters, Pumps(Na^+, K^+, $Ca^{))}$)Ion Channels - ion channels activities, regulation ofopening and closing of channel; Protein transport into organelle.
UNIT 9: Vesicular transport & cell signalling: Vesicular transport–transport of soluble proteins, Clathrins, vesicle budding, vesicle docking, endocytic pathways, general principles of cell signalling.

Practicals **[Contact Hours 30]**

1. Introduction to Lab techniques–Pipetting, preparation of buffers and solutions, Lab equipments (use and maintenance), acquaintance with general laboratory practices **[04 hours]**
2. Cytochemistry: Localisation of Proteins, Carbohydrates & fats **[06 hours]**
3. Comparison of membrane permeability–Cellophane and Chick intestine **[04 hours]**
4. Osmotic studies –Using Human Red blood cells **[02 hours]**
5. Permanent slides: Mitotic stages, Meiotic stages, Study of different cell types(animal cells) **[08 hours]**
6. Practical assessments **[06 hours]**

Reference books:

1) *AlbertsB,HealdR,HopkinK,JohnsonA,MorganD,RobertsK,WalterP(2022).Essentia lCellbiology.Sixth edition.EBook. Norton Illumine.*
2) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K,Walter P (2014): Essential Cell Biology, FourthEdition,Graland ScienceTaylor &Francis Group,UK.*
3) *LodishH,BerkA,KaiserCA,KriengerM,ScottMP,Anthony,BretscherA,AmonA.Scott MP(2013):MolecularCellBiology,SeventhEdition,W.H.Freeman and CompanyNewYork.*
4) *VermaPS and AgarwalVK(2022): Cell Biology (Cytology,Biomolecules and Molecular Biology). SChand and Company PVTLTD, NewDelhi.*
5) *GuptaPK(2003):CellandMolecularBiology,SecondEdition,RakeshKumarRastogifor RastogiPublications,Meerut, NewDelhi,India.*
6) *PollardTD,EarnshawWC, Schwart z J and Johnson GT(2017). CellBiology. Third Edition. Elsevier publication.*
1) *Alberts B, Hopkins, Lewis J, Raff M, Robertis K,Walter P (2014): Essential Cell Biology, FourthEdition,Graland Science Taylor &Francis Group,UK.*
7) *ChaitanyaKV(2013).CellandMolecularbiology A lab manual. PHI Learning Pvt. Ltd New delhi.*

MINOR CORE COURSE

COURSE TITLE: TECHNIQUES OF CELL STUDY AND CELL CHEMISTRY

Course Code: UG-ZOO-104

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will discuss the fundamental processes that enable us to study cell biology. Laboratory work will focus both on exercises that help illustrate cellular phenomena, as well as on the introduction of techniques and procedures commonly utilized in cell biology research.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Analyze the ultra structure of animal cells and utilize microscopy techniques for cell study.
CLO2: Describe the structure and function of biomolecules, including their chemical interactions in cellular processes.
CLO3: Explain cellular signalling pathways and mechanisms of transport across membranes.
CLO4: Execute laboratory techniques in cellular biology, including slide preparation, staining, and microscopy.

Content:

Module I:ANIMAL CELL ARCHITECTURE AND TECHNIQUES OF CELL STUDY
[Contact Hours 15]

UNIT 1:Overview of Animal Cell Architecture (ultra structure of cell organelles)
UNIT 2:Microscopy:LightMicroscopy,Electron Microscopy
UNIT 3: Cell Study Methods: Cell Fractionation, Chromatography and Electrophoresis

Module II: CELL MOLECULES AND CHEMISTRY

[Contact Hours 15]

UNIT 4: Molecules In Cell: Micro molecules in cells: Sugars, Fattyacids, aminoacids, Nucleotides.
UNIT 5: Macromolecules in cells: Nucleic acids, proteins, Polysaccharides, glycogen, fats.
UNIT 6: Chemical Bonds in Bio molecules: Covalent bonds, ionicbonds, noncovalent interactions.

Module III:CELLULAR TRANSPORT IN ANIMAL CELLS **[Contact Hours 15]**

Unit 7:Principle of transmembrane transport (transporters and channels, active and passive transport, osmosis); Unit 8: Transporters and their function- passive transporters, Pumps(Na^+, K^+, Ca)
Unit 9: Ion Channels - ion channels activities, regulation of opening and closing of channels
Unit 10: Protein transport into organelle (nucleus, mitochondria, ER)
Unit11:Vesiculartransport–transport of soluble proteins,Clathrins, vesicle budding, vesicle docking, endocytic pathways

Practicals[Contact Hours 30]

1. IntroductiontoLabtechniques–Pipetting,preparationofbuffersandsolutions,Lab equipments (use and maintenance), acquaintance with general laboratory practices **[04 hours]**
2. Cytochemistry: Localisation of Proteins, Carbohydrates & fats **[06 hours]**
3. Comparison of membrane permeability–Cellophane and Chick intestine **[04 hours]**
4. Osmotic studies –Using Human Red blood cells **[02 hours]**
5. Permanent slides: Mitotic stages,Meiotic stages,Study of different cell types(animal cells) **[08 hours]**
6. Practical assessments **[06 hours]**

Reference books:

1. *AlbertsB,HealdR,HopkinK,JohnsonA,MorganD,RobertsK,WalterP(2022).EssentialCellbiology.Sixth edition. EBook. Norton Illumine.*
2. *Alberts B, Hopkins, Lewis J, Raff M, Robertis K, Walter P (2014): Essential Cell Biology, FourthEdition,Graland ScienceTaylor &Francis Group,UK.*
3. *LodishH,BerkA,KaiserCA,KriengerM,ScottMP,Anthony,BretscherA,AmonA.ScottMP (2013):MolecularCellBiology,SeventhEdition,W.H.FreemanandCompanyNewYork.*
4. *VermaPSandAgarwalVK(2022):CellBiology(Cytology,BiomoleculesandMolecularBiology).SChand and Company PVTLTD, NewDelhi.*
5. *GuptaPK(2003):CellandMolecularBiology,SecondEdition,RakeshKumarRastogiforRastogiPublications,Meerut, NewDelhi,India.*
6. *PollardTD,EarnshawWC,SchwartzJLandJohnsonGT(2017).CellBiology.ThirdEdition.Elsevierpublication.*

MULTIDISCIPLINARY COURSE

COURSE TITLE: TECHNIQUES OF FISH PRESERVATION AND PROCESSING

Course Code: UG-ZOO-MDC 2

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is designed to familiarize the students with different methods of fish preservation and processing with Emphasis on local traditional knowledge. It also gives an insight into the techniques and precautions for hygienic fish handling.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Analyze the nutritional values and significance of locally available fishes and non-pisces in the fishery industry.
CLO2: Describe techniques for fish processing and preservation, including methods for creating value-added fish products.
CLO3: Execute practical techniques for identifying local fish species and applying preservation methods.

Content:

Module I: IMPORTANCE AND NUTRITIONAL VALUE OF FISHES **[Contact Hours 15]**
UNIT 1: Introduction to Locally available fishes (Marine, Freshwater).
UNIT 2: Nutritional value of: Pomfret, mackerel, Bombay duck,Sardines,Kingfish, Salmon, catfish
UNIT 3: Non-Pisces in fishery industry- Crabs, Lobsters, Prawns,Oysters,Mussels.(importance and nutritionalvalue)
UNIT 4: Traditional Knowledge/IKS: Traditional methods of Fishing used along west coast of India (Goa). Nutrient value of locally available fishes.

Module II:PROCESSING AND PRESERVATION OF FISH **[Contact Hours 15]**
UNIT 5: Introduction to fish processing and preservation (history, control of temperature,control of water activity, microbes,processing fresh fish, vacuum packaging).
UNIT 6: Fish preservation techniques – Short term and long term(Chilling/refrigeration,DeepFreezing, Freeze-drying,Salting,Drying,curing,Canning, Smoking, irradiating),
UNIT 7: Value added Fish products – Concept and Purpose, scope, merits and demerits; Selection of fish candidates (fin and shell fishes) for value addition.Value added Fish products (in brief) – Fish Liver Oil, Fish Body Oil, Fish Meal, Fish Manure, Fish Flour, Isinglass, Fish Silage, Fish Sausage, Fish Biscuits, Fish Roe and Caviar, Fish pickles, Fish flakes, Fish wafers, fish noodles, Fish sauces etc.
UNIT 8: Traditional Knowledge/IKS: Local techniques of Fish preservation.

Practicals[Contact Hours 30]

1. Identification of common local fishes [**08 hours]**
2. Determination of quality of fish, using organoleptic tests and Fish cleaning Techniques (Fin fishes and Shell fishes)**[02 hours]**
3. Fish parasites **[04 hours]**
4. Fish filleting **[02 hours]**
5. Fish Preservation Technique (salting/pickling) **[04 hours]**
6. Visit to Fish processing Centre/ Fishing Co-operative Society/ Fishery Institute/ Fish Survey of India/Fish landing Centre/Fish Market **[04 hours]**
7. Practical assessments **[06 hours]**

Reference books:

1. *BamjiMS(2019).TextBookofHumanNutrition.4th edition.Oxford&IBHPublishingCoPvt.Ltd*
2. *BansalR(2021).Food,NutritionandHygiene.SBPDPublishingHouse*
3. *Gopalan C, Ramashastri BV(2021). Nutritive value of IndianFoods. PublishedbyNationalInstituteofNutrition, India.*
4. *JoshiSA(2021).NutritionandDietetics.FifthEdition.Mc.GrawHillPublishers.*
5. *LalH(2022).Textbook of Applied Biochemistry And Nutrition And Dietetics. CBS Publishers & Distributors Pvt.Ltd.*
6. *Roday S(2018).FoodScienceandNutrition.Thirdedition.OxfordUniversityPress.*
7. *SrilakshmiB(2019).Dietetics.NEWAGE InternationalPublishers*

MULTIDISCIPLINARY COURSE

COURSE TITLE: ZOONOTIC DISEASES OF PUBLIC HEALTH IMPORTANCE

Course Code: UG-ZOO-MDC5

Marks: 75 [50 –Theory; 25- Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours:

Theory: 30 hours (02 lec/week)

Practicals: 30 hours (01 practical/week)

Course Objectives:

To provide an in-depth understanding of zoonotic diseases, their classification and epidemiology. To study zoonotic diseases by analyzing the transmission, prevention, and control of zoonotic diseases alongside effective management strategies to mitigate their public health impact.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to

CO1: Classify and describe major zoonotic diseases based on their causative agents.

CO2: Understand the host-pathogen interaction, transmission, symptoms of zoonotic diseases.

CO3: Identify disease causing organisms and analyze epidemiological data to assess zoonotic disease trends and outbreak risks.

Content:

Module I: Introduction to Zoonotic Disease [Contact Hours 15]

UNIT 1: Understanding terminologies- Health, Disease, Pandemic, Epidemic, Zoonosis, Host, Vector, Zoonotic spillover, Vector-borne diseases, Herd immunity, Quarantine; Historical perspective (major outbreaks and pandemics) of zoonotic diseases**;** Classification of zoonoses (bacterial, viral, parasitic, fungal, prion diseases)**;** Modes of transmission: direct, indirect, vector-borne, foodborne, occupational.

UNIT 2: Role of Animals in Zoonotic Disease Transmission- Reservoir hosts and their significance; Spillover events from wildlife to humans; Domesticated animals as carriers of zoonotic pathogens; Role of vectors in disease transmission.

UNIT 3: Factors influencing emergence of zoonotic diseases - Deforestation and habitat destruction leading to wildlife-human interactions, Agricultural intensification and livestock farming, Wildlife trade and consumption, Climate change and its impact on vector-borne zoonoses.

Module II: Zoonotic Pathogens and Disease Outbreak [Contact Hours 15]

UNIT 4: Zoonotic diseases transmitted from domestic/common animals in Goa – Dogs, Cats, Cattle, Poultry, Goat, Pigs, Rats, Pigeon, Ornamental fishes, Turtles/Tortoises (Discuss transmission, diagnosis, prevention and control); Zoonotic disease outbreak in Goa - Kyasanur Forest Disease (KFD), Case studies of Rabies in Goa/India.

UNIT 5: Global and National Efforts in Zoonotic Disease Control - WHO, FAO, OIE initiatives for zoonotic disease surveillance; International health regulations (IHR) related to zoonotic diseases;

Zoonotic disease laws and regulations in India; National zoonotic disease control programs.

UNIT 6: Case studies - Ebola Virus Outbreak (2014-2016, West Africa); Nipah Virus Outbreak (1998-1999, Malaysia & Singapore); SARS-CoV-2/COVID-19; Avian Influenza(H5N1), Pandemic influenza(H1N1), Listeriosis.

