



SNDT Women's University, Mumbai

Bachelor of Science (Zoology)

B.Sc. (Zoology)

As Per NEP - 2020

Syllabus

(2024-2025)

Terminologies

Abbreviation	Full-form	Remarks	Related to Major and Minor Courses
Major (Core)	Main Discipline		
Major (Elective)	Elective Options		related to the Major Discipline
Minor Stream	Other Disciplines (Inter/Multidisciplinary) not related to the Major	either from the same Faculty or any other faculty	
OEC	Open Elective Courses/ Generic		Not Related to the Major and Minor
VSC	Vocational Skill Courses		Related to the Major and Minor
SEC	Skill Enhancement Courses		Not Related to the Major and Minor
AEC	Ability Enhancement Courses	Communication skills, critical reading, academic writing, etc.	Not Related to the Major and Minor
VEC	Value Education Courses	Understanding India, Environmental science/education, Digital and technological solutions, Health & Wellness, Yoga education, sports, and fitness	Not Related to the Major and Minor
IKS	Indian Knowledge System	I. Generic IKS Course: basic knowledge of the IKS II. Subject-Specific IKS Courses: advanced information about the subject: part of the major credit	Subject Specific IKS related to Major
OJT	On-Job Training (Internship/Apprenticeship)	corresponding to the Major Subject	Related to the Major
FP	Field projects	corresponding to the Major Subject	Related to the Major
CC	Co-curricular Courses	Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/Visual/ Performing Arts	Not Related to the Major and Minor
CE	Community Engagement and service		Not Related to the Major and Minor
RP	Research Project	corresponding to the Major Subject	Related to the Major

Programme Template

Degree		B.Sc.
Programme		Zoology
Preamble (Brief Introduction to the programme)		<p>In the dynamic field of zoology, where the principles of the National Education Policy (NEP) 2020 drive comprehensive learning, graduates find a wealth of career opportunities awaiting them. From roles as wildlife technicians, marine biologists, and veterinary technicians to positions as animal nutritionists, environmental scientists, and forest officers, the spectrum of options is vast and diverse. These professionals play pivotal roles in wildlife management, environmental conservation, and animal welfare, employing their knowledge and skills to make a tangible impact on the world around them. The curriculum's emphasis on practical training, research, and interdisciplinary learning equips graduates with the expertise needed to thrive in their chosen careers.</p> <p>Beyond financial considerations, professionals in this field derive immense satisfaction from contributing to the well-being of animals, ecosystems, and the broader community. Whether working in laboratories, research institutions, governmental agencies, or educational settings, zoologists play a vital role in advancing scientific knowledge, promoting environmental sustainability, and fostering a deeper understanding of the natural world. As stewards of biodiversity and champions of animal welfare, they stand at the forefront of efforts to safeguard our planet's rich tapestry of life for generations to come</p>
Programme Specific Outcomes (PSOs)		<p>After completing this programme, the learner will be able to,</p> <ol style="list-style-type: none"> 1. Demonstrate advanced knowledge and skills in the study of nonchordates, chordates, genetics, evolution, and other fundamental concepts in zoology. 2. Conduct laboratory experiments, fieldwork, and observational studies to explore various aspects of animal biology, behavior, and ecology. 3. Analyze and interpret data related to zoological research, contributing to scientific literature and advancements in the field 4. Apply a deep understanding of animal physiology, including comparative physiology, nutrition, and health, to address real-world challenges in animal welfare and conservation 5. Adhere to professional standards and ethical guidelines in interactions with animals and the environment, fostering ethical awareness and responsibility 6. Communicate effectively, both written and orally, to disseminate scientific findings, engage in scientific discussions, and communicate zoological concepts to diverse audiences

	7.	Prepare for further education and research in zoology or related fields, as well as for careers in wildlife conservation, animal welfare, environmental consultancy, and science education
Eligibility Criteria for Programme		12 standard Science
Intake		120

Structure with Course Titles

B. Sc Zoology

SN	Courses	Type of Course	Credits	Marks	Int	Ext
	Semester I					
1.1	Biological Functions	Major (Core)	2	50	50	00
1.2		Major (Core)	2	50	0	50
1.3		Major (Core)	2	50	50	00
1.4	Nutrition & Health	OEC	4	100	50	50
1.5	Experimental Zoology	VSC	2	50	50	0
1.6	Laboratory Safety Measures	SEC	2	50	50	0
1.7	English - I	AEC (English)	2	50	0	50
1.8	Inception of Indian Knowledge System	IKS (Generic)	2	50	0	50
1.9	Sustainable Development	VEC	2	50	0	50
1.10	Co-curricular Activity	CC	2	50	50	0
			22	550	300	250
	Semester II					
2.1	Reproduction and Development	Major (Core)	2	50	0	50
2.2		Major (Core)	2	50	50	00
2.3		Major (Core)	2	50	00	50
2.4		VSC S2	2	50	50	0
2.5		VSC S3	2	50	50	0
2.6	Amazing Animal World	OEC	4	100	50	50
2.7	Fish Aquarium Setting	SEC	2	50	50	0
2.8	English -II	AEC (English)	2	50	00	50
2.9	Ecosystem Conservation	VEC	2	50	0	50
2.10	Co-curricular Activity	CC	2	50	0	50
			22	550	250	300

Exit with UG Certificate with 4 extra credits (44 + 4 credits)

