ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF LIFE SCIENCES (RSLSC)

DEPARTMENT OF ZOOLOGY

COURSE STRUCTURE & SYLLABUS

(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.SC. IN ZOOLOGY

(4 YEARS SINGLE MAJOR)

W.E.F

AY - 2025- 2026

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME

ROYAL SCHOOL OF LIFE SCIENCES

B.Sc. Zoology

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M101	Non-Chordates	100	3	3-0-0
	ZOO142M111	Non-Chordates (Practical)	100	3	0-0-6
Minor	ZOO142N101	Animal Diversity- Non-Chordates	100	3	3-0-0
Interdisciplinary (IDC)	IKS992K101	Introduction to Indian Knowledge System – I	100	3	2-1-0
Ability Enhancement course (AEC)	CEN982A101	Communicative English-I	100	1	1-0-0
	BHS982A102	Behavioural Science- I	100	1	1-0-0
Skill Enhancement Course (SEC)	ZOO142S121	Vermiculture	100	3	0-0-6
Value Added Course (VAC)		Basket of course*	100	3	3-0-0
MOOC Course		MOOC/Online Courses**	100	3	
TOTAL CREDIT FOR 1st SEMESTER				23	
2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M201	Chordates	100	3	3-0-0

	ZOO142M211	Chordates (Practical)	100	3	0-0-6
Minor	ZOO142N201	Animal Diversity-Chordates	100	3	3-0-0
IDC	IKS992K201	Introduction to Indian Knowledge System – II	100	3	2-1-0
AEC	CEN982A201	Communicative English-II	100	1	1-0-0
	BHS982A202	Behavioural Science- II	100	1	1-0-0
SEC	ZOO142S221	Sericulture	100	3	0-0-6
VAC		Basket of Course*	100	3	3-0-0
MOOC Course		MOOC/Online Courses**	100	3	
TOTAL CREDIT FOR 2nd SEMESTER				23	

3rd SEMESTER

COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M301	Comparative Anatomy of Animals	200	4	3-1-0
	ZOO142M311	Comparative Anatomy of Animals (Practical)	200	4	0-0-8
Minor	ZOO142N301	Human Biology	200	4	3-1-0
IDC	ZOO142I301	Understanding of Life Processes	200	3	3-0-0
AEC	CEN982A301	Communicative English-III	200	1	1-0-0
	BHS982A302	Behavioral Science-III	200	1	1-0-0
SEC	ZOO142S321	Wildlife Photography and Ecotourism	200	3	0-0-6

MOOC Course		MOOC/Online Courses*	200	3	
TOTAL CREDIT FOR 3rd SEMESTER					
4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M401	Cell Biology	200	4	3-1-0
	ZOO142M402	Animal Physiology and Endocrinology	200	4	3-1-0
	ZOO142M411	Cell Biology & Animal Physiology and Endocrinology (Practical)	200	4	0-0-8
Minor	ZOO142N401	Aquatic Biology	200	3	3-0-0
	ZOO142N402	Economic Zoology	200	3	3-0-0
AEC	CEN982A401	Communicative English-IV	200	1	1-0-0
	BHS982A402	Behavioral Science-IV	200	1	1-0-0
MOOC Course		MOOC/Online Courses*	200	3	
TOTAL CREDIT FOR 4th SEMESTER				23	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M501	Biochemistry	300	4	3-1-0
	ZOO142M502	Evolutionary Biology	300	4	3-1-0
	ZOO142M511	Biochemistry and Evolutionary	300	4	0-0-8

		Biology (Practical)			
Minor	ZOO142N501	Animal Parasites	300	4	3-1-0
Internship	ZOO142S531	Internship (Mandatory after 4th Semester)	300	4	
TOTAL CREDIT FOR 5th SEMESTER				20	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M601	Molecular Biology	300	4	3-1-0
	ZOO142M602	Biotechnology	300	4	3-1-0
	ZOO142M603	Ecology	300	4	3-1-0
	ZOO142M611	Molecular Biology, Biotechnology & Ecology (Practical)	300	4	0-0-8
Minor	ZOO142N601	Entomology	300	4	3-1-0
TOTAL CREDIT FOR 6th SEMESTER				20	
7th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M701	Genetics and Genomics	400	4	3-1-0
	ZOO142M702	Immunology	400	4	3-1-0
	ZOO142M703	Biostatistics and Bioinformatics	400	4	3-1-0
	ZOO142M711	Genetics and Genomics, Immunology, Biostatistics and	400	4	0-0-8

		Bioinformatics (Practical)			
Minor	ZOO142N701	Ecology and Wildlife	400	4	3-1-0
TOTAL CREDIT FOR 7th SEMESTER				20	
8th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	ZOO142M801	Developmental Biology	400	4	3-1-0
Minor	ZOO142N801	Research Methodology	400	4	3-1-0
Project / Dissertation	ZOO142M821	Dissertation	400	12	
TOTAL CREDIT FOR 8th SEMESTER				20	

*The students will choose one VAC course from the basket of courses

**MOOCs/Online Course will be identified by the Department from the list of courses available on MOOC/SWAYAM online platform.