Practicals [Contact Hours -30]

1. Field Based Practicals:
   a) Field or Institutional visit to veterinary/public health laboratory or wildlife reserve **[06 hours]**
   b) Identification of the following disease-causing organisms: Mosquito, Housefly, Rat Flea, Head Louse, Bed bug, Tick and House Rat. **[02 hours]**
   c) Understanding incidence of prominent Zoonotic diseases in India from secondary data of VCRC-ICMR /WHO resources. **[02 hours]**
2. Analysis of Vector control program for the following vector-borne diseases: a. Malaria b. Schistosomiasis c. Lyme's Disease d. Plague **[04 hours]**
3. Identifying the Zoonotic diseases transmitted through domesticated animals(Dogs and Cats): transmission routes, effect and preventive measures **[02 hours]**
4. Analysis of Impact (health and economic) of any one pandemic/outbreak. (COVID-19/ SARs/ Rabies/Nipah virus/ outbreaks **[04 hours]**
5. Interaction or a session by a doctor/ NGO on Zoonotic disease outbreak **[04 hours]**
6. Practical assessments **[06 hours]**

REFERENCES

1. Chakraborty, P (2010) Textbook of Medical Parasitology. New Central Book Agency (P) Ltd., Kolkota
2. Despommier,D., Griffin, D., Gwadz,R., Hotez, P., and Knirsch, C. (2017) Parasitic Diseases. (6th Ed). Parasites without borders, New York
3. Paniker C.K. (2007) Textbook of Medical Parasitology. Jaypee Brothers medical Publishers (P) ltd. New Delhi
4. Roberts, L., Janovy J. ,Schmidt, G.D., & Roberts, S. L (2009) Foundations of Parasitology. The McGraw hill Companies, New York
5. World Health Organization, Malaria vector control and personal protection. World Health Organization Technical Report Series, nº 936, Geneva, Switzerland. 62 pp., 2006.
6. 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.

VALUE ADDED COURSE (VAC)

COURSE TITLE: SUSTAINABLE DEVELOPMENT GOALS – LIFE BELOW WATER AND ON LAND

Course Code: UG-ZOO-VAC 2

Marks: 50 [50-Theory]

Credits: 02 [02-Theory]

Contact Hours: Theory: 30 hours (02 lectures /week)

Course Objectives:
The course intends to highlight the understanding of Sustainable Development Goal 14 and 15 including significance, historical context and key objectives related to preservation of life below water and on land

Course Outcomes:
On completion of the course, the students will be able to:
CLO1: Analyze the significance of Sustainable Development Goal 14, emphasizing the importance of oceans and marine life.
CLO2: Evaluate the critical role of biodiversity on land as outlined in Sustainable Development Goal 15.

Content:

Module I: SUSTAINABLE DEVELOPMENT GOAL 14**[Contact Hours 15]**
UNIT 01: Overview of SDG 14: Life Below Water, Historical context and significance, Key objectives and targets.
UNIT 02: Importance of Oceans and marine life, Threats to marine ecosystem: Pollution, Climate change and Ocean Acidification; Conservation strategies and marine protected areas.
UNIT 03: Challenges in Global fisheries, Overfishing and its consequences, Sustainable fishing practices and management, Innovation in sustainable fisheries
UNIT 04: Impact of tourism on coastal areas, Sustainable tourism practices and supporting coastal communities.
UNIT 05: Policies addressing SDG 14

Module II: SUSTAINABLE DEVELOPMENT GOAL15**[Contact Hours 15]**
UNIT 06: Overview of SDG 15: Life on Land, Historical context and significance, Key objectives and targets.
UNIT 07: Importance of biodiversity on land, Threats to terrestrial ecosystems, Conservation strategies and protected areas
UNIT 08: Causes and consequences of Deforestation, Reforestation initiatives and sustainable forestry practices
UNIT 09: Importance of recognizing and respecting indigenous land rights, Collaborative approaches for land conservation
UNIT 10: Connection between land use and climate change, Sustainable land management practices for climate mitigation, Carbon sequestration in forests and other ecosystems

Reference Books:

1. *Morton, S., Pencheon, D., and Squires, N. (2017). Sustainable Development Goals (SDGs), and their implementation. A national global framework for health, development and equity needs a systems approach at every level. In British Medical Bulletin. 124: 81-90 .doi: 10.1093/bmb/ldx031*
2. *Department of Economic and Social Affairs. (2023). The Sustainable Development Goals Report. The United Nations. Special Edition. ISBN 978-92-1-101460-0. Retrieved from https://unstats.un.org/sdgs/report/2023/The- Sustainable-Development-Goals-Report-2023.pdf*
3. *The United Nations. (n.d.). Transforming Our World: The 2030 Agenda For Sustainable Development. Retrieved from sustainabledevelopment.un.org.*

SKILL ENHANCEMENT COURSE

COURSE TITLE: BIO-ENTREPRENEURSHIP

Course Code: UG-ZOO-SEC 2

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is designed to familiarize the students the basic skills required for a start-up,have deeper knowledge on generating ideas, preparing a business plan, and regulations and compliances associated with initiating a business venture,with emphasis on opportunities in biological field.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Evaluate key principles and competencies of entrepreneurship.
CLO2: Develop comprehensive business proposals and understand regulatory requirements.
CLO3: Generate business ideas and create a structured business plan through practical activities

Content:

Module I:INTRODUCTION TO ENTREPRENEURSHIP **[Contact Hours 15]**
UNIT1: Understanding terminologies: Entrepreneur, Businessman, Entrepreneurship, Enterprise, Start-up, MSMEs, Unicorns,Bioentrepreneurship.
UNIT2: Entrepreneurial competencies, Qualities, skills, resources and personality types influencing business ventures.
UNIT3: Advantages and Disadvantages of Entrepreneurship
UNIT4: Steps of Entrepreneurial Process-Develop Business plan, Acquire finances, meet legal requirements.
UNIT5: Bioentrepreneurship opportunities (Aquaculture / Pisciculture / Beekeeping / Ecotourism ventures / livestock (piggery /poultry/dairy).

Module II: STRUCTURE AND REGULATIONS **[Contact Hours 15]**
UNIT6: Business model canvas–Structure and presentation.
UNIT7: Introduction to Start-Ups: Start-up features,types of start-ups, Steps in initiating Start-up company, evaluating startup potential, Scaling a start-up, registering a startup ,National status of startups in India.
UNIT 8: Intellectual Property Rights and trademark of biological resources –Types of IPs: Copyrights, Industrial property (patents, trademarks, industrial designs and geographic indications).
UNIT9: Quality, safety and procedural compliances: Quality control, Quality assurance, Quality Improvement and Quality planning. Quality standards (ISO), Quality management principles, procedural compliances.

Practicals [Contact Hours 30]

1. Activity on testing entrepreneurial competencies**[04 hours]**
2. Initiating business ideas**[04 hours]**
3. Interactionswithsuccessfulentrepreneur,Banker/AngelInvestor/workshopsonentrepreneurship**[06 hours]**
4. Preparing and presenting Business Plan**[06 hours]**
5. Case study analysis of successful and failed bio-based startups to identify key lessons **[04 hours]**
6. Practical assessments **[06 hours]**

Reference books:

1. *PatzeltHandBrennerT(2021).HandbookofbioentrepreneurshipSpringerPublisher.*
2. *Pandey and Shukla (2015) Fish and Fisheries, IIIrd Revised Edition, Rastogi Publications Meerut,India*
3. *SinhaD(2021).IntroductiontoBioentrepreneurship.IGIGlobalPublishers.*
4. *SinghBK(2018)AppliedFisheriesandAquacultureSwastikPublishersandDistributersDelhi,India*

SEMESTER III

*UG-ZOO-201 Fundamentals of Animal and Human Genetics
UG-ZOO-202 Biochemistry and Metabolic Regulation
UG-ZOO-203 Inheritance Pattern of Genetic traits and Diseases
UG-ZOO-MDC3 Aquarium maintenance :Freshwater and Marine fishes
UG-ZOO-SEC3 Biological Data Analysis

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: FUNDAMENTALS OF ANIMAL AND HUMAN GENETICS

Course Code: UG-ZOO-201

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is intended to provide solid understanding of concepts and principles of genetics as it applies to animals and humans. Students will receive good foundation of chromosome structure, its aberrations and inheritance patterns of traits and disease which will help one to develop conceptual skills to address questions in genetic research.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Describe the fundamental structure and organization of genes and chromosomes, including key components such as chromatid, centromere, and chromatin types.
CLO2: Relate an organism's genotype to its phenotype, explaining the mechanisms by which genes influence inheritance patterns and express traits.
CLO3: Apply principles of genetics to analyze human genetic phenomena, including the implications of inheritance in various genetic disorders.
CLO4: Construct and analyze pedigrees to determine the modes of inheritance for genetic disorders and traits, demonstrating proficiency in practical genetic analysis techniques.

Content:

Module I:TRANSMISSION GENETICS

[Contact Hours 15]

UNIT 1: Modes of Inheritance: Mendels laws of inheritance, test cross, back cross; Gene interactions: 9:3:3:1 /12:3:1 / 9:3:4 /9:6:1 / 9:7 / 15:1 / 13:3, lethal genes, penetrance; Inheritance of Multiple Alleles and Multiple Genes
UNIT 2: Pattern of Inheritance by Pedigrees- Construction of Pedigrees, Analysis of Pedigree: autosomal dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance, Sex limited and Sex influenced and multifactorial inheritance disorders in humans.

Module II:CHROMOSOME STRUCTURE AND ABNORMALITIES IN HUMANS

[Contact Hours 15]

UNIT 3: Chromosome Structure: Chromosome morphology- chromatid, centromere, secondary constriction, Chromomere; Heterochromatin and euchromatin; Chromosome structure and organization; Human chromosomes and karyotype.
UNIT 4: Chromosomal Aberration: Numerical aberrations: Types- Aneuploidies and Euploidies, Mosaicism; Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications.

Module III:GENE MUTATIONS, SEX DETERMINATION

[Contact Hours 15]

UNIT 05: Genetic Mutations: Characteristics of mutations; Classification of mutations - Based on causative agents, Molecular basis of mutations(Frame shift mutations, Point Mutations); Mutagens –Biological, physical and chemical

UNIT 6: Sex Determination: Environmental Sex Determination – Temperature, pH Levels, Population Density, Social environment; Chromosomal sex determination - XX and XO, XO and XX, ZW and ZZ, XX and XY, Haplodiplody; Molecular basis of sex determination- Genic imbalance: Sex index, X/A Ratio, Intersex and gynandromorphs, Sex determination by Y linked genes, Dosage compensation, X-inactivation. Sex determination in Humans (Sex chromosome, SRY gene on Y chromosome, Abnormal conditions in Humans).

Practicals **[Contact Hours 30]**

1. Verification of Mendel's laws - monohybrid cross **[02 hours]**
2. Verification of Mendel's laws - dihybrid cross **[02 hours]**
3. Manual Karyotyping of human chromosome plates: Normal Male and Female, Downs syndrome **[04 hours]**
4. Drosophila Culture technique **[06 hours]**
5. Study of Mutants of Drosophila **[02 hours]**
6. Exercises for Multiple alleles and Multiple genes **[04 hours]**
7. Construction and analysis of pedigrees **[04 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1. *Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.*
2. *De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.*
3. *Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.*
4. *Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.*
5. *Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.*
6. *Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.*
7. *Marcus A (2011): Genetics, MJP Publishers, Chennai.*
8. *Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology*
9. *Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
10. *Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.*
11. *Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.*
12. *Marcus A(2011): Genetics, MJP Publishers, Chennai.*
13. *Gardner A, Davies T (2010): Human Genetics, Second Edition, Scion Publishing Ltd, UK.*
14. *Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York*

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: BIOCHEMISTRY AND METABOLIC REGULATION

Course Code: UG-ZOO-202

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
To understand the basic principles that governs the functioning of living systems. To know the structure of biomolecules and the role they play in governing life processes through the pathways. To be familiar with enzymes and their activities

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Explain the chemical basis of life, focusing on pH, buffers, and thermodynamics.
CLO2: Describe the principles governing metabolic pathways and their regulation.
CLO3: Analyze enzyme structure and kinetics, including inhibition mechanisms.
CLO4: Perform colorimetric estimations of lipids, proteins, DNA, and carbohydrates using appropriate laboratory techniques.