Course Syllabus

Semester I

1.1 Major (Core)

Course Title	Biological Functions
Course Credits	2
Course Outcomes	After going through the course, learners will be able to:
	1. Analyze the structure and function of the nutritional apparatus in various organisms such as Amoeba, Hydra, Earthworm, Cockroach, Amphioxus, Pigeon, and Ruminants.
	2. Examine the structure of lungs and the physiology of respiration in humans, including the processes of gas exchange and respiratory regulation
Module 1 (Credit 1) - Study of Nutrition and Respiration	
Learning Outcomes	After learning the module, learners will be able to:
	1. Relate to the nutritional aspects in animals & humans
	2. Differentiate between respiratory structures of animals
Content Outline	<ul style="list-style-type: none">● Nutrition:<ul style="list-style-type: none">○ Study of structure and function of nutritional apparatus of : Amoeba, Hydra, Earthworm, Cockroach, Amphioxus, Pigeon and Ruminants.○ Physiology of digestion in humans● Respiration:<ul style="list-style-type: none">○ Study of structure and function of respiratory organs in Earthworm, Spider, Bony fish, Frog and Pigeon.○ Structure of lungs and physiology of respiration in humans
Module 2 (Credit 1) - Study of Circulation and Excretion, Osmoregulation	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze the comparative aspects of circulation in different animals.
	2. Evaluate the structural & functional ability of human heart
	3. Relate to the excretion & osmoregulatory mechanisms in animals with respect to their habitats

Content Outline	<ul style="list-style-type: none"> ● Circulation: <ul style="list-style-type: none"> ○ Types of circulation: (a) Open and Closed, (b) Single and Double ○ Study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Calotes and Pigeon ○ Structure and mechanism of working of heart in human ● Excretion and Osmoregulation: <ul style="list-style-type: none"> ○ Study of excretory and osmoregulatory structures and functions: Contractile vacuoles, Flame cells, Nephridia, Malpighian tubules ○ Categorization of animals based on principal nitrogenous excretory products ○ Structure of kidney, uriniferous tubule and physiology of urine formation in human
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Module 1 - Study of Nutrition and Respiration

Each student will conduct a comparative study of the nutritional apparatus in various organisms listed in the module, including Amoeba, Hydra, Earthworm, Cockroach, Amphioxus, Pigeon, and Ruminants. They will research and document the structure and function of the nutritional apparatus in each organism, focusing on similarities and differences. Students will compile their findings into a comprehensive report or presentation, highlighting key anatomical features and physiological processes involved in nutrition. Additionally, they will analyze the significance of these adaptations in meeting the nutritional needs of each organism within its ecological niche.

2. Module 2 - Study of Circulation and Excretion, Osmoregulation

Each student will conduct a comparative analysis of excretory structures in different animals, focusing on organisms such as Earthworm, Spider, Bony fish, Frog, and Pigeon. They will research and compare the structure and function of excretory organs such as contractile vacuoles, flame cells, nephridia, and malpighian tubules across these organisms. Students will explore how excretory structures vary in complexity and efficiency based on the habitat and physiological requirements of each species. They will present their findings in a detailed report or presentation, highlighting adaptations for osmoregulation and waste elimination in diverse environments.

References:

1. Jordan, E. L., & Verma, P. S. (2015). Invertebrate Zoology (Reprint ed.). S. Chand and Co.
2. Jordan, E. L., & Verma, P. S. (1980). Chordate Zoology and Elements of Animal Physiology (1st ed.). S. Chand and Co. Ltd.
3. Dhama, P. S., & Dhama, J. K. (1979). Invertebrate Zoology (1st ed.). R. Chand and Co.
4. Dhama, P. S., & Dhama, J. K. (1991). Chordate Zoology (Reprint ed.). R. Chand and Co. Ltd.
5. Miller, S. A., & Harley, J. B. (2009). Zoology (8th ed.). Tata McGraw Hill.
6. Kotpal, R. L. (2012). Modern Textbook of Zoology (Reprint ed.). Rastogi Publications.

7. Parker, T. J., & Haswell, W. A. (1992). *A Textbook of Zoology, Invertebrates. Vol. I* (1st Indian ed.). CBS Publishers and Distributors Pvt. Ltd.
8. Parker, T. J., & Haswell, W. A. (1992). *A Textbook of Zoology, Vol. II* (1st Indian ed.). CBS Publishers and Distributors Pvt. Ltd.

1.4 Open Elective Courses/ Generic (OEC)

Course Title	Nutrition & Health
Course Credits	4
Course Outcomes	<p>After going through the course, learners will be able to</p> <ol style="list-style-type: none"> 1. Categorize food into different component groups 2. Design diet as per nutritional requirements 3. Relate the symptoms to identify nutrition related problems 4. Assess the requirements of the community related to nutrition 5. Create awareness about balanced diet
Module 1 (Credit 1)- Concept of Nutrition and Balanced Diet	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Relate the concepts of nutrition and balanced diet with good health 2. Assess the food based on its nutritive value 3. Plan and recommend diet for different age groups
Content Outline	<ul style="list-style-type: none"> ● Definition of Food, Basic Food Groups, Functional Foods ● Concept of Nutrition, Relation of nutrition to health, Adequate nutrition, optimum nutrition, malnutrition and under-nutrition ● Concept of balanced diet, The Food Guide, Pyramid & MyPlate in the Indian context, Importance of Dietary fibres ● Concept of BMR and its calculation using Harris-Benedict equation ● Dietary recommendations for an infant, child, normal adult, pregnant women and aged ● BMI calculation and its significance
Module 2 (Credit 1) - Dietary Components	
Learning Outcomes	<p>After learning the module, learners will be able to</p> <ol style="list-style-type: none"> 1. Classify food into different component groups 2. Interpret the importance and role of different food components
Content Outline	<ul style="list-style-type: none"> ● Carbohydrates - Definition, Properties, formation of glycosidic bond, types and their biological role and clinical significance ● Dietary fibres and significance ● Lipids - Definition, classification of lipids with examples & formation of ester linkage and biological role & clinical significance of lipids ● Role of essential fatty acids, PUFAs, MUFAs ● Amino acids and proteins - Basic structure & classification of amino acids; Essential &

