



SNDT Women's University, Mumbai

**Undergraduate Degree / UG
Programme (Syllabus as Per NEP) -
Faculty of Science & Technology**

**Bachelor of Science
(Zoology) (Non-AEDP)**

**B.Sc. (Zoology)
(Non-AEDP)**

As Per NEP – 2020

Semester – I to IV

**Syllabus
(W.E.F. Academic Year 2025-26)**

Terminologies

Vertical	Full-Form/Definition	Remarks	Related To Major And Minor Courses
Major (Core)	Subject Comprising Mandatory and Elective Courses, Major Specific IKS, Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects Connected to Major	Minimum 50% Of Total Credits Corresponding to Three/Four - Year UG Degree- Mandatory Courses	Related To The Major
Minor Course	Course From Same Or Different Faculty	Minimum 18-20 Credits to Be Completed in The First Three Years of UG Programme	Related To the Minor
OEC	Open Elective Courses/ Generic Courses	10-12 Credits to Be Offered in I And/Or II Year. Faculty-Wise Baskets of OEC To Be Prepared	OEC Is to Be Chosen Compulsorily from Faculty Other Than That of the Major
VSC	Vocational Skill Courses, Including Hands On Training Corresponding To The Major And/Or Minor Subject	8-10 Credits, To Be Offered in First Three Years, Wherever Applicable Vocational Courses Will Include Skills Based on Advanced Laboratory Practical's of Major	Related To the Major or Minor
SEC	Skill Enhancement Courses	06 Credits, To Be Offered in I And II Year, To Be Selected from The Basket of Skill Courses Approved by University	Related To the Major or Minor Any Relevant Skill
AEC	Ability Enhancement Courses	08 Credits, To Be Offered in I And II Year, English: 04 Credits to Be Earned in Sem - I, Modern Indian Language Of 04 Credits to Be Offered in II Year	NA
VEC	Value Education Courses	Understanding India, Environmental Science/Education, Digital and Technological	NA

		Solutions, Health & Wellness, Yoga Education, Sports, And Fitness	
IKS	Indian Knowledge System	Generic IKS Course: Basic Knowledge Of The IKS To Be Offered At First Year Level	Major-Specific IKS Courses: Advanced Information About the Major, Part of the Major Credit to Be Offered at Second- Or Third-Year Level
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	NA
CE	Community Engagement and Service		Related To Major
RP	Research Project	Corresponding To the Major Subject	Related To Major

Programme Template

Faculty		Science and Technology
Programme Degree		B.Sc.
Specialization		Zoology
Preamble		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. 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.
Programme Specific Outcomes (PSOs)		After completing this programme, the learner will be able to:
	1	Demonstrate advanced knowledge and skills in the study of non-chordates, 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		First Year Entry: • Entry to the First Year Program - 40% in H.SC. / CBSE / ISC • At the end of First Year – Student will be eligible for a Certificate in Zoology if all 44 credits are completed Second Year Entry: • Completion of 44 credits for entry into Second Year • At the of Second Year - Completion of 88 credits will give the student Diploma in Zoology Third Year Entry (if applicable): • Completion of 88 credits for entry into Third Year • At the of Third Year - Completion of 132 credits will give the student Degree in Zoology Lateral Entry (if applicable): • Lateral Entry is from other University is permitted at all three years if a student is having Zoology as one of the subjects offered in the previous year (second and/or third year)
Intake		15 students = 1 batch

Structure with Course Titles

B. Sc. (Zoology) (Non-AEDP)

Semester - I

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester - I					
10032401	Biological Functions	Major (Core)	2	50	50	0
	Subject 2	Major (Core)	2	50	50	0
	Subject 3	Major (Core)	2	50	50	0
10432411	Nutrition & Health	OEC	4	100	50	50
10632401	Experimental Zoology	VSC S1	2	50	50	0
10732411	Laboratory Safety Measures	SEC	2	50	0	50
	Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf (Available on Website)	AEC (English) (Any One)	2	50	0	50
10810111	English For Academic Writing - Paper I (For Students of English Medium)					
10810112	English Language and Literature - I (For Students of Non-English medium)					
11051111	Inception of India Knowledge System IKS Link: https://www.sndt.ac	IKS (Generic)	2	50	0	50

	.in/pdf/academics/syllabus-as-per-nep/iks-syllabus/ug-degree/inception-of-indian-knowledge-system.pdf (Available on Website)					
10952111	Introduction to Indian Constitution Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/introduction-to-indian-constitution.pdf (Available on Website)	VEC	2	50	0	50
11450121	Basics of National Service Scheme	CC (Any One)	2	50	50	0
11450221	National Cadets Corps. (NCC) Studies – I					
11450322	Health and Wellness					
11450421	Performing Arts Exploration					
			22	550	300	250

Semester – II

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – II					
20032411	Reproduction and Development	Major (Core)	2	50	0	50
	Subject 2	Major (Core)	2	50	0	50
	Subject 3	Major (Core)	2	50	0	50
		VSC-S2	2	50	50	0
		VSC-S3	2	50	50	0
20432411	Amazing Animal World	OEC	4	100	50	50
20732401	Fish Aquarium Setting	SEC	2	50	50	0
	Ability Enhancement Course (AEC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/ability-enhancement-course.pdf (Available on Website)	AEC (English) (Any One)	2	50	0	50
20810111	English For Academic Writing - Paper II (For Students of English Medium)					
20810112	English Language and Literature – II (For Students of Non-English medium)					
20952111	Environment Awareness Link: https://www.sndt.ac	VEC	2	50	0	50

	.in/pdf/academics/syllabus-as-per-nep/vec-syllabus/ug-degree/environment-awareness.pdf (Available on Website)					
	Co-Curricular Course (CC) Link: https://www.sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-ii-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
21450121	Volunteerism and National Service Scheme					
21450221	National Cadets Corps. (NCC) Studies - II					
21450323	Yoga Education					
21450421	Fine Art					
			22	550	250	300

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

Semester – III

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – III					
30132411	Study of non-chordates	Major (Core)	4	100	50	50
30132412	Genetics-I	Major (Core)	4	100	50	50
30132413	Applied Zoology-I	Major (Core)	4	100	50	50
30332411	Useful & Harmful Insects	Minor Stream	2	50	0	50
30432411	Animal behaviour	OEC	2	50	0	50
	Modern Indian Language Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/aec-syllabus/ug-degree/aec-semester-iii.pdf (Available on Website)	AEC (Any One)	2	50	50	0
30810201	શીખો ગુજરાતી - પ્રાથમિક ભાગ ૧: પરિચય, લેખન અને વાચન કૌશલ્ય (ગુજરાતી) Shikho Gujarati – Prathmik Bhag 1: Parichay, Lekhan ane Vachan Kaushalya (Gujarati)					
30810301	रचनात्मक लेखन (हिन्दी) Rachnatmak Lekhan (Hindi)					
30810401	मराठी भाषेचा परिचय भाग १ - (मराठी) Marathi Bhashecha Parichay- Bhaag 1 (Marathi)					