Content:

Module I:FUNDAMENTALS OF BIOCHEMISTRY AND CARBOHYDRATE METABOLISM **[Contact Hours 15]**

UNIT 1: pH, Buffer and thermodymamics: Principles of pH, buffer; Introduction to thermodynamics; Laws of thermodynamics
UNIT 2: Enzymes: Classification and properties of enzymes; Enzyme kinetics; Michaelis Menten Equation; Enzyme inhibition
UNIT 3: Carbohydrate: Carbohydrate structure; Aerobic and anaerobic glycolysis; Citric acid cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, Pentose phosphate pathway; Disorders: Diabetes mellitus

Module II:LIPID AND PROTEIN METABOLISM **[Contact Hours 15]**

UNIt 4: Lipid: Structure and classification, Fatty acid synthesis, Fatty acid oxidation (saturated and unsaturated), Metabolism of glycerophospholipids, Sphingolipids, cholesterol; Disorders: fatty liver types (NAFL, AFL)
UNIT 5: Protein: Protein Structure (primary, secondary, tertiary), Classification of Proteins, Amino acid biosynthesis, Nucleotide biosynthesis, Amino acid catabolism, Urea cycle, Fate of carbamoyl P; Disorders: Hyper uricemia

Module III:NUCLEOTIDE METABOLISM AND INTEGRATION OF METABOLISM

[Contact Hours 15]

UNIT 6: Nucleic acid: Biosynthesis of purine and pyrimidine (de novo and salvage pathway); Degradation of purine and pyrimidine

UNIT 7: Inter conversions of biomolecules: Interconversions between the three principal components; Metabolism in starvation: Carbohydrate, lipid, proteins (The feed/fast cycle)

Practicals **[Contact Hours 30]**

1. Principle and working of spectrophotometer**[02 hours]**
2. Estimation of reducing sugars DNSA method**[02 hours]**
3. Estimation of protein – Folin Lowry's method**[02 hours]**
4. Estimation of fatty acids by titration method**[02 hours]**
5. Separation of lipids by thin layer chromatography**[04 hours]**
6. Colorimetric estimation of liver glycogen of chick by Anthrone method**[04 hours]**
7. Effect of substrate concentration on amylase activity**[04 hours]**
8. Estimation of DNA by DPA method**[04 hours]**
9. Practical assessments **[06 hours]**

Reference books:

1. *Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John 1. David, L.N. and Cox, M. Michael (2008) Lehninger principles of biochemistry. W.H. Freeman and Company, New York.*
2. *Delvin, T.M. (1997). Textbook of biochemistry with clinical correlations. Wiley liss.*
3. *Harvey, A.R. and Ferrier, D. (2011). Lippincott's Illustrated Reviews Biochemistry. Wolters Kluwer, Lippincott Williams and Wilkins. 5th Edition.*
4. *Pratt, W.C. and K. Cornely 2003 Essential Biochemistry Wiley Publications third edition*
5. *Plummer, M. and D.T. Plummer (1988) Introduction to practical biochemistry. Tata McGraw Hill Education , UK.*

MINOR CORE COURSE

COURSE TITLE: INHERITANCE PATTERN OF GENETIC TRAITS AND DISEASES

Course Code: UG-ZOO-203

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is intended to provide solid understanding of Inheritance pattern of Genetic Traits and Diseases. Students will receive good foundation of inheritance patterns of traits and disease, genetic alterations in human genome, its effects and diagnosis.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Relate genotype to phenotype and explain gene roles in inheritance.
CLO2: Apply genetic principles to analyze human genetic disorders.
CLO3: Construct and analyze pedigrees to determine inheritance modes.
CLO4: Perform experiments to verify Mendelian inheritance and conduct karyotyping.

Content:

Module I: TRANSMISSION GENETICS **[Contact Hours 15]**

UNIT 1: Modes of Inheritance: Mendels laws of inheritance, test cross, back cross; Gene interactions: 9:3:3:1/12:3:1 / 9:3:4/9:6:1 / 9:7 / 15:1 / 13:3, lethal genes, penetrance; Inheritance of Multiple Alleles and Multiple Genes
UNIT 2: Pattern of Inheritance by Pedigrees: Construction of Pedigrees, Analysis of Pedigree analysis: autosomal, dominant, autosomal recessive, X-Linked dominant, X-linked recessive, Y-linked, Mitochondrial inheritance, Sex limited and Sex influenced and multifactorial inheritance disorders in humans

Module II:HUMAN KARYOTYPE AND CHROMOSOME DISORDERS **[Contact Hours 15]**
UNIT 3: Chromosome Structure: Chromosome morphology- chromatid, centromere, secondary constriction, Chromomere; Heterochromatin and euchromatin; Chromosome structure and organization.
UNIT 4: Chromosomal Aberration: Overview of Numerical aberrations: Types-Aneuploidies and Euploidies, Mosaicism; Structural Abnormalities: Types-Deletions, inversions, Translocations, duplications.

Module III:GENETIC DISORDERS AND DIAGNOSIS **[Contact Hours 15]**

UNIT 5: Chromosome Disorders- Non-disjunction of autosomal chromosomes: Trisomy 21, Trisomy 18 & Trisomy 13 syndrome; Non-disjunction of sex chromosomes: Turner's syndrome, Klinefelter's syndrome, XXY males; Deletions & duplications with examples;
UNIT 6: Overview of sex determination in Humans- Chromosomal, geneic imbalance, X-inactivation.

Practicals[Contact Hours 30]

1. Verification of Mendel's laws - monohybrid cross **[02 hours]**
2. Verification of Mendel's laws - dihybrid cross **[02 hours]**
3. Manual Karyotyping of human chromosome plates: Normal Male and Female, Edward syndrome **[06 hours]**
4. Slide Agglutination Reaction (blood groups-A/AB/O with Rh) **[02 hours]**
5. Observation of permanent slides of chromosomal aberrations/Observation of ultrasound abnormalities **[02 hours]**
6. Exercises for Multiple alleles and Multiple genes **[04 hours]**
7. Construction and analysis of pedigrees **[06 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1) *Gardner EJ, Simmons MJ and Snustad DP (2013): Principles of Genetics, Eighth Edition, John Wiley Publication, Singapore.*
2) *De Robertis EDP, De Robertis EMF (2012): Cell and Molecular Biology, Eigth Edition. Wolter Kluwer Publication, Philadelphia.*
3) *Singh BD (2014): Fundamentals of Genetics. Second Edition, Kalyani Publishers, New Delhi.*
4) *Lewis R (2009): Human Genetics, Concepts and Applications, Seventh Edition. McGraw-Hill International Edition, New York.*
5) *Gangane SD (2009): Human genetics, Third Edition, Reed Elsevier India Pvt Ltd., Haryana India.*
6) *Gardner A, Davies T (2010): Human Geentics, Second Edition, Scion Publishing Ltd, UK.*
7) *Marcus A (2011): Genetics, MJP Publishers, Chennai.*
8) *Verma PS and Agarwal VK (2014): Cell Biology Genetics Molecular Biology, Evolution & Ecology. S Chand and Company PVT LTD, New Delhi.*
9) *Kothari ML, Mehta L, Roychoudhury SS (2009): Essentials of Human Genetics, Fifth edition, University Press Pvt. Ltd. Hyderabad.*

MULTIDISCIPLINARY COURSE

COURSE TITLE: AQUARIUM MAINTENANCE: FRESHWATER AND MARINE FISHES

Course Code: UG-ZOO-MDC 3

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
To learn the basic principles, themes and steps involved in setting up and maintaining an aquarium.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Describe and Evaluate key principles and competencies of entrepreneurship.
CLO2: Develop comprehensive business proposals and understand regulatory requirements.
CLO3: Generate business ideas and create a structured business plan through practical activities.

Content:

Module I:INTRODUCTION TO FISH AQUARIUM & MAINTENANCE **[Contact Hours 15]**
UNIT 01: History of fish keeping, Importance and Potential scope,
UNIT 02: Types of aquaria and setup (Salinity, Temperature & Location, Aquarium accessories)
UNIT 03: Aquarium Filters and types of filtration methods (Mechanical, Chemical & Biological – Nitrogen Cycle)
UNIT 04: Types of aquarium feed – Live and Artificial feed
UNIT 05**:** Precautions to be taken for an ideal aquarium, Study of zoonotic diseases of ornam and them control

Module II: INTRODUCTION TO FRESHWATER AND MARINE ORNAMENTAL FISHES AND PLANTS **[Contact Hours 15]**
UNIT 06: Characters, sexual dimorphism, habits and breeding of Freshwater ornamental fishes - Guppy, Neon fish, Gold fish, Angel fish, siamese fighting fish, barbs, Rasboras, Betta fish, Danios fishes, tetras, Gouramis, loaches and suckermouth catfish
UNIT 07: Characters, sexual dimorphism, habits and breeding of Marine ornamental fishes- Anemone fish, Moorish idol and Butterfly fish
UNIT 08: Ornamental aquatic plants; Criteria of selection for aquarium fishes and plants

Practicals **[Contact Hours 30]**

1. Visit to 02 aquarium outlets to document the ornamental fishes**[04 hours]**
2. Visit to 02 aquarium outlets to investigate type of aquaria**[02 hours]**
3. Assembling Aquaria**[02 hours]**
4. Aquaria glass painting/decoration**[04 hours]**
5. Create a fish tank with the right parameters for fresh water fishes. **[02 hours]**
6. Preparation and composition of formulated fish feeds**[04 hours]**
7. Create a fish tank with the fishes of your choice and setup and give detailed justificati choice. Add a report. **[06 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1) *Singh, S. P. (2019). Aquarium fish: A complete guide. Dhanpat Rai & Co.*
2) *Rajasekaran, K. S. (2020). Freshwater aquaculture: Principles and practice. New India Publishing Agency.*
3) *Shaji, K. P. (2021). Aquaculture: Principles and practices. Academic Publishers.*
4) *Bhattacharya, H. M. (2018). Fishkeeping: A complete guide to the freshwater aquarium. Daya Publishing House.*
5) *Sharma, R. B. (2021). Ornamental fish and aquatic plants. Aavishkar Publishers.*
6) *Nair, A. K. (2020). Aquarium management: A practical approach. New India Publishing Agency.*
7) *Nambiar, S. D. K. (2019). Aquatic plants for the home aquarium. Published by the author.Carcacson, R.H. A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans. Published by Harper Collins Distribution Services.*
8) *Martin, M. (2017). Aquarium Care of Goldfish: A Complete Guide to Care and Breeding. Tetra Press.*
9) *Pawelczyk, M. (2020). The Complete Guide to Freshwater Aquarium Fish. Aquatic Books.*
10) *Sullivan, G. (2019). The New Marine Aquarium: Step-By-Step Setup & Stocking Guide. Howell Book House.*
11) *Alderton, D. (2015). The Marine Fish Tank: A Complete Guide to Setting Up and Maintaining a Successful Marine Aquarium. The Crowood Press.*

SKILL ENHANCEMENT COURSE

COURSE TITLE: BIOLOGICAL DATA ANALYSIS

Course Code: UG-ZOO-SEC 3

Marks: 75[50–Theory;25-Practicals]

Credits: 03 [02 –Theory; 01- Practical]

Contact Hours: Theory: 30 hours (02 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will help students understand the fundamental concepts of biological data collection, visualize data through graphical representation, analyse and interpret the outputs using statistical tests and softwares.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Identify and describe various methods for biological data collection and representation.
CLO2: Analyze and interpret data using appropriate statistical tests and techniques.
CLO3: Analyze biological data using MS Excel and GraphPad Prism for data entry, representation, and statistical calculations.

Content:

Module I: INTRODUCTION TO BIOLOGICAL DATA AND STATISTICS **[Contact Hours: 15]**
UNIT 1: Introduction to Statistics: Overview of statistics in biology; Population vs. sample; Types of statistics: Descriptive and Inferential; Scope and applications of statistics in biology, Basic concepts of population and sample
UNIT 2: Data Collection and Sampling Techniques: Types of data: Primary and Secondary; Categorical and Numerical variables; Levels of Measurement: Nominal, Ordinal, Interval, Ratio; Sampling methods: Random, Systematic, Stratified, and Non-Random Sampling
UNIT 3: Data Organization and Representation Data organization: Frequency tables; Graphical representations: Pie Charts, Bar Graphs, Histograms, Line Graphs, and Scatter Plots.