	<p>Non-essential amino acids; formation of peptide bond, Biological role & clinical significance</p> <ul style="list-style-type: none"> • Vitamins (A, B, C, D, E) - Occurrence and biological significance • Water - Its physiological role
Module 3 (Credit 1) - Nutrition related health issues	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify the health problems related to nutritional deficiencies based on symptoms
	2. Plan the control / remedial measures for nutritional disorders
Content Outline	<ul style="list-style-type: none"> • Malnutrition disorders: causes, symptoms, prevention and remedy of: PEM, Anemia (Iron deficiency), Marasmus, Kwashiorkor, Goiter • Obesity- Causes, symptoms and effects • Vitamin deficiency related disorders: causes, symptoms, prevention and remedy: <ul style="list-style-type: none"> ○ Vit A: <i>Xerophthalmia</i>, night blindness ○ Vit B12: Pernicious anaemia ○ Vit. C: Scurvy ○ Vit D: Rickets, Osteomalacia • Acidity • Peptic ulcers
Module 4 (Credit 1) - Nutrition and Public health	
Learning Outcomes	After learning the module, learners will be able to
	1. Discuss the importance of nutrition and health status of the community
	2. Develop a report on improvement of nutritional status of the community
Content Outline	<ul style="list-style-type: none"> • Nutrition and Public Health • Public /Community Nutrition- Concept and Scope • National Nutrition Survey- India • UNICEF Nutrition Strategy • Anthropometric Standards • Indices of Health and Nutrition situation of a community. (IMR, MMR, TFR, Birth rate, Death rate, Life expectancy) • National Nutrition week • National and International agencies in community nutrition: Role of WHO, UNICEF, FAO, UNESCO, WORLD BANK, Red Cross

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Student presentations based on nutritional disorders
2. Group activity - Report submission based on survey related to nutrition / dietary habits and life style
3. Community engagement - Documentation using photography on community health programs to create awareness
4. Videography based on healthy recipes
5. Preparation and submission of scrap-book based on newspaper, magazine articles based on aspects of nutrition

Some course projects are suggested below:

1. Module 1 - Concept of Nutrition and Balanced Diet

Each student will design personalized balanced diet plans for different age groups and life stages. They will research and analyze nutritional requirements based on age, gender, and physiological conditions such as pregnancy and aging. Students will consider factors such as basal metabolic rate (BMR), dietary fiber intake, and body mass index (BMI) calculations using the Harris-Benedict equation. They will incorporate recommendations from the Food Guide Pyramid or MyPlate in the Indian context, emphasizing the importance of dietary diversity and inclusion of functional foods. Each student will present their diet plans in a structured format, including food groups, portion sizes, and meal schedules.

2. Module 2 - Dietary Components

Each student will conduct a nutrient analysis of common foods, focusing on carbohydrates, lipids, proteins, vitamins, and water. They will compile a list of foods commonly consumed in their region and categorize them based on their nutrient composition. Using resources such as food labels, nutritional databases, or laboratory analysis, students will quantify the amount of each nutrient present in selected food items. They will interpret the significance and roles of different dietary components in human health and disease prevention. The findings will be presented in a comparative analysis report, highlighting nutrient-rich food choices for optimal health.

3. Module 3 - Nutrition-related Health Issues

Each student will develop an interactive health education campaign focused on raising awareness about nutrition-related health issues in their community. They will identify common nutritional deficiencies and disorders such as malnutrition, obesity, and vitamin deficiencies, along with their causes, symptoms, and preventive measures. Students will create engaging educational materials such as posters, pamphlets, infographics, or multimedia presentations to convey key messages effectively. They will organize workshops, seminars, or health fairs to disseminate information and provide practical tips for improving dietary habits and overall health.

4. Module 4 - Nutrition and Public Health

Each student will conduct a comprehensive assessment of the nutritional status and health status of a selected community. They will collect anthropometric data, health indicators, and dietary intake information using surveys, interviews, and observation methods. Students will analyze the data to identify prevalent nutrition-related issues and health disparities within the community. Based on their findings, they will develop a detailed report outlining strategies for improving the nutritional status and overall health outcomes of the community. Recommendations may include policy interventions, education programs, or community-based initiatives aimed at addressing specific health needs.

References:

1. Anderson L., Dibble M., Turkki P., Mitchell H. and Rynbergen H. (1982) Nutrition in Health and Disease. 17th Edition J.B. Lippincott Company. Philadelphia, Toronto.
2. Bamji M.S. (2019) Text book of Human Nutrition (4th ed.).Oxford & IBH Publishing Company Pvt. Limited.
3. Bagchi K. (1990) Guidelines for the management of nutrition programmes- A manual for nutrition officers. WHO EMRO Technical Publication no. 15, WHO, Geneva.
4. Bendich A and Deckelbaum R.J. (1997) Preventive Nutrition. The Comprehensive guide for health professional. Churchill Livingstone, Edinburg.
5. Devlin T.M. (1986) Textbook of Biochemistry with clinical correlations (2nd Edition), John Wiley.
6. Davidson S., Passmore R. and Brock J.F., (1986), Human Nutrition and Dietetics Garrow, J.S., James, W.P.T. and Ralph, A. (2000): Human Nutrition and Dietetics, 10th Edition, Churchill Livingstone.
7. Goodhart R.S. and Shils M.E. (Ed) (1994). Modern Nutrition in Health and Disease, Lea and Febiger, Phila.
8. Gopalan C., Rama Sastri B.V. and Balasubramanian S.C. (1989).Nutritive Value of Indian Foods. 2nd Edition ICMR Offset Press, New Delhi.
9. Krause M.V. and Mahan K. (1984) – Foods, Nutrition and Diet Therapy. 7th Edition, W.B. Saunders Company U.S.A.
10. Lehinger A.L. (1984), Principles of Biochemistry. Worth Publishers New York.
11. Machlin L.J. (1984) Ed., Handbook of Vitamins – Nutritional, Biochemistry and Clinical Aspects, M. Dekker, New York.
12. National Institute of Nutrition, (ICMR) Hyderabad, Telangana- Publications- Nutrient Requirements and Recommended Dietary Allowances for Indians.
- 13.14. National Institute of Nutrition, (ICMR) Hyderabad, Telangana- Publications-Indian Food composition Tables by T. Longvah, R. Ananthan, K. Bhaskaracharya, K. Venkaiah.
14. National Institute of Nutrition, (ICMR) Hyderabad, Telangana- Publications-Nutrition, Lifestyle and Immunity.
15. Pike R.L. and Brown M.L. (1984) Nutrition – An Integrated Approach, John Wiley, New York.
16. Protocol for management of malnutrition in children- Published by Ministry of health and Family welfare, Ministry of Women and Child development, India
17. Rajalakshmi (1987) Applied Nutrition, Oxford/IBH
18. <https://www.unicef.org/media/131516/file/2023-HAC-India.pdf>
19. <https://esurvey.nin.res.in>