30810501	लौकिक संस्कृत न्यायः (संस्कृत) Contemporary Sanskrit Nyaya (Sanskrit)					
30132404	Biochemistry	Major (Core)	2	50	50	0
	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iii-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
31450121	Social issues Advocacy and Action					
31450221	National Cadets Corps. (NCC) Studies – III					
31450321	Traditional Sports and Fitness					
31450421	Unfolding The Beauty of Indian Music					
			22	550	300	250

Semester – IV

SN	Courses	Type of Course	Credits	Marks	Int Marks	Ext Marks
	Semester – IV					
40132411	Study of Chordates	Major (Core)	4	100	50	50
40132412	Genetics-II	Major (Core)	4	100	50	50
40332411	Applied Zoology-II	Minor Stream	4	100	50	50
40432411	Human Parasitic Diseases	OEC	2	50	0	50
40732411	Pet Care	SEC	2	50	0	50
	Modern Indian Language Ability Enhancement Course (AEC) Link: https://sndt.ac.in/pdf/academics/syllabus-us-as-per-nep/aec-syllabus/ug-degree/aec-semester-iv.pdf (Available on Website)	AEC (Any One)	2	50	0	50
40810211	શીખો ગુજરાતી - પ્રાથમિક (ગુજરાતી) Shikho Gujarati – Prathmik (Gujarati)					
40810311	सूचना प्रौद्योगिकी और हिन्दी भाषा (हिन्दी) Suchana Praudyogiki aur Hindi Bhasha (Hindi)					
40810411	मराठी भाषेचा परिचय भाग -२ (मराठी) Marathi Bhashecha Parichay- Bhaag 2					

	(Marathi)					
40810511	वाल्मीकीयकृत रामायणम् – अयोध्याकाण्डः (संस्कृत) Valmikiyakrut Ramayanam – Ayodhyakanda (Sanskrit)					
40332402	Homeostasis	Minor Stream	2	50	50	0
	Co-Curricular Course (CC) Link: https://sndt.ac.in/pdf/academics/syllabus-as-per-nep/cc-syllabus/ug-degree/co-curricular-course-as-per-nep-2020-semester-iv-syllabus.pdf (Available on Website)	CC (Any One)	2	50	50	0
41450121	NSS Volunteers under National service scheme special camp					
41450122	Personality and Leadership Development through National Service Scheme					
41450221	National Cadets Corps. (NCC) Studies – IV					
41450321	Basics of Self Defence and Fitness Training					
41450421	Theatre & Dance					
			22	550	250	300

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

Course Syllabus

Semester - I

.1.1 Major (Core)

Course Title	Biological Functions
Course Credits	2 Credit's
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	● Nutrition: ○ Study of structure and function of nutritional apparatus of: Amoeba, Hydra, Earthworm, Cockroach, Amphioxus, Pigeon and Ruminants. ○ Physiology of digestion in humans ● Respiration: ○ Study of structure and function of respiratory organs in Earthworm, Spider, Bonyfish, 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	● Circulation: ○ 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: ○ 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

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

1. PowerPoint presentation on topics related to physiology
2. Preparation of working models illustrating the functional aspects of physiological processes
3. Objective type tests - MCQs with reasoning, assertion; Match the column with three columns; True / False giving reasons; Quiz on online platforms such as Kahoot, Quiznet etc.
4. Conduct survey related to topics of physiological processes e.g. blood pressure, lung capacity, rate of respiration by respirometer among the population

Note: Rubrics to be developed for subjective type of assessment

Suggested Project-based assignments

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 (1sted.). S. Chand and Co. Ltd.
3. Dhami, P. S., & Dhami, J. K. (1979). Invertebrate Zoology (1st ed.). R. Chand and Co.
4. Dhami, P. S., & Dhami, 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 Indianed.). CBS Publishers and Distributors Pvt. Ltd.
8. Parker, T. J., & Haswell, W. A. (1992). A Textbook of Zoology, Vol. II (1st Indian ed.). CBSPublishers and Distributors Pvt. Ltd.

Semester - I

.1.4 Open Elective Courses/ Generic (OEC)

Course Title	Nutrition & Health
Course Credits	4 Credit's
Course Outcomes	After going through the course, learners will be able to
	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	After learning the module, learners will be able to
	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	• 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	After learning the module, learners will be able to
	1. Classify food into different component groups

	2. Interpret the importance and role of different food components
Content Outline	• 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 & Non-essential amino acids; formation of peptide bond, Biological role & clinical significance • 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	• 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: ○ 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	• 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, Birthrate, 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 lifestyle
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 qualitative nutrient data collection 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, students will interpret the significance and roles of different dietary components in human health and disease prevention. The findings will be presented in a comprehensive 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.

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, Edinburgh.
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>

Semester - I

.1.5 Vocational Skill Courses (VSC S1)

Course Title	Experimental Zoology
Course Credits	2 Credit's
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	• 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 ofshark 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 • Study of meiosis using Tradescantia bud / cockroach testis • Study trip to diagnostic laboratory / Industry and submission of report.
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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. 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.
6. 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.

7. Nervous System Investigation: Students will dissect earthworms and examine the nervous system.

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 (1sted.). S. Chand and Co. Ltd.
3. Dhami, P. S., & Dhami, J. K. (1979). Invertebrate Zoology (1st ed.). R. Chand and Co.
4. Dhami, P. S., & Dhami, 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.
9. Verma P.S., Tyagi B.S. and Agrawal A.K. (2000). Animal Physiology. S. Chand and Co. Ltd.

Semester - I

.1.6 Skill Enhancement Courses (SEC)

Course Title	Laboratory Safety Measures
Course Credits	2 Credit's
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	• 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, Respiratory 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	• 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

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 compile data such as number of types of shells (if there is a collection available), height of students, etc. 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.

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, TataMcGraw 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, TataMcGraw 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.

Course Syllabus

Semester - II

.2.1 Major (Core)

Course Title	Reproduction and Development
Course Credits	2 Credit's
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	● Locomotion: ○ 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 ○ 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	● Reproduction ○ 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 ○ 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.
2. Chordate Zoology And Elements of Animal Physiology - E. L. Jordan, P. S. Verma. 1st Edition, 1980. S. Chand and Co. Ltd.
3. Invertebrate Zoology- P. S. Dhami and J. K. Dhami, 1st Edition, 1979. R. Chand and Co.
4. Chordate Zoology - P. S. Dhami and J. K. Dhami, Reprint Edition, 1991. R. Chand and Co. Ltd.
5. Zoology- S. A. Miller and J. B. Harley, 8th Edition, 2009. Tata McGraw Hill
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.
8. A Textbook of Zoology, Vol. II- 1st Indian Edition, 1992. - T. J. Parker and W. A. Haswell-CBS Publishers and Distributors Pvt. Ltd.

Semester - II

.2.6 Open Elective Courses/ Generic (OEC)

Course Title	Amazing Animal World
Course Credits	4 Credit's
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	General Morphology, Habits and habitat and Significance: • Butterflies - the flying jewels - Blue Mormon, Kaiser-i-Hind • Herpetofauna of India- <i>Rhacophorus malabaricus</i>, Monitor lizard, Chameleon • Feathered Biped: 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	After learning the module, learners will be able to

Outcomes	1. Enlist unique characteristics of the animals
	2. Interpret the significance of the unique characteristics
Content Outline	General Morphology, Habits and habitat and Unique features: • Jelly fish - <i>A. victoria</i> • Pistol Shrimp • Suicidal Ant • Praying mantis • Pearl oysters • 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	• Recently discovered fauna: ○ Tapir Frog ○ Stealthy Gecko ○ Rose-rainbow fish ○ Southern maned sloth ○ Sea anemone from Japan – <i>Stylobatus</i> • Unique fauna: ○ 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	• 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 animal's 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:** Students will collect data of different amazing animals (apart from the syllabus) and write an informative article and disseminate this communication through weekly poster exhibits.