Module II: DESCRIPTIVE AND INFERENTIAL STATISTICS **[Contact Hours 15]**
UNIT 4: Descriptive Statistics: Measures of Central Tendency: Mean, Median, Mode, Quartiles; Measures of Dispersion: Range, Variance, Standard Deviation, Interquartile Range

UNIT 5: Data Visualization Techniques: Histograms, Bar Graphs, line graphs, Pie Charts, Box Plots, Scatter Plots

UNIT 6: Inferential Statistics: Probability Concepts: Basic probability, conditional probability, Bayes' theorem; Hypothesis Testing: Null and alternative hypotheses, Type I and Type II errors, t-tests (Independent and Paired), Fisher's exact test, risk assessment in epidemiological studies, ANOVA (One-Way and Two-Way)
UNIT 7: Correlation and Regression Analysis: Pearson and Spearman correlation coefficients; Simple linear regression and multiple regression analysis

Practicals **[Contact Hours 30]**

1. Introduction to Biological data analysis: Experimental design and data collection in lab settings; Data analysis techniques specific to lab research; Case studies: Analyzing results from lab experiments (Experimental, Biodiversity field based, Epidemiological data) **[02 hours]**
2. MS Excel as a tool for Biological data analysis: Data entry and tabulation **[02 hours]**
3. MS Excel as a tool for Biological data analysis: Data analysis (Data representation : Bar graphs scatter plots , histograms , pie charts , correlation) **[04 hours]**
4. Easy Calculation as a tool for Biological data analysis (standard deviation , mean, average fishers exact test) **[02 hours]**
5. Graph pad prism as a tool for Biological data analysis :Data analysis(standard deviation , mean, average , chi square , fishers exact test, Risk calculations and interpretation) **[04 hours]**
6. Biodiversity field based study – Data Analysis – use of Shannon Weiner index **[04 hours]**
7. Project Based – Activity for Data collection: Data collection, representation and Analysis *(adopting suitable techniques for data collection in field studies and analysis)* **[06 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1. *Gurumani,N.(2019).AnIntroductiontoBIOSTATISTICS.SecondRevisededition.M .J.PPublishers.Chennai.*
2. *Rastogi,B.V.(2015).Biostatistics.ThirdRevisededition.Medtech.Chennai.*
3. *Antonisamy,B.,Christopher,S.,andSamuel,P.(2010).Biostatistics:PrinciplesandP ractise.TattaMcGrawHillEducationPvt Ltd.NewDelhi.*
4. *Whitlock,M.C.andSchluter,D.(2014).TheAnalysisofBiologicalData.2ndEdition, W.H.Freeman&Company.*
5. *Rosner,B.(2016).FundamentalsofBiostatistics.EightEdition.CengageLearning,B oston,USA.*
6. *Taveras, J.L. (2016). R for Excel Users: An Introduction to R for Excel Analysts. CreateSpaceIndependent Publishing Platform*
7. *Alexander,M.Kusleika,D.Walkenbach,J.(2019).Excel2019Bible:TheComprehen siveTutorialResource.John Wiley&Sons,Inc.Indianapolis.*
8. *Taveras, J.L. (2016). R for Excel Users: An Introduction to R for Excel Analysts. CreateSpaceIndependent Publishing Platform.*
9. *James,G.(2013).Anintroductiontostatisticallearningwithapplicationin R.Vol.112. NewYork:Springer.*
10. *Acharya,S.(2020).DataAnalyticsusingR.McGrawHillEducation.*

SEMESTER IV

UG-ZOO-204 Endocrinology & Assisted reproductive technologies
UG-ZOO-205 Basic Microbiology and Fundamentals of Animal Biotechnology
UG-ZOO-206 Immunology
UG-ZOO-207 Techniques of Fish processing, Preservation and Aquarium maintenance
UG-ZOO-VOC1 Research methodology for Biological sciences

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: ENDOCRINOLOGY AND ASSISTED REPRODUCTIVE TECHNIQUES

Course Code: UG-ZOO-204

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practical: 30 hours (01 practical/week)

Course Objectives:
This course is intended to provide an understanding of the endocrine organs and physiology of human reproduction and infertilities associated. underlying principles of hormone functions. Students will gain an insight into the current and important issues in endocrinology, prenatal diagnosis and ethics and laws pertaining to reproductive technology.

Course Learning Outcomes:

Upon successful completion of the course, students should be able to:
CLO1: Describe the association of hormones with functions in growth, metabolism, reproduction, and development.
CLO2: Explain the aetiology of endocrine disorders and reproductive biology concepts.
CLO3: Propose reproductive technologies and elucidate the laws governing assisted reproductive technologies (ART).
CLO4: Demonstrate practical skills in endocrine techniques through hands-on laboratory experiences.

Content:

Module I: INTRODUCTION TO ENDOCRINE SYSTEM **[Contact Hours 15]**
UNIT 1: Introduction and Techniques In Endocrinology- Aim and scope of endocrinology; Hormones- Classification, structure and functions; Regulation of hormone secretion: feedback mechanisms (positive, negative, short and long loop); Techniques in endocrinology - Histology, Histochemistry, Immuno-cytochemistry, In-situ hybridisation, Radio immune assay, surgical techniques.
UNIT 2: Anatomy and Histology of Endocrine Glands- Pituitary, Pineal gland, Thyroid, Parathyroid, Thymus, Adrenal, Endocrine pancreas, GI tract, Endocrine hypothalamus, Gonads, Placenta

Module II: ENDOCRINE CONDITIONS AND INTRODUCTION TO REPRODUCTIVE BIOLOGY **[Contact Hours 15]**
UNIT 3: Endocrine Conditions- Calcium and Glucose Homeostasis; Growth factors - neurotropic growth factors, hematopoietic growth factors, other peptide growth factors; Endocrine disorders - goitre, gigantism, dwarfism, cretinism, diabetes mellitus, insipidus
UNIT 4: Reproductive Biology- Male reproductive system: Anatomy and overview of physiology; Female reproductive system: Anatomy and overview of physiology; Infertility in males and females: Types, causes (including endocrine basis)

Module III: ASSISTED REPRODUCTIVE TECHNIQUES **[Contact Hours 15]**

UNIT 5: Infertility: Definition and epidemiology of infertility; Male and female factors contributing to infertility; techniques and procedures for diagnosing infertility (semen analysis, hormonal assays, genetic testing, ultrasound, DNA Fragmentation Index (DFI), BBT test, Swim Count Sperm Quality test and Fertility SCORE).

UNIT 6: Assisted reproductive technologies: History and types (IUI, IVF, ICSI, GZIT, ZIFT,PIGD); Techniques, indications and consideration for IUI, IVF, ICSI, GZIT, ZIFT,PIGD, INVOcell Technology,

UNIT 7: Surrogacy and Laws Governing A-R-T: Definition, concepts and Types of surrogacies, process and ethics. Commercialization of surrogacy; Laws governing Reproductive technologies - PNDT act, gender equality/inequality component of laws governing ART in India.

Practicals **[Contact Hours 30]**

1. Histological slides of Endocrine hypothalamus, Gonads, Placenta Pituitary, Pineal gland, Thyroid gland, Parathyroid, Thymus, Adrenal gland, Pancreas, Ovary, Testis**[06 hours]**
2. Display of Pituitary and gonads in fishes/chick**[02 hours]**
3. Preparation of histological slides using microtomy**[08 hours]**
4. Diagnosis of pregnancy by ELISA test**[02 hours]**
5. Nigrosin-Eosin sperm vitality test**[02 hours]**
6. Seminar/Interaction with a doctor on reproductive disorders/ contraceptive methods **[02 hours]**
7. Visit to infertility clinic/museum/hospital **[02 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1. *David, N.O. and J.A. Carr (2013) Vertebrate Endocrinology. Academic press publications 5th edition.*
2. *Hadley, M. and Levine, J (2006) Endocrinology. Benjamin Cummings 6th edition.*
3. *Kovacs, J.W. and S.R. Ojeda (2011) Textbook of endocrine physiology 6th edition. Oxford university press.*
4. *Yadav, P.R (2004) Endocrinology. Discovery Publishing House, New Delhi.*
5. *Jones R and Lopez KH. (2013). Human Reproductive biology, 4th Edition, Academic Press. ISBN: 9780123821850 99(E book available).*
6. *Bittar E. (1998). Reproductive Endocrinology and Biology, Vol 12. Elsevier Science.*
7. *Gardner DK. (2011). Human Assisted Reproductive Technology. Cambridge University Press.*
8. *Rao KA,Howard C and Fischer R. (2016). Principles & Practices of Assisted Preproductive Technology. Jaypeedigital publishers.*

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: BASIC MICROBIOLOGY AND FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY

Course Code: UG-ZOO-205

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
To provide a comprehensive survey of microbiology with basic information on bacteria and learn the funda biotechnological techniques.

Course Learning Outcomes:

Upon successful completion of the course, students should be able to:
CLO1: Describe the structure, culture, and significance of bacteria in biotechnology.
CLO2: Identify and utilize various biological tools and techniques in biotechnology.
CLO3: Explain genetic engineering methods, including gene cloning and sequencing techniques.
CLO4: Demonstrate practical skills in basic microbiological techniques and laboratory procedures.

Content:

Module I:MICROBIOLOGY **[Contact Hours 15]**
UNIT 1: Introduction to Micro-organisms- Bacteria Structure; Identification of bacteria (morphological types); Nutritional types; Reproduction in bacteria; Nutritional requirements- media and its maintenance
UNIT 2: Isolation and Culture of Bacteria- Cultivation of bacteria; Different methods of isolation and maintenance of pure cultures; Culture characteristics
UNIT 3: Use of microorganisms in Biotechnology: An overview- Production of valuable substances, Fuel Production, Recovery of minerals and oils, Microorganisms in bioassays, Food and agriculture sector, Medicine and health

Module II: TOOLS IN BIOTECHNOLOGY **[Contact Hours 15]**
UNIT 4: Scope and importance of Biotechnology-Biotechnology: Definition; Old and Modern Biotechnology: An overview; Biotechnology: Scope and Importance
UNIT 05:NucleicAcidEnzymology- Restriction enzymes, Ligases, Alkaline Phosphatase, Polynucleotide kinase, Terminal Transferase, S1Nuclease, Polymerases and Reverse transcriptase
UNIT 06:GeneCloningVectors- Plasmids, Bacteriophages, Cosmids, Shuttle and expression vectors

Module III:GENETIC ENGINEERING **[Contact Hours 15]**
Unit 07:Techniques In GeneticEngineering- Gene transfer methods; Methods of Labeling Nucleic acids; Nucleic acid Hybridization; Polymerase chain reaction; Genomic library; Colony and Plaque Hybridization.
Unit 08:RecombinantDNATechnology- Procedure/Technique
Unit 09: Blotting Techniques- Southern Blotting, Northern Blotting, Western Blotting

Unit 10: DNA sequencing Techniques- Chemical Degradation method, Chain termination method, Automated Sequencing

Practicals **[Contact Hours 30]**

1. Introduction to basic laboratory techniques in Microbiology Laboratory **[02 hours]**
2. Staining of Microorganisms (Gram staining, negative staining) **[04 hours]**
3. Preparation of culture media for bacteria(Plates, Slants, deeps, Broth) **[06 hours]**
4. Isolation of pure colonies of Bacteria(streak plate method –3 Quadrant And 5 Quadrantmethods) **[04 hours]**
5. Identification of Products of metabolic pathways of microbial cells **[04 hours]**
6. Bacteriological testing of Milk **[02 hours]**
7. DNA sequencing-Analysis of prints **[02 hours]**
8. Practical assessments **[06 hours]**

Reference books:

1) *DubeyRCandMaheshwariDK(2012).AtestbookofMicrobiology.SChandPublishers,NewDelhi.*
2) *PelczarMJ,ChanECS,KriegNR(2009).Microbiology.TataMcGrawHill,NewYork.*
3) *PraveP,FaustU,SittigWandSukatshDA(2004).FundamentalsofBiotechnolgy.*
4) *PurohitSS(2008).BiotechnologyFundamentalsandapplications.Agrobios,JodhpurIndia.*
5) *RangaMM(2012):AnimalBiotechnology.Agrobios,JodhpurIndia.*
6) *BlackJG(2005).Microbiologyprinciplesandexplorations.JohnWileyandsonsInc*
7) *SulliaSBandShantharamS(2006).GeneralMicrobiology.OxfordandIBHPublishingCoPvtLtd,NewDelhi*.
8) *GunasekaranP(2009).LabManualinMicrobiology.NewAgeInternationalLtd.Publishers,NewDelhi.*

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE:IMMUNOLOGY

Course Code: UG-ZOO-206

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course will make the students learn about the structural features of the components of the immune system as well as their functions, and understand the mechanisms involved in immune system development and responsiveness.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CLO1: Describe the components and functions of the immune system.
CLO2: Explain the mechanisms underlying the immune response, including innate and adaptive immunity.
CLO3: Analyze the roles of cytokines, the complement system, and immune dysfunctions.
CLO4: Demonstrate practical skills in basic immunological laboratory techniques and assays.

Content:

Module I:INTRODUCTION TO IMMUNOLOGY **[Contact Hours 15]**
UNIT 1: Overview Of Immune System- Basic concepts in immunology, Components of the immune system
UNIT 2: Innate And Adaptive Immunity- Innate immunity: Anatomical barriers/ layers of defense; Cells and molecules involved in innate immunity; Adaptive immunity- cell mediated and humoral immunity, passive immunity (artificial and natural), Active (artificial and natural), Immune dysfunction.