1.5 Vocational Skill Courses (VSC)

Course Title	Experimental Zoology
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Develop the experimental skills and hands on training
	2. Apply suitable techniques for studying various physiological processes
Content Outline	<ul style="list-style-type: none"> • Principle, structure, working, precautions while handling Microscope. • To focus slide under 10x, 40x and 100x objective • Study of mouthparts in insects-Biting and chewing, siphoning, sponging, piercing and sucking, lapping and chewing • Effect of varying pH on enzyme amylase activity • Effect of varying temperature on enzyme amylase activity • Study of nutritional apparatus - gastrovascular cavity of hydra, digestive system of liver fluke, earthworm and cockroach and bird, ruminant stomach • Dissection of preserved earthworm for its digestive system • Dissection of shark for its digestive system • Detection of blood glucose level using glucometer • Study of respiratory apparatus – spiracle and trachea of cockroach, gills of shark and bony fish, lungs of frog and mammals • Determination of vital capacity of lung by balloon method • Study of circulatory apparatus – heart of cockroach, fish, frog and mammal • Detection of normal and abnormal constituents of urine • Types of fins in fishes – Cartilaginous and Bony • Dissection of preserved earthworm for its nervous system • Study of control and coordination – nervous system of earthworm, cockroach, sepia, T.S of nerve cord in earthworm and spinal cord in vertebrates, outer view and V.S of mammalian brain • Study of reproduction – Binary fission and Conjugation in Paramecium, Hydra budding, T.S of mammalian testis and ovary, Hen's egg • Study of mitosis using onion root tip

	<ul style="list-style-type: none"> • Study of meiosis using Tradescantia bud / cockroach testis • Study trip to diagnostic laboratory / Industry and submission of report.
Module 1 (Credit 1) -	
Learning Outcomes	After going through the course, learners will be able to,
Content Outline	
Module 2 (Credit 1) -	
Learning Outcomes	After going through the course, learners will be able to,
Content Outline	

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) :

1. Journal Assessment and certification
2. End Semester Practical examination
3. Submission of visit report

Some illustrative assignments for students

1. Microscope Basics: Students will learn the principles and structure of a microscope, along with proper handling precautions, through interactive workshops and demonstrations.
2. Enzyme Activity Investigation: Students will conduct experiments to observe the effects of varying pH and temperature on the activity of the enzyme amylase, providing insights into enzyme kinetics and practical applications.
3. Insect Mouthparts Study: Through microscopic examination and research, students will explore the diverse mouthpart adaptations of insects, including biting, chewing, siphoning, piercing, and sucking, fostering an understanding of insect feeding behaviors.
4. Nutritional Apparatus Dissection: Students will dissect preserved specimens such as earthworms and cockroaches to study their digestive systems, gaining hands-on experience in anatomical observation and comparative anatomy.

5. **Respiratory System Exploration:** Through dissections and investigations, students will explore the respiratory apparatus of various organisms, including cockroaches, frogs, and mammals, enhancing their understanding of respiratory adaptations and structures.
6. **Circulatory System Examination:** Students will dissect hearts from cockroaches, fish, frogs, and mammals to study their circulatory systems, enabling them to identify anatomical structures and understand cardiac function.
7. **Urine Analysis:** Students will conduct experiments to detect normal and abnormal constituents of urine, utilizing laboratory techniques to analyze urine samples and interpret diagnostic indicators.
8. **Finned Fish Diversity:** Through research and observation, students will categorize and compare the types of fins found in cartilaginous and bony fishes, enhancing their understanding of fish morphology and locomotion.
9. **Nervous System Investigation:** Students will dissect earthworms and examine vertebrate nervous tissues to study the nervous systems of various organisms, aiding in the comprehension of neural anatomy and function.
10. **Reproductive Process Study:** Students will explore reproductive processes such as binary fission, conjugation, budding, and hen's egg development, using microscopy and dissection to observe reproductive structures and mechanisms.

References:

1.6 Skill Enhancement Courses (SEC)

Course Title	Laboratory Safety Measures
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Develop the skill sets required for performing experiments
	2. Translate the good laboratory practices in practical courses of the curriculum
	3. Integrate the skills in field work / mini research projects
	4. Demonstrate the SOPs to the peers for cooperative learning
	5. Analyze the results of the experiments through appropriate statistical tools
Module 1 (Credit 1) - Lab safety	
Learning Outcomes	After learning the module, learners will be able to
	1. Integrate good laboratory practices in regular practicals
	2. Demonstrate the skills acquired through carrying out SOPs correctly
Content Outline	<ul style="list-style-type: none"> ● Introduction and scope and principles of Good Laboratory Practices; brief idea about the GLP certification process; SOPs & OECD guidelines. ● Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing, compressed gas, Aspiratory hazards and Biohazardous infectious agents. ● SOPs for maintenance of laboratory equipment - Microscope, pH meter, Colorimeter, Centrifuge ● Handling and usage of glassware ● Methods of sterilization - Autoclave, Hot air oven, Laminar flow, Millipore filter assembly
Module 2 (Credit 1) - Lab skills	
Learning Outcomes	After learning the module, learners will be able to
	1. Design experiments with correct resources and accurate measurements
	2. Analyze the results of the experiments through appropriate statistical tools