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 such fauna. 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: Conservation strategies

Using case studies and real-world scenarios, students will present the various success stories of the wildlife conservation and also highlight where such efforts are needed

References:

1. Jordan, E. L., & Verma, P. S. (2013). Chordate Zoology Volume I. S. Chand and Co. Ltd.
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.
6. Moore, J. (2006). Introduction to Vertebrates. Cambridge University Press.
7. Miller, S. A., & Harley, J. B. (1999). Zoology. Tata McGraw Hill.
8. Kotpal, R. L. (2013). Modern Textbook of Zoology, Invertebrates. (12th ed.). Rastogi Publications.
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.

Semester - II

.2.7 Skill Enhancement Courses (SEC)

Course Title	Fish Aquarium setting
Course Credits	2 Credit's
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	• 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, Bloodworms • 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	• Aquarium set up: ○ 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
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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.

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 stating 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,
11. K. V. (2015). Home Aquarium. Saras Publication.

Course Syllabus

Semester - III

.3.1 Major (Core)

Course Title	Study of non-chordates (Th+Pr)
Course Credits	4 Credit's (2 Th + 2 Pr)
Course Outcomes	After going through the course, learners will be able to
	1. Relate the characteristic features of invertebrate phyla with their levels of organizations
	2. Interpret phylogenic relationships between the invertebrate phyla
	3. Identify the animals based on their observations of the external characteristics
	4. Perform experiments based on temporary mountings
	5. Prepare field report based on observations done during field excursions
Module 1(Credit 1) : General organization of Phylum Protozoa to Nematoda	
Learning Outcomes	After learning the module, learners will be able to
	1. Differentiate between the various levels of body wall and coelom organization
	2. Evaluate the development of organ systems across phylum Protozoa to Nematoda
Content Outline	General organization of: • Unicellular organization Kingdom Protista - Phylum Protozoa • Multicellular organization: ○ Colonization level - Phylum Porifera ○ Division of labour – Phylum Cnidaria • Triploblastic acoelomate and pseudocoelomate organization ○ Acoelomate organization – Phylum Platyhelminthes • Pseudocoelomate organization – Phylum Nematoda
Module 2(Credit 1) : General organization of Phylum Annelida to Phylum Echinodermata	
Learning Outcomes	After learning the module, learners will be able to :
	1. Evaluate the development of organ systems across phylum Annelida to Echinodermata
	2. Interpret the phylogenic relationship between the invertebrate coelomates

Content Outline	• Triploblastic Coelomate organization ○ Animals with metameric segmentation: Phylum Annelida ○ Animals with jointed appendages: Phylum Arthropoda ○ Animals with mantle: Phylum Mollusca ○ Animals with enterocoel: Phylum Echinodermata • General organization of Phylum Hemichordata
PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify the invertebrate animals from their external characters
	2. Perform temporary mounting for observations and hands on experiments
	3. Sketch and label specific body structures of animals
	4. Prepare report based on field study
Content Outline	• Classification of Phylum: ○ Protozoa: <i>Amoeba</i>, <i>Euglena</i>, <i>Paramoecium</i>, <i>Plasmodium</i> ○ Porifera: <i>Leucosolenia</i>, <i>Euplectella</i>, <i>Euspongia</i> ○ Phylum Cnidaria: <i>Hydra</i>, <i>Obelia</i> colony, <i>Aurelia</i>, <i>Adamsia</i>, <i>Fungia</i>, <i>Madrepora</i> ○ Phylum Platyhelminthes: <i>Planaria</i>, Liver fluke, Tapeworm ○ Phylum Nematoda: <i>Ascaris</i> - male and female ○ Phylum Annelida: <i>Nereis</i>, Earthworm, Leech ○ Phylum Arthropoda: Crab, Lobster, <i>Lepisma</i>, Beetle, Dragonfly, Butterfly, Spider, Tick, Scorpion, Centipede, Millipede ○ Phylum Mollusca: <i>Chaetoderma</i>, <i>Neopilina</i>, <i>Chiton</i>, <i>Dentalium</i>, <i>Pila</i>, <i>Unio</i>, <i>Sepia</i>, <i>Nautilus</i> ○ Phylum Echinodermata: Starfish, Brittle star, Feather star, Sea urchin, Sea cucumber ○ Phylum Hemichordata : <i>Balanoglossus</i> • Mounting of foraminiferan shells • Observation of food vacuole and contractile vacuole in paramecium from live culture • Mounting of Setae from Earthworm • Study of locomotory appendages of arthropods : Leg of cockroach, appendages of prawn, wings of insects

	• Types of metamorphosis in insects - Ametabolous (Lepisma), Hemimetabolous (Cockroach), Holometabolous (Butterfly) • Types of crustacean larvae • Study of different types of shell in Mollusca • Study of modification of foot in mollusca • Types of echinoderm larvae • Study trip to local zoo / national park / aquarium / coastline / biodiversity park and submission of report.
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Documentation using photography - biodiversity in and around the local vicinity / campus or videography (self-made videos uploaded on social media)
2. Padlet activity – Designing Infographics on topics related to the syllabus and uploading them on Padlet for collaborative learning
3. Submission of field report based on actual study trip or virtual.

Note: Rubrics to be developed for subjective type of assessment

References: -

1. Invertebrate Zoology - E. L. Jordan and P. S. Verma. Reprint Edition, 2015. S. Chand and Co.
2. A Textbook of Invertebrate Zoology: Vol. I. - T. C. Majumuria. 1st edition, 1962- , S. Nagin and Co.
3. Invertebrate Zoology - P. S. Dhami and J. K. Dhami, 1st Edition, 1979. R. Chand and Co.
4. Zoology - S. A. Miller and J. B. Harley, 8th Edition, 2009. Tata McGraw Hill
5. Modern Textbook of Zoology - R. L. Kotpal. Reprint Edition, 2012. Rastogi Publications.
6. A Textbook of Zoology, Invertebrates. Vol. I - T. J. Parker and W. A. Haswell. 1st Indian Edition, 1992.-CBS Publishers and Distributors Pvt. Ltd.
7. An Introduction to the Invertebrates - Janet Moore. 2nd Edition, 2006. Cambridge University Press.