Module II:ANTIGENS AND IMMUNOGLOBINS **[Contact Hours 15]**
UNIT 3: Antigens- Antigenicity and immunogenicity, Immunogens; adjuvants and haptens; Factors influencing immunogenicity; B and T cell epitopes
UNIT 4: Immunoglobulins- Structure and function of different classes of Immunoglobulin; Antigen-Antibody interactions; Immunoassays, monoclonal & polyclonal antibodies
UNIT 5: Major Histocompatibility Complex- Structure and function of endogenous and exogenous pathways of antigen presentation

Module III: IMMUNE RESPONSES **[Contact Hours 15]**
UNIT 6: Cytokines and Complement System- Properties and functions of cytokines, cytokine-based therapies; Components and pathways of complement activation
UNIT 7: Hypersensitivities, Autoimmunity and Transplantation- Gell and Coombs' classification, types of hypersensitivities(overview); Autoimmune responses against self-antigens (SLEs), responses to alloantigens and transplant rejection (graft rejection), types and mechanisms of transplant rejection.

UNIT 8: Vaccines- Types of vaccines: inactivated, attenuated, toxoid, subunit, conjugate, experimental (DNA and recombinant vaccine), monovalent/polyvalent vaccines.

Practicals **[Contact Hours 30]**

1. Preparation of serum from goat blood. **[04 hours]**
2. Agglutination Reaction (blood groups – A / AB / O with Rh) **[02 hours]**
3. Differential count of leukocytes **[02 hours]**
4. Detection of presence of antigen/antibody- Simple immuno diffusion **[02 hours]**
5. Antibody Titre determination- Ouchterlony immunodiffusion. **[02 hours]**
6. Antigen–antibody reaction by immunoelectrophoresis. **[04 hours]**
7. Serological tests involving precipitations (Pregnancy & Widal) **[02 hours]**
8. Phagocytosis – WBC (demonstration) **[02 hours]**
9. Practical assessments **[06 hours]**

Reference books:

1) Abbas KA, LechtmanHA(2016). Basic Immunology.V edition. Elsevier Publication.
2) David M, Jonathan B, David RB and Ivan R(2006). Immunology. VII Edition, Mosby, Elsevier Publication.
3) Abbas KA, Lechtman HA (2006). Cellular and Molecular Immunology. VI edition. Elsevier Publication.
4) Kindt TJ, Goldsby RA, Osborne BA and Kuby J(2006). Immunology. VI edition. W H Freeman and company.
5) Frank SA(2002).Immunology and evolution of infectious diseases. Princeton University Press, Princeton and Oxford.
6) Zabriskie JB(2009). Essential Clinical Immunology. Cambridge UniversityPress.
7) Mohanty SA and Leela SK (2014). Textbook of Immunology. Jaypee Brothers Medical Publishers
8) Talwar GP and Gupta SK(2012).A handbook of practical and Clinical Immunology, CBS publishers.

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: TECHNIQUES OF FISH PROCESSING, PRESERVATION, AND AQUARIUM MAINTENANCE

Course Code: UG-ZOO-207

Marks: 100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course explores the techniques and practices involved in fish processing and preservation, as well as the fundamentals of aquarium maintenance. Students will learn practical skills and theoretical knowledge essential for ensuring the quality and longevity of fish products and maintaining healthy aquatic environment for aquarium set up with the right selection of components.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to

CLO1: Demonstrate proper fish handling and processing techniques, including filleting and the creation of value-added fish products.
CLO2: Evaluate and implement various fish preservation methods to ensure product safety and quality, incorporating traditional practices.
CLO3: Design and maintain aquariums, selecting appropriate species and managing ecosystems while addressing potential health issues in ornamental fish.
CLO: Demonstrate practical skills in identifying fishes, preparing fillets, and applying preservation methods, and setting up an aquarium culminating in a comprehensive report.

Content:

Module 1: FISH HANDLING AND PROCESSING **[Contact Hours 15]**
UNIT 1: Introduction to Fish Handling: Importance of proper fish handling techniques; Best practices for minimizing stress and injury to fish; Handling equipment and safety measures
UNIT 2: Fish Processing Techniques: Overview of fish processing methods; Hygiene and safety regulations in processing; Processing equipment and technologies
UNIT 3: Filleting and Cutting Techniques: Filleting and portioning fish, canning; Techniques for minimizing waste; Quality assessment of fish cuts.
UNIT 4: Value added Fish products – Fish Liver Oil, Fish Body Oil, Fish Meal, Fish Manure, Fish Flour, Isinglass, Fish Silage, Fish Sausage, Fish Biscuits, Fish Roe and Caviar, Fish flakes, Fish wafers, fish noodles, Fish sauces etc
UNIT 5: Traditional Knowledge/IKS: Marine and Inland Fishing Crafts and Gears used in Goa, traditional methods of Fishing, Local processing methods of Pisces and non-Pisces products (*Including goan cuisine).*

Module 2: PRESERVATION TECHNIQUES **[Contact Hours 15]**

UNIT 6: Economically important fishes (Mackerels, Kingfish, Sardines, Catfish, Stingray, Hilsa, Tuna, Pomfrets, Bombay Duck, Anchovies, Ribbonfish / Non-pisces: Mussels, Oysters, Prawns (*Penaeid and Palaemonid*), crabs, squids.

UNIT 7: Fish Preservation Methods: Overview of preservation techniques: freezing, drying, salting, smoking, and curing; Principles of food preservation and shelf-life extension; Packaging methods for preserved fish.

UNIT 8: Traditional Knowledge/IKS: Local techniques of Fish preservation - Balchão (Bombil, prawn, tigerprawns), Molhe (Bombil, kingfish, mackrel, prawns, squids), Parra (mackrel), Sundrying(Galmo, Ribbonfish, mackrels, stingray, anchovies, Bombay duck, Shark).

UNIT 9: Quality Control and Safety in Fish Products: Fish quality standards and grading; Common contaminants and food safety regulations; Sensory evaluation of fish products.

Module 3: AQUARIUM SET-UP AND MAINTENANCE **[Contact Hours 15]**

UNIT 7: Aquarium Set-Up: Types of aquaria and setup; Factors- Salinity, Temperature & Location, Aquarium accessories; Aquarium Filters and types of filtration methods; Types of aquarium feed – Live and Artificial feed; Ornamental aquatic plants (Mechanical, Chemical & Biological – Nitrogen Cycle); Ornamental aquatic plants

UNIT 6: Fish Selection: Criteria of selection for aquarium fishes and plants; Characters, sexual dimorphism, habits and breeding of freshwater ornamental fishes (Guppy, Neon fish, Gold fish, Angel fish, Siamese fighting fish, barbs, Rasboras, Betta fish, Danios fishes, tetras, Gouramis, loaches and sucker mouth catfish); Marine ornamental organisms (Anemone fish, Moorish idol and Butterfly fish); Zoonotic diseases of ornamental fishes and their control.

Practicals **[Contact Hours 30]**

1. Identification of Important edible prawns, shrimps and crabs (any two), Important Freshwater and Marine edible fishes- oil sardine, sole fish, white sardine, mullet, Scianera**[04 hours]**
2. Study of Fish Parasites – Ectoparasites (gills); endoparasites (gut) **[02 hours]**
3. Preparation of fish Fillet **[02 hours]**
4. Method of fish preservation (salting, pickling) **[04 hours]**
5. Visit to Fish processing Centre/ Fishing Co-operative Society/ Fishery Institute/ Fish Survey of India/Fish landing Centre/Fish Market **[04 hours]**
6. Visit to 02 aquarium outlets to investigate type of aquaria commonly preferred by customers. **[02 hours]**
7. Preparation and composition of formulated fish feeds **[02 hours]**
8. Create a fish tank with the fishes of your choice and setup and give detailed justification for the choice (with aquaria glass painting and decor) Add a report. **[04 hours]**
9. Practical assessments **[06 hours]**

Reference books:

1) Rahman, R. M. S. M. (2020). Fish processing: Sustainability and new technologies. Wiley.
2) Shankar, V. A. K. G. (2021). Aquaculture and fisheries management. Springer.
3) Prasad, B. S. M. S. (2019). Principles of fishery science. Daya Publishing House.
4) Ranjan, S. M. (2021). Aquarium fish: A complete guide to care and maintenance. New India Publishing Agency.
5) Thakur, R. K. R. B. (2020). Fish and fishery products: Quality, safety, and technology. CRC Press.

DISCIPLINE SPECIFIC VOCATIONAL COURSE

COURSE TITLE: RESEARCH METHODOLOGY FOR BIOLOGICAL SCIENCES

Course Code: : UG-ZOO-VOC1

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is designed to introduce the students to fundamentals of research methodology, familiarize them with the scientific process and research design and emphasize the importance of ethics and responsible conduct in research

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:

CLO 1: Explain the significance and characteristics of in biological research and differentiate between various types of research.
CLO 2: Suggest appropriate data collection techniques and experimental methods, and statistical tools for biological research.
CLO 3: Adopt appropriate data collection techniques, and analyze biological data effectively and draw valid conclusions.
CLO 4: Demonstrate proficiency in scientific writing by drafting research paper and formulating research proposals.

Content:

Module I: 1. OVERVIEW OF RESEARCH IN BIOLOGICAL SCIENCES **[Contact Hours 15]**
UNIT 1: Definition and significance of research, characteristics of research, Types of research (basic & applied, quantitative and qualitative, deductive and inductive, experimental and non-experimental.
UNIT 2: Scientific Method: Formulating research questions and hypotheses, Scientific elements-Variables, controls, and reproducibility, Types of research design (Experimental, observational, case-control, cohort studies).
UNIT 3: Ethics in Biological research: Ethical considerations: Animal welfare, human subjects, and environmental impact; regulatory bodies in India governing ethical clearance, 02 case studies and dilemmas.

Module II: DATA COLLECTION AND ANALYSIS **[Contact Hours 15]**
UNIT 4: Data Collection Techniques: Sampling methods- Random, stratified, and systematic sampling; Techniques in biological research- Surveys, fieldwork, laboratory experiments, and observational studies.
UNIT 5: Experimental Techniques and Instrumentation: Application of common biological research tools and techniques- Microscopy, Spectroscopy, PCR, Electrophoresis, Blotting techniques, cell culture techniques, animal models in behavioural studies, bioinformatics, epidemiology.

UNIT 6: Statistical Analysis: Introduction to statistical concepts- Descriptive vs. inferential statistics; introduction to statistical softwares for field data and lab data.

Module III: WRITING AND PRESENTING RESEARCH WORKS **[Contact Hours 15]**

UNIT 7: Scientific Writing: Structure of a scientific paper/dissertation/: Abstract, Introduction, Methods, Results, Discussion, conclusion and References; Drafting research proposal.

UNIT 8: Literature review: Conducting literature review, Identifying research gaps and formulating research questions.

UNIT 9: Creating Effective Research Posters and Presentations: Structuring and designing posters for conferences; Preparing for oral presentations.

UNIT 10: Publishing research works: Understanding the publication process- Choosing journals, peer review, and ethical considerations; Open access vs. subscription-based journals;

Practicals **[Contact Hours 15]**

1) Familiarise with equipments/instruments used in biological research.(2 hrs)
2) Design a research study for biodiversity studies(4 hrs)
3) Project based Practical(12 hrs):
    1) Field based survey for collecting biological data (4 hrs)
    2) Writing research paper (4hrs)
    3) Preparation of research poster (2 hrs)
    4) Presentation of research findings (mock conference) (4hrs)
    5) Drafting research proposal (4hrs)
4) PA (6 hrs)

Reference books:

1) *Kumar R(2018).Research Methodology: A Step-by-Step Guide for Beginners, Sage publishers*
2) *Rao GPN(2019). Research Methodology in Biological Sciences.*
3) *Gurumani N(2011)Research Methodology for Biological Sciences. MJP publishers*
4) *Taylor NM and Lasker G(2005). Research Strategies in Human biology: Field and survey studies, Cambridge university press .*
5) *Arumugam N(2019)Research Methodology for Biological Sciences. Saras publishers*
6) *Vukanti RV (2018)Basic Research Techniques in Biology : Research Techniques in Biology. Notion Press Publishers.*

SEMESTER V

UG-ZOO-301 Health & Nutrition
UG-ZOO-302 Developmental Biology
UG-ZOO-303 Ecology And Environmental Toxicology
UG-ZOO-PRJ Project(a)
UG-ZOO-VOC2 Wildlife Photography

DISCIPLINE SPECIFIC CORE COURSE

COURSE TITLE: HEALTH & NUTRITION

Course Code: UG-ZOO-301

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is an introduction to the nutrients, their functions and role in maintaining good health of humans. It will give an insight into the nutritional requirements of humans and diseases associated with nutrient deficiency or over-dose. It will also enable students to interprete food labels and prepare diet plans for different age groups.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:

CLO1: Explain the nutritional requirements for humans at different life stages and the impact of a balanced diet and malnutrition.
CLO2: Interpret food labels and assess food quality and safety while analyzing key nutrient properties.
CLO3: Analyze how lifestyle choices and dietary habits contribute to diseases and nutritional deficiencies.
CLO4: Perform and evaluate results of food tests and Design diet plans for various age groups.