Content Outline	<ul style="list-style-type: none"> ● Collection of data and Preparation of Frequency Distribution Table ● Graphical representation of the statistical data through - Bar diagram, Histogram and Pie diagram. ● Prepare molar and normal solutions of different concentrations ● Perform serial dilutions and find the concentration of unknown diluted samples using standard graphs. ● Titration of strong acid - strong base ● Titration of weak acid - weak base ● Calibration of Colorimeter, pH meter & Analytical balance
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Journal Assessment and certification
2. End Semester Practical examination
3. Solving problems based on central tendencies and / or appropriate graphical representation of the given data
4. Ill-defined practical preparation to be improvised by students
5. Laboratory mini-research project based on the skill / SOPs learnt in this course

Some Illustrative assignments for students

1. Laboratory Safety Practices Integration: Students will learn about good laboratory practices (GLP) and safety symbols, integrating these principles into regular practical sessions to ensure safe experimentation and equipment maintenance.
2. Experimental Design and Statistical Analysis: Through hands-on activities, students will design experiments with accurate measurements and collect data for analysis. They will learn to interpret results using statistical tools such as frequency distribution tables, graphical representations, and titration techniques, enhancing their analytical skills in laboratory settings.
3. Glassware Handling and Sterilization Techniques: Students will acquire proficiency in handling laboratory glassware and master methods of sterilization including autoclaving, hot air oven usage, and laminar flow techniques, ensuring the integrity of experimental setups and minimizing contamination risks.
4. Solution Preparation and Dilution Techniques: Participants will gain expertise in preparing molar and normal solutions of varying concentrations, as well as performing serial dilutions and analyzing unknown samples using standard graphs. This skillset is crucial for accurate chemical analyses and experimentation.
5. Equipment Calibration and Maintenance: Students will learn to calibrate laboratory instruments such as colorimeters, pH meters, and analytical balances, ensuring accurate measurements and equipment functionality. This module emphasizes the importance of proper equipment maintenance for reliable experimental outcomes.

References:

1. Biological instruments and methodology – Dr. P. K. Bajpai, December 2010 Edition. S. Chand company Ltd.
2. Calculations in Molecular biology and Biotechnology - Frank H. Stephenson, 3rd

Edition 2016 Academic Press.

3. A Manual of Medical Laboratory Technology -A. H. Patel, 2016 Edition, Navneet Prakashan Ltd.
4. Introduction to Practical Biochemistry – David T. Plummer, 3rd Edition 2017, Tata McGraw Hill Publishing Co. Ltd.
5. Introductory Practical Biochemistry – S.K. Sawhney and Randhir Singh, Reprint 2014 Edition, Narosa Publishing House
6. Microscopy and Cell Biology - V. K. Sharma, First Edition 1991, Tata McGraw Hill Publishing Co. Ltd.
7. Bioinstrumentation – L. Veerakumari, January 2011 Edition, M.J.P. Publishers
8. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker, 5th Edition 2000, Cambridge University Press.

1.9 Value Education Courses (VEC)

Course Title	Sustainable Development
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Highlight the significance, targets and indicators of SDGs
	2. Analyse the national strategies and progress of implementation of SDGs
	3. Reflect on case studies related to SDGs 7, 12, 13, 14 and 15
	4. Carry out sustainable practices in daily life on and off-campus
Module 1 (Credit 1) - Theme of UN Sustainable Development Goals (SDGs)	
Learning Outcomes	After learning the module, learners will be able to
	1. Relate the SDGs with the current scenario in the context of climate change
	2. Identify the various issues that need to be addressed through the goals of sustainable development
Content Outline	<ul style="list-style-type: none"> ● Introduction to the Sustainable Development – Definition and significance, the need for sustainable development ● UN SDGs – History, United Nations Conference on Sustainable Development, Rio+20 and its objectives ● Overview of all the 17 SDGs – Targets and Indicators
Module 2 (Credit 1) - Case studies on sustainable practices	
Learning Outcomes	After learning the module, learners will be able to
	1. Relate the SDGs with the current scenario in the context of climate change
	2. Recommend measures to mitigate the effects of climate change through the SDG guidelines
Content Outline	<ul style="list-style-type: none"> ● Concept of Clean and Green Energy to combat climate change ● Sustainable practices for production and consumption ● Sustainable use of natural resources

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Report submission based on survey related to SDGs such as electricity consumption audit, green audit, water consumption audit on campus

2. Poster exhibition to create awareness about SDGs - Design the poster on each goal with their information, new logo, pictures from real world related to the goal
3. Presentation based on the case studies related to SDGs 7, 12, 13, 14 and 15

Some Illustrative assignments for students

1. **SDG Awareness and Analysis:** Students will delve into the significance and targets of the UN Sustainable Development Goals (SDGs), understanding their relevance in addressing global challenges like climate change. They will identify key issues necessitating sustainable development efforts.
2. **National Strategies and Progress:** Learners will analyze national strategies and progress in implementing SDGs, gaining insights into how countries are aligning their policies with sustainable development objectives to achieve meaningful progress.
3. **Case Studies Reflection:** Through case studies focused on SDGs 7, 12, 13, 14, and 15, students will reflect on real-world scenarios, examining the challenges, solutions, and implications for sustainable development. They will develop a deeper understanding of how these goals apply in different contexts.
4. **Sustainable Practices Implementation:** Students will apply sustainable practices in their daily lives, both on and off-campus, contributing to environmental conservation and resource efficiency. They will conduct audits and assessments related to electricity consumption, green practices, and water usage, fostering a culture of sustainability. Additionally, they will create awareness through poster exhibitions highlighting each SDG and their associated actions, as well as presentations showcasing case studies aligned with SDGs 7, 12, 13, 14, and 15.