Semester - III**.3.2 Major (Core)**

Course Title	Genetics – I (Th+Pr)
Course Credits	4 Credit's (2 Th + 2 Pr)
Course Outcomes	After going through the course, learners will be able to :
	1. Understand the basic concepts of inheritance
	2. Solve the case specific crosses of inheritance
	3. Relate the inheritance of various characteristics with mendelian genetics and its exceptions
	4. Identify and predict the various patterns of inheritance
	5. Perform experiments based on the concepts of genetics
Module 1(Credit 1) : Introduction to Mendelian inheritance	
Learning Outcomes	After learning the module, learners will be able to :
	1. Understand the basic concepts of inheritance
	2. Relate the inheritance of various characteristics with mendelian genetics and its exceptions
Content Outline	• Introduction to Genetics ○ Definition, Scope and Importance of Genetics ○ Classical and Modern concept of Gene ○ Brief explanation of the following terms: Allele, Wild type and Mutant alleles, Locus, Dominant and Recessive traits, Homozygous and Heterozygous, Genotype and Phenotype, Genome • Mendelian Genetics ○ Mendelian Genetics: Mendel's Laws of Inheritance, Monohybrid & Dihybrid Cross, ○ Test Cross, Back Cross, Reciprocal cross, significance ○ Mendelian Traits in humans • Exceptions to Mendelian inheritance ○ Incomplete dominance and Co- dominance, ○ Lethal Genes - Dominant, recessive and intermediate ○ Epistasis - Recessive, Double recessive, Dominant and Double dominant • Cytoplasmic inheritance: Kappa particles in Paramecium, Shell coiling in Snails

Module 2(Credit 1) : Human Genetics	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify and predict the various patterns of inheritance
	2. Interpret the genetic basis for the various types of inheritance
Content Outline	• Pedigree Analysis: Autosomal dominant and recessive, X-linked dominant and recessive • Genetic Counselling: Risk of recurrence of hereditary diseases, causes and significance of genetic counseling. • Mendelian genetics in humans: • Autosomal Dominant inheritance: Huntington's chorea disorder, • Autosomal recessive inheritance: Harlequin-type Ichthyosis • X-linked recessive inheritance: Duchenne muscular dystrophy, • X-linked Dominant inheritance: Rett Syndrome. • Chromosomal Abberations: - - Numerical abnormality: Monosomy – Turner Syndrome; Tetrasomy/Trisomy – Down Syndrome.
PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Solve the problems based on mendelian genetics
	2. Interpret the genetic basis of the case studies involving a given type of inheritance
	3. Perform experiments based on the concepts of genetics
Content Outline	• Problems in genetics based on Monohybrid cross • Problems in genetics based on Dihybrid cross • Analyzing the pattern of inheritance from the given pedigree chart • Constructing the pedigree chart from the given information • Extraction of DNA • Extraction of RNA • Study of polytene chromosomes • Study of chromosome morphology based on the position of centromeres • Study of karyotypes: Normal, Turner's syndrome, Klinefelter syndrome, Down's syndrome

	• Application of genetics in forensic science – concept of DNA fingerprinting and problems based on it
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE):

- Project on Survey of some hereditary characteristics in human population: Data collection, analysis of the distribution of dominant and recessive traits in a population,
- Experiment based on how the mitotic index is affected due to different environmental conditions. Different seeds / onion / garlic roots grown in normal water as control and different concentrations of test solutions could be observed and mitotic index calculated. Analysis to be done as to how cell division is affected. Data to be recorded along with photomicrographs. Report to be submitted.

References: -

1. Gardner, E. J., Simmons, M.J. and Snustad, D.P. (2006) *Principles of Genetics*. (8th ed.). John Wiley and Sons.
2. Tamarin R.H. (2001). *Principles of Genetics*. (4th ed.). McGraw-Hill
3. Weaver R.F., Hedrick P.W. (1992). *Genetics* (2nd ed.). W.C. Brown.

Semester - III**.3.3 Major (Core)**

Course Title	Applied Zoology – I (Th+Pr)
Course Credits	4 Credit's (2 Th+ 2 Pr)
Course Outcomes	After going through the course, learners will be able to :
	1. Identify and describe the tools and techniques involved in apiculture and sericulture
	2. Interpret the role of various strategies of pest management
	3. Set up the vermicomposting unit
	4. Analyse the vermicompost soil parameters by performing experiments
	5. Prepare field report based on observations done during field excursions
Module 1(Credit 1) : Economic Entomology	
Learning Outcomes	After learning the module, learners will be able to
	1. Identify and describe the tools and techniques involved in apiculture and sericulture
	2. Interpret the role of various strategies of pest management
Content Outline	• Honeybee – Social life and communication, life history, apiculture, pests, enemies, diseases, commercial importance • Silk moth – Life history, sericulture, Diseases and control measures, economic importance • Life history and control measures of insect pests: Schistocerca gregaria, Aphids, Sitophilus oryzae • Insect Pest Management - Chemical and biological control: • Overview of chemical pesticides- Major classes of chemical pesticides and their mode of action • Biological control agents: Pathogens - Bacteria (Bacillus thuringiensis), Fungi, Viruses, Parasitoids
Module 2(Credit 1) : Vermiculture and Vermicomposting	
Learning Outcomes	After learning the module, learners will be able to :
	1. Demonstrate the process of vermiculture and vermicomposting
	2. Relate the scope of vermicomposting as entrepreneurship

Content Outline	• Earthworm Ecology: ◦ Distribution, Habit and habitat, ◦ Different species of earthworms useful in vermiculture ◦ Role of earthworms in soil ecosystem • Components of vermicomposting: ◦ selection of suitable species of earthworms, ◦ substrate and environmental conditions, ◦ different models/designs of equipment used in vermicomposting (For small scale and commercial set up), maintenance ◦ Enemies of earthworm ◦ Harvesting ◦ Applications of vermiculture- In aquaculture, poultry, piggery and vermicomposting ◦ Benefits of vermicompost , use in agriculture • Vermiwash collection , composition and use
PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify and describe the tools and techniques involved in apiculture, sericulture and pest management
	2. Prepare field report based on observations done during field excursions
Content Outline	• Study of honeybee: - Life cycle - types of legs - sting apparatus - mouthparts • General tools and techniques of apiculture (Study of Bee box) • Study of insect pests: Schistocerca gregaria, Aphids, Sitophilus oryzae, Tribolium confusum • Study of insect control - chemical and biological • Life cycle of silk moth • Identification of various types of earthworm species used for vermiculture

	• Study of types of vermicomposting set-up • Hands-on vermicomposting (to be carried out by students) • Study of various parameters of vermicompost soil–moisture, pH, organic content of • Field visit to sericulture / apiculture farms and report submission
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

- Infographics based on the social insects / parasite life cycles
- Project based on testing the efficacy of soil with and without vermicompost added on the growth of plants. Students to record observations w.r.t. the height of the plant, leaf measurements over a month at least. Analyze the data and submit the report
- Submission of field visit report

References: -

1. Ahsan J. and Sinha S.P. Prasad () A Handbook on Economic Zoology. S. Chand & Co.
2. Hassall K.A. (2013). The Chemistry of Pesticides Their Metabolism, Mode of Action and Uses in Crop Protection. Scientific Publishers, India.
3. Metcalf, C. L., Metcalf R. L. and Flint W. P. (2018) Destructive and Useful Insects. Agri Horti Press.
4. Rahman A. (2017) Apiculture in India. Indian Council of Agricultural Research.
5. Sathe T.V. (2020). Biological Pest Control. Astral Publication.
6. Sehgal P.K. (2018). Textbook of Sericulture, Apiculture and Entomology. Kalyani Publishers.
7. Shukla G.S. and Upadhyay V. B. Economic Zoology. Rastogi Publication.
8. Kale R.D. (1998) Earthworms: Cinderella of Organic Farming, Prism Books Pvt. Ltd. Bangalore
9. Ismail, S.A. (1997) Vermicology - The Biology of Earthworms, Orient Longman.
10. The Complete Technology Book on Vermiculture and Vermicompost, (2010) published by National Institute of Industrial Research, Delhi-7, India
11. Lekshmy, M.S., Santhi R. (2012) Vermitechnology, Sara Publications, New Delhi, India