Content:

Module I: BASIC CONCEPT OF FOOD AND NUTRITION **[Contact Hours 15]**
UNIT 1: Overview of health and nutrition:
Definition of health and nutrition; Scope of nutrition, food as a source of nutrients; Nutrients and energy ; Adequate, optimum and balanced diet ; Malnutrition and health.
UNIT 2: Nutritional Biochemistry (Overview)
Carbohydrates, lipids, proteins - definition, classification, structure and properties; Significance of acid value, iodine value and saponification value of lipids; Essential and non-essential amino acids; Enzymes- definition, classification, properties (overview); Coenzymes, vitamins (fat soluble and water soluble), structure and properties ; Minerals- iron, calcium, phosphorus, iodine, selenium and zinc and their properties

Module II: NUTRIENTS AND DIETARY PATTERN FOR HUMANS **[Contact Hours 15]**
UNIT 3: Functions of food components of food-nutrients
Overview of the Vitamins and minerals - Dietary sources of macro and micronutrients(carbohydrates, lipids and proteins, fat soluble vitamins-A, D, E and K , water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin - C Minerals – calcium, iron and iodine).
UNIT 4: Changes in Nutrient values
Changes of nutrient value during cooking of the following food groups: cereals, pulses, vegetables and meats; Methods of cooking and Nutrient loss - dry, moist, frying and microwave cooking. Canning of food.

UNIT 5: Nutrition and Dietetics

Physiological considerations, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, pre-school and school children, adolescents and geriatric nutrition; Nutrient labels; Diet plans for different age groups

Module III: DIET AND HEALTH **[Contact Hours 15]**

UNIT 6: Food based dietary guidelines, enhancing the nutritional quality of the diet.

UNIT 7:Health and diseases

Major nutritional deficiency diseases- Protein energy malnutrition, Vitamin deficiency, Iron deficiency anaemia, Iodine deficiency disorders (causes, symptoms, treatment, prevention and government programmes, if any); *Diet influenced Life style disorders*- Causes and prevention through dietary/lifestyle modifications of a) Obesity, b)hypertension, c)hyperurecimia, 4)diabetes mellitus, 5)polycystic ovarian syndrome (PCOS), 6)irritable bowel syndrome (IBS).

UNIT 6: Traditional Knowledge (IKS): Traditional Nutritional habits of Goa for healthy lifestyle (Regular diet, Diet for lactating mothers, diet for disease recovery patients, diet variations associated with seasons and local festivals of Goa).

*UNIT 7: Food hygiene*s

Potable water- source and methods of purification at consumer level; Brief account of food spoilage: Causes and preventive measures; Common ailments- contaminated food & water, constipation (causes and dietary management)

Practicals **[Contact Hours 30]**

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric e) Honey (06 hrs)
2. Estimation of lactose in milk *(Qualitative and quantitative)* (04 hrs)
3. Titrametic estimation of:
   - Ascorbic acid estimation in food (02 hrs)
   - Calcium in food(02 hrs)
4. Observation of any two grain pests(02 hrs)
5. Project based (any 2)
   - Identify nutrient rich sources of foods, their seasonal availability and price (04 hrs)
   - Study of nutrition labeling on selected foods(04 hrs)
   - Documentation of traditional Nutritional habits of Goa for healthy lifestyle(04 hrs)
6. PA (06 hrs)

Reference books:

1) *Rangnath, R. (2020). Fundamentals of nutrition and diet therapy. Jaypee Brothers Medical Publishers.*
2) *Ghosh, S., & Ray, S. (2019). Nutrition and health: A comprehensive guide. New India Publishing Agency.*
3) *Sharma, R. (2021). Health and nutrition: Concepts and applications. Academic Publishers.*
4) *Kumar, P., & Gupta, R. (2020). Nutritional science and health. CBS Publishers & Distributors.*
5) *Bansal, R., & Singh, A. (2019). Public health nutrition in India. Springer India. Wardlaw GM, Hampl JS. (2007). Perspectives in Nutrition; Seventh Ed; Mc Graw Hill.*
6) *Lakra P, Singh MD. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.*

COURSE TITLE: DEVELOPMENTAL BIOLOGY

Course Code: UG-ZOO-302

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
To provide a comprehensive understanding of the concepts of early animal development. Compare and contrast various events that occurs during gametogenesis, cleavage and fertilization. To understand the embryological processes through direct observation of chicken eggs

Course Learning Outcomes:
Upon successful completion of the course, students will be able to
CLO1: Explain the basic processes of early embryonic development.
CLO2: Describe gametogenesis, fertilization, and early developmental stages in some organisms.
CLO3: Analyze early developmental processes in model organisms, focusing on their embryological significance
CLO4: Demonstrate techniques of invitro observation of embryo and the process of regeneration.

Content:

Module I: EARLY EMBRYONIC DEVELOPMENT **[Contact Hours 15]**
UNIT 1: Introduction to cell cycle and cell division: mitosis and meiosis.
UNIT 2: Basic concepts of developmental Biology: Gametogenesis-Spermatogenesis and Oogenesis; Structure of the gametes; Fertilization: Species recognition specificity of egg and sperm, Gamete fusion and the prevention of polyspermy, The activation of egg metabolism, Fusion of the genetic material, Rearrangement of the egg cytoplasm, Significance of fertilization.
UNIT 3: Types of eggs and cleavage, Blastulation,gastrulation, Fate of germ layers and fate maps.

Module II: EARLY DEVELOPMENT OF MODEL ORGANISM. **[Contact Hours 15]**

UNIT 4: Model organism Sea Urchin: Systematic position, Reasons for Sea Urchin embryology, Fertilization, Cleavage, Blastulation, Gastrulation, Fate maps of Sea Urchin

UNIT 5: Model organism Chick: Systematic position, Reasons for Chick Embryology, Reproduction, Fertilization, Cleavage, Blastulation, Gastrulation

UNIT 6: Development upto three days of incubation: Neurulation, Somitogenesis, Mesogenesis; Development for 3 days (24 hrs, 36 hrs, 48 hrs, 56 hrs and 72 hrs); Extra Embryonic membranes of chick: development, structure and functions of yolksac, amnion, chorion and allantois.

Module III: GROWTH AND REGENERATION **[Contact Hours 15]**

UNIT 7: Nuclear transplantations and embryonic inductions

UNIT 8: Size and proportion, aging, theories of ageing, postnatal disorders of growth and differentiation

UNIT 9: Distribution of regenerative capacity, Planarian regeneration, regeneration of limb and tail in vertebrates: Hejmadi Mohanty's experiment

Practicals **[Contact Hours 30]**

1. Study of developmental stages of frog through permanent slides: Cleavage, blastula, gastrula (02hrs)
2. Study of developmental stages of Chick through permanent slides: 18, 24, 36, 48, 72, and 96 hours of incubation(04hrs).
3. Window opening technique for study of morphogenetic movement in hens egg (02hrs)
4. Preparation of permanent slides of chick embryo: 24hours, 36hours, 48hours, 72hours (06 hrs)
5. Invitro observation of different extra embryonic membrane in a six days old chick embryo (02 hrs)
6. Mounting of eye vesicles and limb buds of six-day old chick embryo (04 hrs)
7. Comparison of Effect of retinoic acid and aspirin on fin regeneration of fish (04 hrs)
8. PA (06 hrs)

Reference books:

1. *Saha, S. (2021). Developmental biology: A comprehensive approach. Academic Publishers.*
2. *Mishra, S. K., & Singh, A. (2020). Fundamentals of developmental biology. New India Publishing Agency.*
3. *Patel, S. S., & Chatterjee, S. (2019). Principles of developmental biology. CBS Publishers & Distributors.*
4. *Basu, S. (2020). Developmental biology: From embryo to organism. Springer India.*
5. *Dutta, A. (2021). Essentials of developmental biology. Himalaya Publishing House. BeffaMari M. and Knight J. (2005) Key experiments in practical developmental biology. Cambridge University Press.*
6. *Gilberts,S.F. (2013).Developmental Biology, Sinauer Associates, Sunderland.*
7. *Jain,P.C.(2013).Elements of developmental biology, Vishal Publications, Jalandhar*
8. *Slack,J.M.W.(2006). Essential developmental biology*
9. *Tyler,M.S.(2000)Developmental biology, a guide for experimental study. Sinauer Associates, Inc.Publishers,Sunderland,MA.*

COURSE TITLE: ECOLOGY & ENVIRONMENTAL TOXICOLOGY

Course Code: UG-ZOO-303

Marks:100[75–Theory;25-Practicals]

Credits: 04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
To study the distribution of organisms, their interrelations in populations and communities and interactions between biotic and abiotic components and study the impact of environmental pollutants and their toxicity on ecosystem.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:

CLO1: Explain key ecological concepts, including ecosystem dynamics, energy flow, and nutrient cycling of trace elements.
CLO2: Analyze population and community dynamics, focusing on survivorship curves, predator-prey interactions, and community succession.
CLO3: Assess the principles of toxicology, including the sources, types, and environmental impacts of toxicants, such as heavy metals and agro-chemicals.
CLO4: Evaluate the safety and toxicity of food additives and conduct toxicity tests based on exposure duration and species

Content:

Module I: ECOLOGY **[Contact Hours 15]**
UNIT 1: Introduction to Ecology: What is Ecology? History of ecology, ecology today, scope of ecology, objective of study,subdivisions of ecology
UNIT 2: Ecosystem Ecology:kinds of ecosystem,Gaia hypothesis, energy flow within the Ecosystem, food chains, ecological pyramids, ecological niche nutrient and Cycling of trace elements: Cobalt (Co), Molybdenum (Mo) and Lead.
UNIT 3: Population Ecology: survivorship curve and life tables,age distribution,biotic potential of population, growth models, population dispersal, regulation of population, co-operative and disoperative coactions and carrying capacity,predator – prey relationships,symbiosis
UNIT 4: Community Ecology: characters of a community, classification of a community,community periodism, community stratification, community succession

Module II: ENVIRONMENTAL TOXICOLOGY **[Contact Hours 15]**
UNIT 4: Introduction To Toxicology: Definition and History of Toxicology and Toxicity; Disciplines of Toxicology; Biouptake, Bioaccumulation, Biotransfer and Biological Magnification, Relationship to Other Sciences, Scope and importance of Toxicology.
UNIT 5: Classes of Toxicant**:** Toxicant and Toxins, their classification; Toxicants in Air, Water and Soil; Toxicants in Domestic and Occupational Settings; Synthetic drugs: Solvents; Therapeutic drugs, Drugs of abuse, Combustion products, Cosmetics; Movement and fate of Toxicants in the environment
UNIT 6: Agro-Chemical Pesticides and their Environmental Impact Mitigation: Definition, Classification: Organochlorine Insecticides, Organophosphate Insecticides,

Carbamates, Pyrethroid Insecticides, Dinitrophenols, Herbicides, Fungicide; Control of Pesticide Pollution; Integrated Pest management.

Module III: IMPACT OF ENVIRONMENTAL TOXICANTS **[Contact Hours 15]**

UNIT 7: Toxicity Of Heavy Metals: Impact of Toxicity of Arsenic, Lead, Mercury, Cadmium,Copper, Zinc, Aluminium,Iron and Manganese; Sources and portals of heavy metal pollutants; Toxicity of substances on Human and Animals.

UNIT 8: Impact of Food Additives**:** General account of Food Additives: a)Incidental or Indirect additives b) Intentional or Direct additives(Antioxidants, Emulsifiers, Enzymes, Flavouring agents, Colour and preservatives)

UNIT 9: Toxicity testing: Types of toxicity tests; Test types based on number and species; Test types based on exposure of toxicant; Test types based on length of exposure(acute ,sub acute, chronic).