References:

1. United Nations. (n.d.). The 17 Goals - Sustainable Development. Retrieved from <https://sdgs.un.org/>
2. United Nations. (2023). The Global Sustainable Development Report 2023. Retrieved from <https://unstats.un.org/sdgs/report/2023/>
3. UNESCO Publishing. (2017). Global Ocean Science Report: The Current Status of Ocean Science around the World.
4. NITI Aayog. (2023). Annual Report 2022-2023. Retrieved from <https://www.niti.gov.in/reports-sdg>
5. Venkatesh, G. (2015). ABC of Sustainable Development (1st ed.). Bookboon.com. ISBN 978-87-403-1005-4.

Semester-II

2.1 Major (Core)

Course Title	Reproduction and Development
Course Credits	2
Course Outcomes	After going through the course, learners will be able to:
	1. Relate how the various physiological processes help the organisms to adapt to their environment
	2. Evaluate the interrelationship between the various human physiological processes
Module 1 (Credit 1) - Locomotion, Control and Coordination	
Learning Outcomes	After learning the module, learners will be able to:
	1. Compare the locomotory organs among the invertebrates and vertebrates
	2. Relate the control and coordination process with the habits and habitats of the organisms
Content Outline	<ul style="list-style-type: none">● Locomotion:<ul style="list-style-type: none">○ Locomotory organs - structure and functions of: Pseudopodia in Amoeba, Ciliary movement in Paramecium, Setae and peristaltic movement in annelids, Jointed legs in arthropods, Tube feet in starfish○ Structure of striated muscle fibre in human and sliding filament theory● Control and Coordination<ul style="list-style-type: none">○ Irritability in Paramecium, nerve net in Hydra, nerve ring and nerve cord in earthworm.○ Types of neurons based on the structure and function.○ Conduction of nerve impulse: Resting potential, Action potential and Refractory period, Synaptic transmission
Module 2 (Credit 1) - Reproduction	
Learning Outcomes	After learning the module, learners will be able to:
	1. Compare the modes of reproduction among the invertebrates and vertebrates
	2. Interpret the advancements in the reproductive system among the organisms
Content Outline	<ul style="list-style-type: none">● Reproduction<ul style="list-style-type: none">○ Types of reproduction – asexual and sexual○ Asexual – Types of fission, Types budding, Parthenogenesis; Sexual reproduction – Syngamy, Conjugation in Paramoecium○ Gametogenesis, Types of gametes, External and internal fertilization

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| | <ul style="list-style-type: none">○ Oviparity, ovoviviparity and Viviparity○ Reproductive system of earthworm○ Reproductive system of rat |
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) –

No Internal Examination.

References:

1. Invertebrate Zoology. E. L. Jordan and P. S. Verma. Reprint Edition, 2015. S. Chand and Co.
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4. Chordate Zoology - P. S. Dhama and J. K. Dhama, Reprint Edition, 1991. R. Chand and Co. Ltd.
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6. Modern Textbook of Zoology. R. L. Kotpal. Reprint Edition, 2012. Rastogi Publications
7. A Textbook of Zoology, Invertebrates. Vol. I , 1st Indian Edition, 1992. - T. J. Parker and W. A. Haswell-CBS Publishers and Distributors Pvt. Ltd.
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2.6 Open Elective Courses/ Generic (OEC)

Course Title	Amazing Animal World
Course Credits	4
Course Outcomes	After going through the course, learners will be able to
	1. Interpret the uniqueness of the animals enlisted
	2. Relate the distinguishing characteristics with the adaptations
	3. Create awareness of the wonders of animal kingdom through activities
	4. Prepare models of the animals to illustrate their unique characters
Module 1 (Credit 1) - Fauna of National / State	
Learning Outcomes	After learning the module, learners will be able to
	1. Enlist the distinguished characteristics
	2. Evaluate the unique characteristics as per the adaptations
Content Outline	<p>General Morphology, Habits and habitat and Significance:</p> <ul style="list-style-type: none"> ● Butterflies - the flying jewels - Blue Mormon, Kaiser-i-Hind ● Herpetofauna of India- <i>Rhacophorus malabaricus</i>, Monitor lizard, Chameleon ● Feathered Bipeds: Yellow footed green Pigeon, Peacock ● Mammals of India: Giant Indian Squirrel, Gangetic Dolphin, Royal Bengal Tiger, Elephant, Swamp Deer, Rhinoceros
Module 2 (Credit 1) - Amazing animals	
Learning Outcomes	After learning the module, learners will be able to
	1. Enlist unique characteristics of the animals
	2. Interpret the significance of the unique characteristics
Content Outline	<p>General Morphology, Habits and habitat and Unique features:</p> <ul style="list-style-type: none"> ● Jelly fish - <i>A. victoria</i> ● Pistol Shrimp ● Suicidal Ant ● Praying mantis ● Pearl oysters

	<ul style="list-style-type: none"> ● Electric eel ● Puffer fish ● Axolotl larva ● Pebble toad ● Flying Snake ● Indian Cuckoo ● Red Panda
Module 3 (Credit 1) - Incredible Fauna	
Learning Outcomes	After learning the module, learners will be able to
	1. Enlist the recently discovered fauna
	2. Justify the uniqueness of the fauna listed
Content Outline	<ul style="list-style-type: none"> ● Recently discovered fauna: <ul style="list-style-type: none"> ○ Tapir Frog ○ Stealthy Gecko ○ Rose-rainbow fish ○ Southern maned sloth ○ Sea anemone from Japan – <i>Stylobatus</i> ● Unique fauna: <ul style="list-style-type: none"> ○ Kangaroo ○ Duck-billed Platypus ○ Penguins ○ Whale ○ Sphenodon
Module 4 (Credit 1) - Marvels of animals	
Learning Outcomes	After learning the module, learners will be able to
	1. Relate the marvels with their application in the practical world
	2. Evaluate the significance of the marvels for the survival of the animals
Content Outline	<ul style="list-style-type: none"> ● Coral reef ● Bioluminescent animal - Fireflies, Angler fish ● Parental care in fishes ● Parental care in amphibians ● Migration in birds ● Social organization - Honey bee, Hanuman Langur ● Hibernation/aestivation in frog ● Echolocation - Bats, Dolphin