Semester - III**.3.4 Minor Stream**

Course Title	Useful and harmful insects
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to :
	1. Identify the useful and harmful insects
	2. Describe the life cycle of the insects
	3. Evaluate the economic importance of the insects
	4. Enlist the various control measures for harmful insects
	5. Create the record book / atlas of the insect fauna of the campus
Module 1(Credit 1) : Useful Insects	
Learning Outcomes	After learning the module, learners will be able to :
	1. Describe the useful insects
	2. Identify the stages in life cycle of insects
	3. Interpret the forensic investigations based on insect study
Content Outline	• Honey bee- Structure of bee hive, Life cycle and uses • Silk moth- Life cycle and uses • Lac insect-Life cycle and uses • Insects useful as biocontrol agents- Entomophagous insects- Ladybird beetle, Parasitoid wasps • Insects of forensic importance • Post Mortem Index using insects
Module 2 (Credit 1) : Harmful Insects	
Learning Outcomes	After learning the module, learners will be able to:
	1. Describe the life cycle of common insect pests
	2. Identify the insect pests
	3. Design / Propose the control measures with reference to the insect pests
Content Outline	• Life cycle and damage /disease caused by insect pests and control measures: ○ Common Household insect pests- cockroach, termites ○ Pests of stored grains- Rice weevil, Red Flour Beetle ○ Insects as vectors- Mosquito, Housefly, Rat flea

	○ Insects of veterinary importance- Horse fly, Screw worm fly ○ Pests of agriculture- Red cotton bug, Rhinoceros beetle Lemon butterfly ○ Desert locust ○ Aphids
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Documentation using photography (Collection of photos and making the report)
2. Padlet Activity: Preparation Infographics based on the life cycles of insects and upload on Padlet

Note: Rubrics to be developed for subjective type of assessment

References: -

1. Modern Entomology- Tembhare, D. B
2. Textbook of applied Entomology Volume I and Volume II- K. P. Srivastava- Kalyani Publishers
3. An Introduction to Sericulture- G. Ganga, J. Sulochana Chetty- Oxford & IBH Publishing Co Pvt Ltd
4. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami
5. Lac culture in India- N. Ghorai. Published by International books & periodicals Supply Service
6. Applied Entomology- Dr. P. G. Fenemore, Dr. Alka Prakash, published by New Age International (P) Ltd.

Semester - III**.3.5 OEC**

Course Title	Animal Behaviour
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to :
	1. Analyze and evaluate different types of learned behaviour with examples
	2. Analyze and evaluate different types of innate behaviour with examples
	3. Interpret the significance of different types of animal behaviour from various examples
Module 1(Credit 1): Learned behaviour	
Learning Outcomes	After learning the module, learners will be able to
	1. Analyze and evaluate different types of learned behaviour with examples 2. Relate the various types of behaviour through everyday life observations
Content Outline	• Definition, History and Scope of Animal Behaviour • Types of Animal behaviour - Innate and Learned behaviour • Learned Behaviour: ○ Habituation ○ Sensitization ○ Imprinting ○ Classical Conditioning ○ Operant conditioning ○ Insight learning
Module 2(Credit 1) : innate & social behaviour	
Learning Outcomes	After learning the module, learners will be able to:
	1. Analyze and evaluate different types of innate behaviour with examples
	2. Interpret the significance of different types of animal behaviour from various examples
Content Outline	• Introduction to innate behaviour ○ Types of innate behaviour a) Fixed Action pattern b) Reflexes

	c) Taxis d) Instincts • Introduction to social behaviour in animals Aggression ○ Schooling in fishes ○ Flocking in birds ○ Herding in mammals ○ Social organization in Insects and Primates
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

- Project based on observation of a given species in its natural habitat: Select a species to observe in its natural habitat (e.g. dog, cat, birds in a park, squirrels, or insects / spiders) Spend time observing the animal(s) over a period of two weeks. Record different types of behaviors such as feeding, social interactions, territorial behaviors, and grooming. Record your observations in detail, noting the time of day, the animal's surroundings, and any stimuli that might trigger certain behaviors. Compile the findings into a report discussing key observations and linking them to biological principles like survival, adaptation, and communication.
- Study of Animal Communication: Vocalizations and Body Language: Record the bird calls, barking of dogs etc. Analyze the different calls as per the time of the day, and relate them to the body gestures such as flight and perching (birds) or while barking (dogs).
- Mini research project based on how environmental factors like light, temperature, or the presence of other animals affect the behavior of an animal species. Aquarium fish species or zebrafish could be used as model organism and subjected to manipulated environmental factors. Observations could be recorded for 10 minutes, data to be analyzed and report to be submitted with conclusions drawn from the experimental studies.

References: -

1. Arora M. (2019). Animal Behaviour. (8th ed.). Himalaya Publications.
2. Eibl-Eibesfeldt, I. (1970). The biology of Behaviour. Ethology. Holt, Rineheart & Winston Publication, New York.
3. Manning A. and Dawkins M.S. (2012). An introduction to Animal Behaviour (6th ed.). Cambridge University Press.
4. McFarland D. (1999). Animal Behaviour Psychobiology, Ethology and Evolution. (3rd ed.). Longman Publication.
5. Vessey S., Jacob E., Vessey S. H. and Drickamer L. C. (2002). Animal Behaviour: Mechanisms, Ecology and Evolution. (5th ed.). McGraw-Hill.

Semester - III

.3.7 Major (Core)

Course Title	Biochemistry
Course Credits	2 Credit's (1 Theory + 1 Practicals)
Course Outcomes	After going through the course, learners will be able to
	1. Review the intricacies of biomolecules in living systems.
	2. Evaluate the importance of biomolecules & their clinical significance.
Module 1(Credit 1): Carbohydrates and Lipids	
Learning Outcomes	After learning the module, learners will be able to
	1. To study the structural & functional organization of carbohydrates in living systems.
	2. To study the structural & functional organization of lipids in living systems.
Content Outline	• Overview of Biomolecules: Concept of micromolecules and macromolecules; significance in biological systems • Carbohydrates: Introduction and classification; structural features and chemical properties; formation of glycosidic linkages; detailed study of monosaccharides (glucose, fructose); disaccharides (lactose, sucrose); polysaccharides (cellulose, glycogen, chitin); functional importance and medical relevance • Lipids: Introduction and classification with suitable examples; ester bond formation; physicochemical characteristics of lipids; saturated and unsaturated fatty acids; essential fatty acids and their importance; physiological functions and health-related implications. • Amino Acids and Proteins: General structure and classification of amino acids; essential and non-essential amino acids; peptide bond formation and polypeptide chain; structural organization of proteins (primary, secondary, tertiary, quaternary); functional roles and clinical importance
Module 2	PRACTICAL COURSE: (1 Credit)
Learning Outcomes	After learning the module, learners will be able to: Qualitative & quantitative estimation of biomolecules
Content Outline	• To estimate concentration of glucose by GOD-POD method. • Qualitative tests for detection of Carbohydrates: Molisch's test, Benedict's test, Barfoed's test, Anthrone test • Qualitative test for detection of Lipids:

	Solubility test, Sudan III test, Saponification test, Salkowski test • To separate different classes of lipids using Thin Layer Chromatography. • To separate amino acids by paper chromatography • To estimate concentration of proteins by Folin-Lowry method. • Qualitative tests for detection of Protein: Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test • Study of clinical disorders due to carbohydrates, proteins & lipids imbalance (Photograph to be provided / symptoms to be given & disorder to be identified) ▪ Diabetes Type I & II ▪ Hyperglycaemia & Hypoglycaemia ▪ Obesity ▪ Lactose Intolerance ▪ Fatty liver disease ▪ Atherosclerosis
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Survey on the topics related nutrients & balance diet.
2. Documentation using photography or videography (self-made videos uploaded on social media) diseases & disorders
3. Prepare best out of waste models of various biomolecules.

Note: Rubrics to be developed for subjective type of assessment

References: -

- Powar, C. B. (2019b). *Cell biology*. 3rd edition
- Jain, J. L. J. & S. J. & N. (2022b). *Fundamentals of Biochemistry*. S. Chand Publishing. 9th edition
- Cooper, G. M., & Adams, K. W. (2022). *The cell: A Molecular Approach*. Oxford University Press. 6th edition
- Stryer, L., Berg, J., Tymoczko, J., & Gatto, G. (2019). *Biochemistry*. WH Freeman. 8th edition
- Conn, E., & Stumpf, P. (2009). *Outlines of Biochemistry, 5th Ed*. John Wiley & Sons. 5th edition
- Nelson, D. L., & Cox, M. M. (2021). *Lehninger Principles of Biochemistry*. 8th edition

Course Syllabus

Semester - IV

.4.1 Major (Core)

Course Title	Study of Chordates (Th+Pr)
Course Credits	4 Credit's (2 Th + 2 Pr)
Course Outcomes	After going through the course, learners will be able to:
	1. Compare the characteristics between the chordate classes
	2. Interpret phylogenic relationships between the chordate classes
	3. Identify the animals based on their observations of the external characteristics
	4. Perform experiments based on temporary mountings
	5. Prepare field report based on observations done during field excursions
Module 1(Credit 1) : General organization of lower chordates	
Learning Outcomes	After learning the module, learners will be able to:
	1. Differentiate between the organization of invertebrate phyla studied earlier and the lower chordates
	2. Interpret the evolutionary advancement among lower chordates
Content Outline	• General characteristics of chordates • General organization of Sub-phylum Urochordata and Cephalochordata • General organization of Cyclostomata
Module 2(Credit 1) : General organization of Vertebrates	
Learning Outcomes	After learning the module, learners will be able to
	1. Distinguish between the various systems of the all the classes
	2. Relate the characteristic features of various classes with reference to the adaptations for the mode of living
Content Outline	• General organization of Class: ○ Pisces ○ Amphibia ○ Reptilia ○ Aves ○ Mammalia

PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify the animals based on their observations of the external characteristics
	2. Perform experiments based on temporary mountings
	3. Prepare field report based on observations done during field excursions
Content Outline	• Identification of Urochordata: (<i>Herdmania</i>), Cephalochordata (<i>Amphioxus</i>), Cyclostomata (<i>Petromyzon</i>, <i>Myxine</i>) • Identification of Pisces: Chondrichthyes (Shark, Sting ray, Electric ray) & Osteichthyes (Mackerel, Flying fish, Puffer fish and Sea horse) • Identification of Amphibia (Frog, Toad, Salamander, Caecilian) • Identification of Reptilia (Chameleon, <i>Calotes</i>, <i>Phrynosoma</i>, Russel's Viper, Cobra, Rat snake, Python, Turtle, Tortoise, Crocodile) • Identification of Aves (Kite, Duck, Parakeet) • Identification of Mammalia : Duck-billed Platypus, Kangaroo, Shrew, Hedgehog, Guinea pig, Bat • Mounting of scales in fish – Cycloid, Ctenoid and Placoid • Types of tailfins in fishes – Cartilaginous and Bony • Types of Feathers, Beaks and Feet in birds • Study of parental care in fishes • Study of parental care in amphibians • Study of neotenic forms in Amphibia • Identification keys for venomous and non-venomous snakes • Adaptations of aquatic Mammals - Dolphin, Seal, Walrus, Dugong, Blue Whale • Study trip to local zoo / national park / aquarium / coastline / biodiversity park and submission of report.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE) :

1. Documentation using photography based on biodiversity in and around the local vicinity / college campus) or videography (self-made videos uploaded on social media)
2. Padlet activity - Designing Infographics on topics related to the syllabus and uploading them on Padlet for collaborative learning
3. Digitization of the museum (if available)- Barcoding of the specimens and slides (The information on classification and distinguishing characteristics to be included to assist learning of taxonomy)

4. Submission of field report based on actual study trip or virtual.

References: -

1. Chordate Zoology - E. L. Jordan and P.S. Verma. 14th Revised Edition, 2013. S. Chand and Co. Ltd.
2. Chordate Zoology - P. S. Dhami and J. K. Dhami, Reprint Edition, 1991. R. Chand and Co.
3. Zoology- S. A. Miller and J. B. Harley, 8th Edition, 2009. Tata McGraw Hill
4. Modern Textbook of Zoology : Vertebrates - R. L. Kotpal. 2010. Global Media Publications
5. A Textbook of Zoology, Vol. II- T. J. Parker and W. A. Haswell-Low Price Indian Edition. 1991. CBS Publications and Distributors Pvt. Ltd.
6. Chordate Zoology And Elements of Animal Physiology - E. L. Jordan, P. S. Verma. 1st Edition, 1980. S. Chand and Co. Ltd.

Semester - IV**.4.2 Major (Core)**

Course Title	Genetics – II (Th+Pr)
Course Credits	4 Credit's (2 Th + 2 Pr)
Course Outcomes	After going through the course, learners will be able to :
	1. Understand the various inheritance patterns related to diverse types of factors
	2. Apply the knowledge to explain inheritance of various types such as linkage, sex-linkage, multiple alleles and multiple genes
	3. Make predictions by solving the crosses related to real-world examples
	4. Perform experiments based on the genetics related studies
	5. Prepare the field report based on the study visits
Module 1(Credit 1) : Linkage, Crossing over and multiple alleles	
Learning Outcomes	After learning the module, learners will be able to:
	1. Describe the concepts of linkage, crossing over, multiple alleles, polygenic inheritance
	2. Apply the knowledge to explain real-world examples / case studies
Content Outline	• Linkage and Crossing Over: ○ Introduction to Linkage ○ Crossing over, Types of crossing over, Cytological basis of crossing over • Multiple Alleles: ○ Concept of Multiple Alleles, ○ Coat colour in rabbit, ○ ABO and Rh blood group system, ○ Bombay blood group • Polygenic inheritance with reference to skin colour and eye colour in humans. • Concept of Pleiotropy
Module 2(Credit 1) : Sex determination and Sex-linkage	
Learning Outcomes	After learning the module, learners will be able to
	1. Describe the various methods of sex determination and related phenomena