Practicals **[Contact Hours 30]**

6. Study of an aquatic/mangrove ecosystem: Measurement of the area, temperature, turbidity, determination of pH, and dissolved oxygen content (Winkler's method),and free CO_2 (4 hrs).
7. Estimation of total dissolved solids in given water sample. [02 hrs]
8. Estimation of Primary Productivity by Light and Dark bottle method[02 hrs]
9. Separation of carbamate pesticide residues by thin layer chromatography[02 hrs]
10. Qualitative evaluation of the presence of pesticide residues in vegetable samples[02 hrs]
11. Determination of LC50 of a pollutant on mosquito larvae/bivalves [04 hrs]
12. Effect of pesticides on Oxygen consumption in fish[02 hrs]
13. Estimation of Phosphorus or Boron in given water sample by Spectrophotometer [02 hrs]
14. Estimation of Fluorides and Nitrates in given water sample [02 hrs]
15. Field trip/ Case study of polluted water body (4 Hrs)
16. PA (06 hrs)

Reference books:

1. *Ramakrishnan, P. S., & Rajan, K. (2020). Ecology: Principles and applications. Oxford University Press.*
2. *Singh, J. S., & Singh, S. P. (2019). Ecosystem and biodiversity: A comprehensive guide. New India Publishing Agency.*
3. *Kumar, A., & Rani, S. (2021). Fundamentals of ecology and environmental science. CBS Publishers & Distributors.*
4. *Kumar, V., & Shukla, S. (2021). Environmental toxicology: Principles and practices. Academic Publishers.*
5. *Bhatnagar, A., & Vats, S. (2019). Toxicology and environmental health: A comprehensive approach. Springer India.*
6. *Rao, P. S., & Kumar, R. (2020). Essentials of environmental toxicology. Regal Publications.*

VOCATIONAL COURSE

COURSE TITLE: WILDLIFE PHOTOGRAPHY

Course Code: : UG-ZOO-VOC2

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
This course is designed to enable students to understand and effectively apply technical skills of photography to create visually compelling and technically sound wildlife photographs wildlife Photography with understanding of wildlife behaviour.

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:
CO 1: Demonstrate ability to evaluate and select appropriate gear and accessories for diverse wildlife photography scenarios.
CO 2: Develop and execute effective strategies for capturing high-quality images in varying lighting and environmental conditions.
CO 3: Analyze wildlife behaviour to anticipate movements and capture natural and refine wildlife photographs to enhance visual impact.
CO 4: Apply technical skills to create visually compelling and technically sound wildlife photographs.

Content:

Module I: EQUIPMENTS USED IN WILDLIFE PHOTOGRAPHY **[Contact Hours 15]**
UNIT 1: Introduction to wildlife photography
UNIT 2: Types of cameras used in wildlife photography
UNIT 3: Understanding Functions and features of DSLR.: Detail Menu Settings of DSLR camera. features-crop sensor v/s full frame, megapixels, bust rate;
UNIT 4: Understanding Lenses- The basics of lenses - different focal lengths as well as minimum f-values and depth of field; popular wildlife lenses, Zoom lenses vs Prime lenses
UNIT 5: Support systems for cameras-Monopods, tripods, gimbleheads and support arms, etc

Module II: CAMERA SETTINGS FOR WILDLIFE PHOTOGRAPHY **[Contact Hours 15]**
UNIT 6: Camera Mode options- Aperture priority, shutter priority, manual mode, ISO
UNIT 7:Focus: Depth of field – f-stop , focal length, distance from the photo subject; Auto focus mode – lock focus or track focus; Low light conditions – low f-values and high ISO values
UNIT 8: Exposure – over exposure and underexposure effects (metering); White balance - temperature of your images(auto white balance, settings for photographing in JPEG, RAW)
UNIT 9: Night photography – shutter priority, auto ISO, exposure compensation

Module III: PHOTOGRAPHIC SKILLS AND BASICS OF ANIMAL BEHAVIOUR

[Contact Hours 15]

UNIT 10: Light: Understanding concept of Light & its importance for photography (Available/Natural), Direction of light, Types of light, Colour of light, height of light: Capture with front light, pros and cons: Highlight detail and texture with side light: Back light –(early morning and late afternoon effects): Handling harsh light, diffused light; Flashlight and spot light photography

UNIT 11: Composition: What is composition, rules of composition. Capturing animals in the wild- use of wide lens, aperture values, rule of third.; Zooming – use of golden mean, space in frame, maintaining balance(negative space), angle, vertical composition; Using design elements in photography viz. lines, curves, shapes

UNIT 12: Creativity: Black & white wildlife photographs: conditions of high in contrast, lot of texture, editing; High key and low key photos - post-processing of either grossly over-exposed or grossly under-exposed; Blurring the background/foreground; Look for natural frames, reflections, repetition and scale

UNIT 13: Animal behaviour: Habit and habitat of the animals: distribution, habitat preference, activity patterns, specific behaviour, calls/alarm calls,; Understanding bird behaviour for capturing birds in flight. Settings for bird photography – Birds in flight(adjusting shutter speed, depth of field, burst rate, zoom); Photographic hides

Practicals **[Contact Hours 15]**

1) Familiarising functioning and features of an SLR , Mobile camera features and accessories(2 hrs)
2) Field based Practical (04 Hrs):
   a) Still Photography: Flora on the campus
   b) Still Photography: Fauna on the campus
3) Field based Practical (04Hrs):
   a) Photography of Birds and insects in flight
   b) Wildlife photography (chordates /non-chordates)
5) Editing Photos: Photoshop/Mobile photo editing apps (04 Hrs)
6) Project based Practical(12 hrs):
   a) Wildlife – Animal of choice: Resting, feeding, nesting, in flight, natural habitat, colony/brood.
   b) Creating video/short documentary
7) PA (6 hrs)

Reference books:

1) *Cox, R. K. (Ed.). (2022). Wildlife photographer of the year: Portfolio 32. Natural History Museum.*
2) *Melford, M. (2019). The complete guide to wildlife photography. Amphoto Books.*
3) *Excell, L. (2015). Wildlife photography: From snapshots to great shots. Peachpit Press.*
4) *Winter, S. (2013). Wildlife photography: A beginner's guide. Amphoto Books.*
5) *Tipling, D. (2012). The art of wildlife photography: Tips and techniques for capturing the natural world. Amphoto Books.*

SEMESTER VI

UG-ZOO-304 Molecular genetics and Basics of Forensic Science
UG-ZOO-305 Wildlife Biology and Ethology
UG-ZOO-306 Human Physiology
UG-ZOO-VOC3 Ecotourism

COURSE TITLE: MOLECULAR GENETICS AND BASICS OF FORENSIC SCIENCE

Course Code: UG-ZOO-304

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives: *This course will ellucidate the functional aspects of the genetic material at molecular level, focusing on gene expression and gene regulation. It will also expose students to the basics of forensic science and understand diagnostic genetics*.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

CLO1: Differentiate the mechanisms of gene expression in prokaryotes and eukaryotes, highlighting key regulatory processes and their implications.

CLO2: Explain the systematic steps involved in crime scene investigation, emphasizing the importance of evidence collection and preservation.

CLO3:Enumerate and analyze the significance of cytogenetic, molecular, and biochemical diagnostic techniques for detecting genetic disorders in newborns, adults, and during prenatal assessments.

CLO4:Perform basic forensic analysis and execute steps of a crime scene investigation, ensuring proper methodology and accuracy

Content:

Module I: GENE EXPRESSION AND GENE REGULATION **[Contact Hours 15]**

UNIT 1: DNA Replication: DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication

UNIT 2: Transcription: transcription Unit, mechanism of transcription in prokaryotes and eukaryotes,
synthesis of rRNA and mRNA, transcription factors

UNIT 3: Translation: Genetic code, Process of protein synthesis, Difference between prokaryotic and
eukaryotic translation, Post Transcriptional modifications and Processing of Eukaryotic RNA

UNIT 4: Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac-operon and trp-operon; Transcription regulation in eukaryotes: Activators,repressors, enhancers, silencers elements; Gene silencing

Module II: BASICS OF FORENSIC SCIENCE **[Contact Hours 15]**

UNIT 5: Definition, overview of Disciplines of Forensic science

UNIT 6: Types of crime scenes: i) Based on Motive ii) Location of the crime scene evidence, iii) Mode of Committing crime, iv) Physical location, v) Size of the geographical Area Involved vi) Criminal behavior associated with scene

UNIT 7: Crime and Crime Scene management
Stages of crime scene examination: 1. Securing the crime scene, 2. Scanning the scene, 3. Sketching the scene, 4. Searching for evidence, 5. Documentation of crime scene, 6. Securing, Collecting & Packaging of evidence, 7. Chain of Custody, 8. Crime Scene. Reconstruction.

Module III: DIAGNOSTIC GENETICS **[Contact Hours 15]**
UNIT 8: : Cytogenetics/ Molecular Cytogenetics/ Biochemical/ Molecular methods of detecting genetic disorders - Adult and Newborn screening
UNIT 9: Prenatal Diagnosis and Preimplantation Genetic Diagnosis
UNIT 10: Forensic testing - DNA fingerprinting, paternity testing, personal /individual identification

Practicals **[Contact Hours 30]**

1. To perform ridge tracings and ridge counting (2 hrs)
2. Analysis of DNA fingerprints (06 hrs)
3. Isolation of DNA from peripheral blood/tissue (chick liver).(2 hrs)
4. Microscopic examination of Hair (06 hrs)
    a. Human scalp Hair
    b. Animal Hair
    c. Hair Sample analysis in Forensics
5. Presumptive Tests for Blood (02 hrs)
    a. Phenolphthalin Assay
6. Crime Scene Analysis (Enactactment of crime scene): Securing the crime scene, Scanning, Sketching, Searching for evidence, Documentation of crime scene, Collecting & Packaging of evidence (06 hrs)
7. PA (06 Hrs)

Reference books:

1) *Sinha, A. K. (2020). Molecular genetics: A laboratory manual. New Central Book Agency.*
2) *Ghosh, D. (2019). Principles of molecular genetics. Academic Publishers.*
3) *Chakraborty, S. (2021). Molecular genetics and genomics. Himalaya Publishing House.*
4) *Kumar, A., & Singh, R. (2021). Forensic science: Fundamentals and applications. CBS Publishers & Distributors.*
5) *Chaturvedi, A. (2019). Basics of forensic science: Principles and practice. Kalpaz Publications.*
6) *Sahu, P. K. (2020). Introduction to forensic science: Theory and practice. Anmol Publications.*
7) *Pandey, A. (2019). Forensic science in India: A comprehensive overview. Rajat Publications.*
8) *Kumar, R., & Singh, S. (2020). Genetic diagnosis: Principles and practices. New India Publishing Agency.*
9) *Basu, S., & Ghosh, S. (2019). Clinical genetics and genetic counseling. Jaypee Brothers Medical Publishers.*
10) *Chatterjee, A. (2021). Molecular diagnostics: Techniques and applications in genetic disease. Springer India.*
11) *Bhattacharya, D., & Mukherjee, S. (2019). Fundamentals of genetic counseling and diagnosis. Academic Publisher*

COURSE TITLE: WILDLIFE BIOLOGY AND ETHOLOGY

Course Code: UG-ZOO-305

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives: *The course on Wildlife Biology and Ethology aims to provide students with a comprehensive understanding of wildlife ecosystems, conservation strategies, and animal behavior. Students will explore key concepts in population management and human-wildlife interactions.*

Course Learning Outcomes:
Upon successful completion of the course, students should be able to:

CLO1: Describe and analyze the principles of wildlife biology, including conservation ethics, human-wildlife interactions, and the ecological roles of different species within their habitats.

CLO2: Assess and apply various population estimation and management techniques, including habitat evaluation and suggest restoration strategies, to effectively manage wildlife populations.

CLO3: Examine the principles of ethology by exploring animal behaviour, communication methods, and social structures, and their relevance to wildlife conservation.

CLO4: Apply the techniques of wildlife population estimations and evaluate the data obtained to assess ecological roles and interactions.

Content:

Module I: INTRODUCTION TO WILDLIFE BIOLOGY **[Contact Hours 15]**

UNIT 1: Overview of Wildlife Biology: Definition and importance of wildlife biology; History and evolution of wildlife studies; Conservation principles and ethics, Habitat carrying capacity, visitors carrying capacity, concept of climax persistence, ecology of perturbance; Human-wildlife interactions and conflicts.

UNIT 2: Biodiversity and Ecosystems: Wildlife Habitats- Types of habitats and habitat characteristics; Wildlife Ecology- Ecological roles and interactions, Trophic Levels and Food webs.

UNIT 3: Wildlife Conservation: Characteristics of wildlife habitats; Protected Sites- National parks, Sanctuaries, Conservation strategies for biodiversity- In-situ and ex-situ conservation; Tiger conservation - tiger reserves in India.- In-situ and ex-situ conservation; Tiger conservation - tiger reserves in India.

Module II: POPULATION ESTIMATION AND MANAGEMENT OF WILDLIFE

[Contact Hours 15]

UNIT 4: Population Estimations: Population estimation: Population density, natality, mortality, fertility schedules and sex ratio computation. Analysis of scat and dropping of ungulates and carnivores; Direct and in-direct methods: Trichotaxonomy, pug marks and census method based on indirect evidences.