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Presentation based on related topics

2. Preparation models of the animals to illustrate their unique characters

Some illustrative assignments for students

1. Module 1 Project: Animal Adaptation Garden

Students will create a miniature garden or terrarium representing a specific habitat (e.g., desert, rainforest) and populate it with plant species and small animal figurines. They will research the adaptations of animals native to their chosen habitat and strategically place the figurines within the garden to reflect these adaptations. For example, animals with camouflage adaptations could be placed among plants with similar colors and patterns. This project will not only reinforce understanding of animal adaptations but also provide hands-on experience in designing and creating habitat models.

2. Module 2 Project: DIY Wildlife Camera Trap

Students will design and build a simple wildlife camera trap using basic materials such as cardboard, a digital camera, motion sensors, and infrared LEDs. They will learn about animal behavior and habitat preferences, then strategically place their camera traps in outdoor locations such as parks or nature reserves to observe wildlife activity. This project will allow students to apply their knowledge of animal behavior and habitat ecology in a real-world setting while also gaining practical skills in electronics and DIY construction.

3. Module 3 Project: Neighborhood Biodiversity Survey

Students will conduct a biodiversity survey in their neighborhood or local park to identify and document animal species present in the area. Using basic tools such as binoculars, field guides, and smartphone apps, they will observe and record sightings of birds, insects, mammals, and other wildlife. Students will then compile their data and create a report or presentation highlighting the diversity of species found, as well as any trends or patterns observed. This project will enable students to apply their knowledge of animal taxonomy and ecology while also contributing to scientific research and conservation efforts in their community.

4. Module 4 Project: Animal Rescue Simulation

Students will participate in a simulated animal rescue operation, either in-person or through virtual role-play scenarios. Working in teams, they will assume the roles of wildlife rehabilitators, veterinarians, and conservationists tasked with rescuing and rehabilitating injured or endangered animals. Using case studies and real-world scenarios, students will apply their knowledge of animal behavior, physiology, and conservation biology to make informed decisions and develop effective rescue strategies. This project will provide hands-on experience in wildlife management and conservation while also fostering teamwork and critical thinking skills.

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2. Jordan, E. L., & Verma, P. S. (2022). Invertebrate Zoology. S. Chand and Co. Ltd.
3. Majupuria, T. C. (1962). A Textbook of Invertebrate Zoology: Vol. I. (1st ed.). S. Nagin Co.
4. Dharmi, P. S., & Dharmi, J. K. (2006). Chordate Zoology. R. Chand and Co.
5. Dharmi, P. S., & Dharmi, J. K. (2021). Invertebrate Zoology. R. Chand and Co.
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7. Miller, S. A., & Harley, J. B. (1999). Zoology. Tata McGraw Hill.
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9. Parker, T. J., & Haswell, W. A. (1992). A Textbook of Zoology, Invertebrates. Vol. I (1st Indian Edition). CBS Publishers and Distributors Pvt. Ltd.
10. Parker, T. J., & Haswell, W. A. (1992). A Textbook of Zoology, Invertebrates. Vol. I (1st Indian Edition). CBS Publishers and Distributors Pvt. Ltd.

2.7 Skill Enhancement Courses (SEC)

Course Title	Fish Aquarium setting
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Acquire skills of fish aquarium setting
	2. Prepare a list of resources required for aquarium setting
	3. Perform experiments related to aquarium maintenance
	4. Create aquarium keeping as one of the departmental activities
Module 1 (Credit 1) - Ornamental fishes, Aquarium plants & Fish feed	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify various ornamental fishes and their feed
	2. Identify various aquarium plants
Content Outline	<ul style="list-style-type: none"> • Identification and breeding and maintenance of: Ornamental fishes: Angel, Danio, Discus, Flower horn, Gourami, Siamese fighter, Goldfish • Aquarium plants: Hydrilla, Amazon sword, Aqua rose, Pistia, Cork screw, Cobamba. Ludwigia • Fish Feed : Live feed - Artemia, Daphnia, Moina, Infusoria, Chaetoceros, Blood worms • Formulated feed - Composition and nutritional value
Module 2 (Credit 1) - Aquarium equipment	
Learning Outcomes	After learning the module, learners will be able to
	1. Perform experiments of water testing parameters
	2. Demonstrate use of various accessories by setting up aquarium
Content Outline	<ul style="list-style-type: none"> • Aquarium set up: <ul style="list-style-type: none"> ○ Monitoring water quality parameters - pH, Temperature, Conductivity, Dissolved Oxygen, Free Carbon dioxide, Ammonia, Nitrate, Phosphates ○ Monitoring the air siphons, cleaning techniques, aerators, filters ○ Types of gravel ○ Types of feeding cups

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Journal Assessment and certification
2. End Semester Practical examination
3. Aquarium setting up and maintenance based on this course

Some Illustrative assignments for students

1. Ornamental Fishes, Aquarium Plants & Fish Feed

Each student will select a specific ornamental fish species from the list provided in the course outline (e.g., Angel, Danio, Discus, etc.). They will research and document the key characteristics, habitat preferences, and feeding habits of their chosen fish species. Using this information, students will set up a small aquarium at home or in the lab, carefully selecting appropriate tank mates and aquarium plants to mimic the fish's natural environment. Over the course of several weeks, students will observe and record the behavior of their fish, noting feeding patterns, interactions with tank mates, and any signs of distress. Additionally, they will experiment with different types of formulated feed and live feed to determine the most suitable diet for their ornamental fish. At the end of the project, students will present their findings, including recommendations for optimal care and feeding practices for the chosen fish species.