	2. Analyze the cases related to sex-linked inheritance and predict the probability by solving crosses
Content Outline	- Sex- determination - Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW - Sex determination in Honey bees- Haplodiploidy - Sex determination in Drosophila-Genic balance theory, Intersex, Gynandromorphs - Hormonal influence on sex determination-Freemartin and Sex reversal. - Role of environmental factors- Bonelia and Crocodile - Barr bodies and Lyon hypothesis - Parthenogenesis - Sex linked, sex influenced and sex-limited inheritance. - X-linked: Drosophila, Colour-blindness, Haemophilia - Y-linked: Hypertrichosis - Sex-influenced genes - Sex-limited genes
PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Perform the experiments of temporary mounting preparation
	2. Evaluate the data obtained for the survey project
	3. Apply theoretical knowledge to solve problems based on inheritance
Content Outline	- Study of Barr body from buccal epithelium cells. - Detection of blood groups and Rh factor - Problems in Genetics based on X- linked inheritance - Problems in Genetics based on Multiple Alleles - Observation of Drosophila culture for the various phenotypic characteristics - Project – Survey of blood groups w.r.t. ABO and Rh factor among human population - Study of Griffith's transformation experiments, Avery-Macleod and McCarty, Hershey Chase experiment of Bacteriophage infection

	• Visit to the blood bank or a diagnostic centre to understand the blood transfusion protocols - submission of report of the visit
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Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

- Survey-based project on different types of characteristics that are determined by polygenic inheritance. Data compilation, analysis to draw conclusions about the extent of diversity found in the human population. Submission of report.
- Participate in the blood donation drive organized by NSS and submit the report based on the observations regarding the blood typing procedure and the donor criteria

References: -

1. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., & Silver, L. M. (2021). Genetics: From Gene to Genome (7th ed.). McGraw Hill Education.
2. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). Principles of Genetics. (8th ed.). John Wiley and Sons.
3. Pierce, B. A. (2017). Genetics: A Conceptual Approach. (6th ed.). W.H. Freeman and Company, New York.
4. Russel, P. J. (2006). Genetics: A Mendelian Approach. Pearson Benjamin Cummings.
5. Strickberger, M. W. (2015). Genetics. (3rd ed.). Pearson Education India
6. Weaver, K. F., & Hedrick. (1992). Genetics. (2nd ed.). McGraw Hill Education.

Semester - IV

.4.3 Major (Core)

Course Title	Applied Zoology – II (Th+Pr)
Course Credits	4 Credit's (2 Th + 2 Pr)
Course Outcomes	After going through the course, learners will be able to :
	1. Describe the various Indian cattle breeds
	2. Evaluate the economic importance of dairy industry
	3. Describe the economically important fishes in India
	4. Evaluate the economic importance of fishery in India
	5. Evaluate and appreciate the role of ICAR in supporting the economy and employability.
Module 1(Credit 1) : Dairy Science	
Learning Outcomes	After learning the module, learners will be able to:
	1. Understand scope of dairy industry
	2. Describe various cattle breeds and relate their importance in Indian dairy industry
Content Outline	• Overview of Indian Cattle Breeds - Origin, distribution, Salient features & Economic significance of: ○ Gir, Malvi, Hariyana, Deoni, Red Sindhi and Khillari ○ Nagpuri, Bhadawari, Murrah, Jafrabadi • Common cattle diseases and vaccination • Dairy Processing: Filtration, cooling, chilling, clarification, pasteurization, freezing • Milk and milk products: Composition of milk, Types of milk - Buffalo milk & Cow milk (A1 and A2), Whole milk and toned milk, Milk products • Dairy development in India: Role of dairy development in rural economy, employment opportunities
Module 2(Credit 1) : Fishery	
Learning Outcomes	After learning the module, learners will be able to :
	1. Describe the various fisheries and the commercially important fishes in India
	2. Evaluate the economic significance of fisheries and its products
Content Outline	• Introduction to fisheries in India – Freshwater, Marine, Brackish • Crafts & Gears used on Indian coasts:

	○ Crafts – Dugout, Outrigger, Masula, Catamaran, Satpati, Trawler ○ Gears – Gill and drift net, Dol net, Cast net, Purse seine, Lines and hooks • Fishery biology of commercially important fishes : Catla, Rohu, Catfish, Mackerel, Sardine, Pomfret, Bombay duck • Fish Preservation, Processing and value addition • SONAR, GPS, Remote Sensing, Tidal and lunar pattern
PRACTICAL COURSE: (2 Credits)	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify the various Indian cattle breed
	2. Perform the experiments related to simple dairy techniques
	3. Identify the various commercially important fishes and their crafts and gear used
	4. Write the field visit report based on the practical knowledge gained
Content Outline	• Breeds of Indian cows and buffaloes • Breeds of Indian goats and sheep • Extraction of casein from milk and its qualitative estimation • Preparation of paneer from given milk sample • Preparation of various milk sweets/products • Measurement of density of milk using different samples by Lactometer • Study of crafts and gears • Study of commercially important fishery (Catla, Rohu, Catfish, Mackerel, Sardine, Pomfret, Bombay duck) • Study trip to dairy farm / apiculture centre / fisheries institutes / docks to observe fish landing / aquaculture farms etc.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Survey related to milk products available in the market, brands, shelf life , preservatives used. Submit the report analyzing the data compiled.
2. Study of characteristics of fresh fish and spoiled fish from suitable fish samples. Submit the report.
3. Model making of various craft and gear used in Indian fishery as well as the dairy products prepared by students. An exhibition could be held displaying these and to appreciate the economic importance of these two industries that come under ICAR

References: -

1. Banerjee G.C. (2021). A Textbook of Animal Husbandry. (8th ed.). Oxford & IBH Publishing, New Delhi
2. Candler, W., & Kumar, N. (1998). India: The dairy revolution: The impact of dairy development in India and the World Bank's contribution. World Bank Publications.
3. Park, Y. W., & Haenlein, G. F. (Eds.). (2013). Milk and dairy products in human nutrition: production, composition and health. John Wiley & Sons,
4. Venkatasubramanian, V., Singh, A. K., & Rao, S. V. N. (2003). Dairy development in India: An appraisal of challenges and achievements. Concept Publishing Company,

Semester - IV**.4.4 OEC**

Course Title	Human parasitic diseases
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to :
	1. Relate the various types of host-parasite interactions
	2. Interpret the pathogenicity of the various parasitic infections
	3. Describe the pathogenicity of the various zoonotic diseases
	4. Evaluate the importance of national health programs for control of zoonotic infections
Module 1(Credit 1) : Introduction to parasitology	
Learning Outcomes	After learning the module, learners will be able to
	1. Relate the various types of host-parasite interactions
	2. Interpret the pathogenicity of the various parasitic infections
Content Outline	• Introduction to Parasitology and Types of Parasites: ○ Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical ○ Types of parasite: Ectoparasite, Endoparasite and their parasitic adaptations ○ Types of host: Intermediate and definitive, reservoir • Life cycle of the parasite, pathogenicity, control measures and treatment of : • Amoebic dysentery • Malaria • Leishmaniasis (Kala azar) • Taeniasis (Tape worm infection) • Filariasis • Ascariasis
Module 2(Credit 1) : Zoonotic diseases	
Learning Outcomes	After learning the module, learners will be able to :
	1. Describe the pathogenicity of the various zoonotic diseases