UNIT 5: Habitat management techniques-; Habitat evaluation -Remote sensing and GIS; Assessing habitat quality and requirements for different species; Habitat management - Techniques for habitat restoration and enhancements by grazing logging, mechanical treatment, advancing the succession process, artificial feeding grounds, cover construction, preservation of general genetic diversity, restoration of degraded habitats.
UNIT 6: Human-Wildlife Conflict Resolution: Understanding the causes of human-wildlife conflict; Techniques for mitigating conflict (fencing, deterrents); Community engagement and education for conflict resolution; two case studies of successful conflict management

Module III: ETHOLOGY **[Contact Hours 15]**

UNIT 6: Introduction to Ethology**:** Definition and scope of Ethology; Historical background and key figures in Ethology *(e.g., Konrad Lorenz, Nikolaas Tinbergen, Jane goodal, Karl von Frisch, Ivan Pavlov)*; Key concepts: instinct v/s learnt behaviour; Role of genetics in animal behaviour.
UNIT 7: Social Behaviour and Communication: Social structures in wildlife populations (e.g., packs, colonies, schools); Communication methods: olfaction in different species, alarm signals, scent marking in animals, vocalization in wildlife, sound producing mechanisms, distress auditory signals, echolocation and mechanisms (bats, birds, shrews); Territoriality and aggression in wildlife.
UNIT 8: Foraging and Predation Strategies: Optimal foraging theory; predation and competition; prey distribution; Central place foraging and hoarding of food; Predator-prey interactions- Warning Coloration, Camouflage, Mimicry *(Batesian, Mullerian, Emsleyan/Mertensian, Auto-mimicry)*, Chemical defences (venom, pheromones), Symbiosis and commensalism, Physical methods (spines, slime production, body hardening, emitting light and electricity, etc.), Predator-prey relationship;
UNIT 9: Courtship behaviour and Parental Care: Courtship behavior: Polygamy, monogamy and promiscuity *(Polygyny and polyandry),* Types of courtship displays (visual, auditory, tactile), Role of courtship in mate selection and reproductive success, Examples of elaborate courtship rituals in different species (e.g. birds, bees); Parental Care: Nest building, altruism, brood parasitism, altricial and precocial young

Practicals **[Contact Hours 30]**

1. Acquainting oneself with basic equipment needed in wildlife studies; use, care and maintenance (compass, Binoculars, spotting scope, range finders, Global Positioning System, Cameras and lenses)(2 hrs)
2. Field Based:
   a) Study of butterflies on the campus and suggest their host plants (2 hrs)
   b) Study of birds on the campus and their behaviour (2 hrs)
   c) Study of species-specific evidences in the field through pugmarks, hoof marks, scats, pellet groups, nest, antlers, feathers, etc. – case study. (4 hrs)
   d) Report on a visit to National Parks/Biodiversity Parks/ Wild life sanctuary. (4 hrs)
   e) Trail/transect-quadrate monitoring for abundance and diversity estimation of mammals and birds. (2 hrs)
   f) Determination of population density of Molluscs by Quadrat method in intertidal zone.(2hrs)
3. Study of Nests of Birds and Insects (2 hrs)
4. Study of habituation to light stimulus in earthworm/crabs/snails/ spider web. (2 hrs)
5. Study the phototactic and geotactic responses of the animal provided (earthworm/crabs). (2 hrs)
6. PA(6 hrs)

Reference books:

1. *Alcock, J. (2019). Animal behavior: An evolutionary approach (10th ed.). Sinauer Assoc*
2. *Bolen, E. G., & Robinson, W. L. (2017). Wildlife ecology and management (6th ed.). Pre*
3. *Kumar, A., & Singh, K. (2019). Wildlife conservation and management in India. Publishing Agency.*
4. *Lindenmayer, D. B., & Burgman, M. A. (2017). Wildlife conservation in a changing clim Publishing.*
5. *Slater, P. J. B., & Templeton, J. S. (2020). Ethology: The mechanisms and evolution o Cambridge University Press.*
6. *Singh, J. (2018). Ecology and wildlife management. S. Chand Publishing.*
7. *Sundar, K., & Balakrishnan, M. (2020). Conservation biology: Principles, concepts, a Wiley.*
8. *Whittaker, R. J. (2021). The social behavior of animals. Harvard University Press.*

COURSE TITLE: HUMAN PHYSIOLOGY

Course Code: UG-ZOO-306

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives:
The primary goal of this course is to offer an in-depth presentation of the function of the major organ systems of the human body. The course is designed to expand physiological concepts p prerequisite courses.

Course Learning Outcomes:
Upon successful completion of the course, students will be able to:

CLO1: Describe and explain the normal functions of cells, tissues, organs, and organ systems in the human body, emphasizing their interrelationships.
CLO2: Analyze the functional relationships among anatomical structures, highlighting their integration within various physiological systems.
CLO3: Identify and discuss disorders associated with different organ systems and correlate the malfunctions to broader physiological effects and health conditions
CLO4: Perform tests and evaluate test results of detection of disorders and physiological changes.

Content:

Module I: PHYSIOLOGY OF DIGESTION AND RESPIRATION **[Contact Hours 15]**

UNIT 1: *Digestive System :* Structural organization, histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins.

UNIT 2: *Respiratory System:* Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen in the blood oxygen- hemoglobin & myoglobin , dissociation curve and the factors influencing it Carbon monoxide poisoning; Carbon dioxide transport in the blood; Buffering action of blood and haemoglobin Control of respiration

Module II: PHYSIOLOGY OF EXCRETION AND CIRCULATION **[Contact Hours 15]**

UNIT 3: Excretory System: Structure of kidney and its histological details, Renal blood supply; Mechanism urine; Formation and its regulation, Regulation of acid-base balance.

UNIT 4: Circulatory System: An outline structure of heart and working of heart; Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; nervous and chemical regulation of heart rate; Blood pressure and its regulation; Electrocardiogram; Components of blood and their functions; Haemopoiesis.

Module III: PHYSIOLOGY OF NERVOUS & REPRODUCTIVE SYSTEM **[Contact Hours 15]**

UNIT 5: Nervous System: Structure of neuron, resting membrane potential , Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission and, Neuromuscular junction; Reflex action & its types -reflex arc; Physiology of hearing and vision

UNIT 6: Muscle: Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation & tetanus

UNIT 7: Reproductive System: Histology of male and female reproductive systems; Puberty, Physiology of male and female reproduction.

Practicals [Contact Hours 30]

1. Enumeration of red blood cells & WBC using haemocytometer (4hrs)
2. Estimation of haemoglobin using Sahli's haemoglobinometer(2 hrs)
3. Determination of activities of digestive enzymes (Amylase, Pepsin, Trypsin and Lipase)(4 hrs)
4. Temporary preparation of Striated muscle fibers and nerve cells.(4 hrs)
5. Urine analysis (for organic, inorganic and abnormal components) (6 hrs)
6. Examination of sections of mammalian tissues: Lung, Kidney, Gonads, Intestine, Muscles, Spinal cord, Bone and cartilage (4 hrs)
7. PA(6 hrs)

Reference books:

1. *Chatterjee, C. C., & Shinde, R. (2021). Human physiology. Academic Publishers.*
2. *Jain, A. K. (2019). Textbook of human physiology. CBS Publishers & Distributors.*
3. *Kachhwaha, S., & Sharma, P. (2020). Fundamentals of human physiology. Paras Medical Publisher.*
4. *Ghosh, D. (2020). Human physiology: A textbook for medical and dental students. Modern Publishers.*
5. *Bhattacharya, A. (2018). Human physiology and anatomy for nursing and allied sciences. S. Chand Publishing.*
6. *Patnaik, J. (2019). Human physiology: A comprehensive approach. Blackwell Publishing India.Guyton Ac and Hall JE(2011). Testbook of Medical Physiology, 12th Edition, Harcourt Asia Pvt Ltd, WB Saunders Company*.
7. *Openstax College (2013). Anatomy and Physiology. Vol II. Mainstreet MS, Houston Texas(Ebook*
8. *Forciea B (2012). An eText of Human Anatomy and Physiology(Ebook).*
9. *Wingerd B(2008). The Human Body, Essential Anatomy and Physiology. University Readers, SanDiego CA.*

VOCATIONAL COURSE

COURSE TITLE: ECOTOURISM

Course Code: : UG-ZOO-VOC3

Marks:100[75–Theory;25-Practicals]

Credits:04 [03 –Theory; 01- Practical]

Contact Hours: Theory: 45 hours (03 lec/week)
Practicals: 30 hours (01 practical/week)

Course Objectives: *This course is designed to provide students with a comprehensive understanding of ecotourism concepts, principles, types, and global trends, and enable students to understand sustainable practices in ecotourism and develop practical skills in ecotourism planning and impact assessment*

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Course Learning Outcomes:

Upon successful completion of the course, students should be able to:

CLO1: Define and analyze key concepts and principles of ecotourism, including its types, objectives, and global landscape.

CLO2: Evaluate the economic, socio-cultural, and environmental impacts of ecotourism activities and the role of ecotourism in conservation.

CLO3:Analyse and Identify emerging trends in ecotourism, including special interest tourism and developments in the sector, particularly in Goa.

CLO4: Discuss the significance of community-based ecotourism and stakeholder initiatives in promoting responsible and sustainable tourism practices.

Content:

Module I: INTRODUCTION TO ECO-TOURISM **[Contact Hours 15]**

UNIT 1: Basic concepts of ecotourism: Definitions of ecotourism, introduction to tourism and ecotourism; Principles, concepts and objectives of ecotourism; Ecotourism and its types; Benefits and trends affecting ecotourism; Classification of ecotourism

UNIT 2: Global scenario of ecotourism: Ecotourism infrastructure, Ecotourism and conservation; Biosphere Reserves; Rain forest Ecotourism; Mountain Ecotourism; Polar, Islands and Coasts Ecotourism; Wilderness ecotourism & Marine Ecosystem; Ecotourism in Biodiversity Hotspots (e.g. Western Ghats).

UNIT 3: Impacts of Ecotourism: Economic Impacts (Fiscal Impacts, Concept and Methods); Impacts from ecotourism activities; Socio-cultural Impacts; Ecotourism Research; Disasters and Ecotourism.

Module II: EMERGING TRENDS IN ECOTOURISM **[Contact Hours 15]**

UNIT 4: Trends in Ecotourism: Innovation in Ecotourism; Special Interest Tourism: definition and scope; Importance of developing Special Interest Tourism; Factors related to Special Interest Tourism; Recent trends: Wildlife tourism; Backwater tourism; Island and beach tourism; Mountain tourism; Mangrove Tourism; Wetland Tourism.

UNIT 5: Recent trends in the Ecotourism Sector of Goa: Role of Government and

NGO's in Ecotourism; Role of private individuals and organisations in Ecotourism

Module III: ENVIRONMENTAL CONSERVATION AND ECOTOURISM **[Contact Hours 15]**

UNIT 6: Natural resource conservation & ecotourism: The relevance of Ecotourism as a tool for conservation; Environmental degradation and Ecotourism; Ecotourism and natural resource management

UNIT 7: Sustainable tourism and Society: Community based Ecotourism; Significance of ecotourism planning; Carrying capacity and development Benefits of sustainable tourism; Peoples' initiatives on Ecotourism

UNIT 8: Development of Ecotourism: Relevance of responsible tourism; World Ecotourism Summit: policies and formulations; Ecotourism development in India

Practicals **[Contact Hours 30]**

1) Field Based:
   a) Visit local ecotourism destinations (e.g., nature reserves, wildlife sanctuaries) to observe practices and conservation efforts in action(04 hrs)
2) Project Based:
   a) Conduct an ecotourism impact assessment of a local ecotourism site, evaluating economic, social, and environmental impacts through surveys and observations(06 hrs)
   b) Design / Create a sustainable ecotourism itinerary for a selected region, including activities, accommodations, and conservation considerations(existing site or propose new).(06 hrs)
   c) Community engagement project: Visit and interact with local communities to develop an ecotourism initiative, focusing on community involvement and sustainable practices.(06 hrs)
3) Interaction with Ecotourism entrepreneurs for understanding Business models for ecotourism(2hrs)
4) PA (6 hrs)

Reference books:

1) *Singh, R. K. (2020). Ecotourism: Principles and practices in India. Kalyani Publishers.*
2) *Kumar, P., & Ghosh, S. (2019). Ecotourism in India: Challenges and opportunities. New India Publishing Agency.*
3) *Dadhich, A., & Joshi, S. (2018). Sustainable ecotourism development in India. Concept Publishing Company.*
4) *Dutta, A. (2021). Ecotourism: A sustainable approach. Oxford University Press India.*
5) *Sharma, S. (2020). Ecotourism and biodiversity conservation in India. Anmol Publications.*
6) *Gupta, S. (2019). Ecotourism and sustainable development in India. Regal Publications.*
7) *Scheyvens, R. (2018). Ecotourism and the global economy. In Tourism, sustainability and development (pp. 153-174). Routledge.*
8) *Dharmalingam, A., & Cottam, D. (2019). Ecotourism: Principles and practices. Springer.*

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