2. Aquarium Equipment

Each student will design and conduct a series of experiments to evaluate the effectiveness of various aquarium equipment in maintaining water quality. They will set up identical experimental tanks, each equipped with different types of filtration systems, aerators, and monitoring devices. Throughout the experiment, students will measure and record key water quality parameters such as pH, temperature, ammonia levels, and dissolved oxygen concentrations at regular intervals. They will also assess the efficiency of different cleaning techniques and gravel types in maintaining water clarity and reducing organic waste buildup. Based on their experimental data, students will analyze the performance of each equipment setup, identifying strengths and weaknesses in water quality management. Finally, they will compile their findings into a comprehensive report, outlining recommendations for optimizing aquarium equipment for effective water quality maintenance.

References:

1. Hawlins, Ed. (1981). *Aquarium Systems*. Academic Press.
2. Hunnam. (1981). *Living Aquarium*. Ward Lock.
3. Ratjak, K., & Zukal. (Year not provided). *Aquarium Fishes and Plants*.
4. Spotte. (1979). *Seawater Aquariums*. John Wiley & Sons.
5. Straughan. (1976). *Saltwater Aquarium in the Home*. Wh Smith Pub.
6. Mills, D. (1987). *Illustrated Guide to Aquarium Fishes*. Galley and Price, an imprint of W.H. Smith and Sons Limited.
7. Singh, N., Gupta, S., & Joshi, G. (2023). *Aquarium and its Management*. AkiNik Publications.
8. Tekrival, K. L., & Rao, A. A. (1999). *Ornamental Aquarium Fishes of India*. TFH United Kingdom.
9. Cato, J. C., & Brown, C. L. (2008). *Marine Ornamental Species (Collection, Culture and Conservation)*. Blackwell Science.

10. Srivastava, C. B. L. (2002). Aquarium: Fish Keeping. Kitab Mahal. Devi, C. S. T., & Jayashree, K. V. (2015). Home Aquarium. Saras Publication.

2.9 Value Education Courses (VEC)

Course Title	Ecosystem Conservation
Course Credits	2
Course Outcomes	After going through the course, learners will be able to
	1. Interpret the concept of ecosystem and its types
	2. Evaluate the interdependence and interactions between abiotic and biotic factors in the environment
	3. Examine the scenario of wild life conservation in India in the light of guidelines from different relevant governing agencies
	4. Carry out activities to create awareness about the environment conservation in the society
Module 1 (Credit 1) - Concepts of Ecosystem	
Learning Outcomes	After learning the module, learners will be able to
	1. Interpret the concept of ecosystem and its types
	2. Evaluate the interdependence and interactions between abiotic and biotic factors in the environment
Content Outline	<ul style="list-style-type: none"> • Concept of ecology and components of an ecosystem and their interactions • Types of ecosystems: terrestrial and aquatic and their sub-types • Food chain and food web in ecosystem, Ecological pyramids - energy, biomass and number
Module 2 (Credit 1) - Biodiversity Conservation	
Learning Outcomes	After learning the module, learners will be able to
	1. Examine the scenario of wild life conservation in India in the light of guidelines from different relevant governing agencies
	2. Create awareness about the environment conservation in the society through environment related activities
Content Outline	<ul style="list-style-type: none"> • Conservation strategies: <i>in situ</i>, <i>ex-situ</i>, National parks, Sanctuaries, Biosphere reserves and Sacred Groves. • Introduction to legislations and authority bodies for biodiversity conservation (IUCN, NBB, Wildlife Protection Act of India) • Conservation projects in India - (Sanjay Gandhi National Park, Tadoba Tiger Reserve, Corbett National Park, Kaziranga

National Park, Gir National Park, Silent Valley, Pirotan Island Marine Park, Keoladeo Ghana National Park, Bandipur Sanctuary)
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. Miniature Ecosystem Creation

Description: Each student will create a miniature ecosystem in a glass container or terrarium. They will select a suitable container and gather materials such as soil, rocks, small plants, and decorative elements to represent different components of the ecosystem. Students will carefully arrange these elements in layers, mimicking the structure of a natural ecosystem. They will introduce a small population of organisms, such as insects or small invertebrates, into the ecosystem. Over the course of several weeks, students will observe and document interactions between biotic and abiotic factors within their miniature ecosystem. They will analyze the dynamics of the ecosystem, including nutrient cycling, energy flow, and the role of decomposers. At the end of the project, students will present their miniature ecosystems to the class, explaining their design choices and observations.

2. Biodiversity Conservation

Description: Each student will design and implement a wildlife conservation awareness campaign in their local community. They will identify a specific wildlife conservation issue or species of concern, based on the content covered in the module. Students will create educational materials such as posters, brochures, and online resources to raise awareness about the importance of biodiversity conservation and the threats facing wildlife populations. They will organize outreach events such as workshops, seminars, or nature walks to engage community members and educate them about conservation practices. Students will collaborate with local conservation organizations or government agencies to support their initiatives and promote conservation efforts. At the conclusion of the project, students will evaluate the impact of their awareness campaign and reflect on their experiences in promoting wildlife conservation in their community.

References:

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2. Dash, M. C. (1993). *Fundamentals of Ecology* (2nd ed.). Tata McGraw Hill.
3. Rana, S. V. S. (2013). *Essentials of Ecology and Environmental Science* (5th ed.). PHI Publications.
4. Rana, S. V. S. (January 2009). *Biodiversity* (4th ed.). Prentice Hall Publications.
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7. Purohit, M. (2007). *Wildlife Laws and its Impact on Tribes*. Deep and Deep Publications.