	2. Evaluate the importance of national health programs for control of zoonotic infections
Content Outline	• Introduction to zoonosis: • Causes, symptoms, prevention and treatment of : ○ Bird flu ○ Rabies ○ Toxoplasmosis ○ Japanese Encephalitis ○ outbreaks of Nipah Virus ○ Outbreaks of nCovid-19 • Role of National Center for Vector Borne Diseases for disease control through various awareness programs and health services

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

- Literature review on epidemiology of the various parasitic diseases - Five research articles and newspaper articles to be included. Statistical data to be collected and conclusions drawn from these as report submission.
- Conduct a survey-based project on the awareness of the general public regarding the causes of parasitic diseases and their control. The findings could be compiled and submitted as a brief report.

References: -

1. Parasitology. Chatterjee K. D. Chatterjee Medical Publishers.
2. Textbook of Medical Parasitology- C. K. Jayaram Paniker, Jaypee Brothers.
3. Essentials of Parasitology- Gerald D. Schmidt: Universal Bookstall, New Delhi.
4. Introduction to Parasitology- Chandler and Read John Wiley & Sons

Semester - IV**.4.5 SEC**

Course Title	Pet Care
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to :
	1. Identify and describe the various breeds of pets in India
	2. Interpret the various types of pet behaviours and relate them to their health conditions
	3. Apply the pet management guidelines
	4. Create healthy and easy pet nutritional products
Module 1(Credit 1) : Breeds of Pets in India and their grooming	
Learning Outcomes	After learning the module, learners will be able to :
	1. Identify and describe the various breeds of pets found in India
	2. Identify and relate the various behaviour that pets show during the various phases of life
Content Outline	• Identification of exotic breeds of dogs in India- German shepherd, Beagle, Bull dog, Great dane, Indian spitz, Pug, Labrador, Golden retriever, Shih Tzu, Siberian Husky. • Identification of Indian breeds of dogs- Indian Pariah dog, Rajapalayam, Gaddi, Rampur hound, Mudhol hound, Chippiparai, Kanni dog, Himalayan sheepdog (Bhutia), Kaikadi, Jonangi. • Identification of common breeds of cats- Persian cats, Bombay cats, maine coons, Turkish van, Siamese cat, Ragdoll. • Identification of behaviour of a pet animal from its body language- Dog and Cats (Body language charts). • Study of the stages of the oestrus cycle in female cats and dogs through behavioural changes, vocalization, and physical signs. • Study of grooming techniques- brushing, bathing, nail trimming, and ear cleaning, teeth brushing, hair trimming.
Module 2(Credit 1) : Pet health management	
Learning Outcomes	After learning the module, learners will be able to:
	1. Identify the various need-based regimens for a healthy pet

	2. Apply the theoretical knowledge to prepare the various quality pet foods
Content Outline	• Pet First Aid tips- wound care, seizures, choking and poison. • Study of Body Condition Scoring (BCS) techniques for Weight assessment and overall Well-being in Dogs and Cats. • Estimation of moisture content in dry pet food. • Formulation of Nutrient-Rich Dry Food for Dogs and Cats. • Study of common parasites in pets: Understanding, Treating, and Preventing in Dogs and Cats – Fleas, Ticks, Mites (Ear mites and Sarcoptic mites), Tapeworm and Giardia. • Study of deworming, vaccination schedules, and other preventive healthcare measures for cats and dogs. • Study of Zoonotic and reverse zoonotic diseases.

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

- Literature review and survey of pet owners to prepare reports on rights and responsibilities of pet owners in India.
- Assignment on rearing and care of lesser-known pet animals.
- Visit to an animal rescue centre/ animal care centre and prepare a report based on it.
- Visit an animal training centre/ veterinary hospital/ pet grooming centre and prepare a report based on it.

References: -

1. Yeates, J. (Ed.). (2019). Companion animal care and welfare: The UFAW companion animal handbook. John Wiley & Sons. ISBN:9781118688793
2. Alderton, D., Edwards, A., Edwards, A., Larkin, P., Stockman, M. The Complete Book of Pets & Petcare: The Essential Family Reference Guide to Pet Breeds and Petcare T Hong Kong: Anness Publishing. 2018. ISBN:9781844779338.
3. Companion Animals: Their Biology, Care, Health, and Management. Campbell, Karen L., and Campbell, John R.. United Kingdom, Pearson Prentice Hall, 2009. ISBN:9780135047675
4. The Book of Indian Dogs. Baskaran, S. Theodore. Aleph. 2017. ISBN:9789384067571.
5. Encyclopedia of Dogs: A Comprehensive Guide to Dog Breeds. United Kingdom, NPP Books, 2014. ISBN:9780755494958

Semester - IV

.4.7 Minor Stream

Course Title	Homeostasis (Th)
Course Credits	2 Credit's
Course Outcomes	After going through the course, learners will be able to
	1.know concept of homeostasis-thermoregulation and osmoregulation
	2. understand life processes & relate the adaptations of body according to the environment.
Module 1(Credit 1) : Thermo-regulation	
Learning Outcomes	After learning the module, learners will be able to:
	1. Relate the basis of body metabolism
	2. Analyse the change in the behaviour according to the environmental change
Content Outline	• External and internal environment; Acclimation and acclimatization • Body clock - Circadian & Diurnal rhythm • Endothermy and ectothermy • Temperature balance: Heat production - shivering and non-shivering thermogenesis; brown fat, mechanisms of heat loss • Adaptive response to temperature - daily torpor, hibernation, aestivation
Module 2 (Credit 1) : Osmotic and Ionic Regulation	
Learning Outcomes	After learning the module, learners will be able to:
	1. Analyse and evaluate the various processes for balance with the surrounding changes.
	2. Relate the changes in body according to different habitats.
Content Outline	• Living in hypo-osmotic, hyper-osmotic and terrestrial environment - Water absorption, • salt water ingestion and salt excretion, salt glands, metabolic water • Role of kidney in ionic regulation

Assignments/Activities towards Comprehensive Continuous Evaluation (CCE)

1. Models of thermo-regulations.
2. Project based on the topics related to Osmotic and Ionic Regulation

Note: Rubrics to be developed for subjective type of assessment

References: -

1. Comparative Animal Physiology; Knut Schmidt Nielson; Cambridge Press
2. Comparative Animal Physiology; Prosser and Brown
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4. Text book of Comparative Physiology; R Nagabhushanam, Ms Kodarkar, Sarojini R India Book House Pvt. Ltd.
5. Animal Physiology; N. Arumugam, A. Mariakuttikan; Saras Publication
6. Text book of Endocrinology; Williams
7. Textbook of Endocrinology Hardcover; Dharmalingam; 2010
8. Endocrinology; 6th Edition; Mac Hadley , Jon E. Levine
9. Bailey's textbook of histology Hardcover; Frederick R Bailey
10. Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi; 1978