Semester-I
Subject Name: Non-Chordates **Type of course: Major Paper Code: ZOO142M101** **Course Level: 100 Credit: 3 L-T-P-C- 3-0-0-3** **Scheme of Evaluation: Theory**

Course Objective: This course is designed to introduce the students to the diversity of non-Chordates, their systemic classification, phylogeny, characteristics, affinities and significance.

Course Learning Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and list the major characteristics that distinguish non-chordate animals from chordates, including absence of a notochord.	BT 1
CO 2	Explain the diversity of non-chordate animals and their adaptations to different environments and ecological niches.	BT 2
CO 3	Apply knowledge of non-chordate anatomy and physiology to identify and classify different non-chordate species based on shared features.	BT 3
CO 4	Analyze invertebrate relationships and anatomical comparisons.	BT 4

Detailed syllabus:

Modules	Course contents	Periods
I	**Introduction to Invertebrates-** Diversity, general characteristics and phylogeny of invertebrates. **Protozoa:** General characters and outline classification up to class.	**15**

	Protozoa– nutrition, locomotion and diseases associated with Protozoans. **Metazoa:** Origin of metazoa, metamerism and coelom. **Porifera:** General characters and outline classification up to classes. Porifera- canal system and affinities.	
II	**Cnidaria:** General characters and outline classification up to class. Polymorphism, alternation of generation, nematocysts and locomotion in Cnidarians. **Platyhelminthes:** General characters and outline classification up to class. General discussion on parasitic Platyhelminthes. Phylogenetic significance. **Aschelminthes:** General characters and outline classification up to class. Discussion of phylogenetic position of aschelminthes. Parasitic nematodes and diseases caused by them.	**15**
III	**Ctenophora:** General characteristics and affinities **Annelida:** General characters and outline classification up to class. Metamerism and nephridia. Adaptive radiations in Annelida. **Arthropoda:** General characters and outline classification up to class. Larval forms of crustacea; social life, metamorphosis in Insecta.Onychophora: Affinities of Onychophora.	**15**
IV	**Mollusca:** General characters and outline classification up to class. Torsion in Gastropods; pearl formation. **Echinodermata:** General characters and outline classification up to class. Affinities of Echinodermata. Water-vascular system and larval forms. Brief discussion on minor phyla of non-chordates. Economic and ecological significance of non-chordates.	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs** Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Ruppert, E.E., Fox R.S., and Barnes R. (2004). Invertebrate Zoology. (7th ed), Holt Saunders International Edition. Thompson- brooks/ Cole

2. Kotpal, R.L. (2015). Modern textbook of Zoology: Invertebrates. (11th ed). Rastogi publications.

References:

1. Solomon, E.P., Martin, E.C., Martin, D.W., Berg, L. R. (2019). Biology. (11th Ed). Cengage.

2. Miller, S.A., & Harley, J.P. (2016). Zoology. (10th ed). Mcgraw-Hill.

3. Campbell, N.A., & Reece, J.B. (2005). Biology. (7th ed). Pearson Benjamin Cummings.

Semester-I
Subject Name: Non-Chordates (Practical) **Type of course: Major** **Paper Code: ZOO142M111** **Course Level: 100** **Credit: 3** **L-T-P-C- 0-0-6-3** **Scheme of Evaluation: Practical**

Course Objective: The objective of the course is to help students learn and identify the invertebrate species based on their morphological and anatomical characteristics and the behavioural patterns exhibited by different invertebrate species.

Course Outcomes: After completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and identify the major characteristics of non-chordate animals, including their body plans, locomotion methods, and feeding strategies.	BT 1
CO 2	Demonstrate an understanding of the diversity of non-chordate organisms and their adaptations to different environments through practical observations.	BT 2
CO 3	Apply knowledge of non-chordate anatomy and morphological features to identify and classify specimens collected during fieldwork and lab exercises.	BT 3
CO 4	Analyze invertebrate relationships and anatomical comparisons.	BT 4

Detailed syllabus:

Modules	Course contents	Periods
I	1. Study of Museum Specimens Identification and classification up to order- *Spongilla, Physalia, Metridium (Seaanemone). Pennatula*, (Sea-pen) *Gorgonia, Fasciola. Taenia, Echiurus, Limulus, Scolopendra* (Centipede) *Julus* (Millipede), *Carausius* (stick insect), *Lepisma, Mantis*, Termite queen, *Belostoma* (Giant water bug), *Peripatus, Chiton, Achatina, Pinctada* (Pearl oyster), *Loligo, Mytilus, Limax, Cucumaria* (Sea Cucumber), *Echinus* (Seaurchin).	**24**
II	1. Identification of prepared slides – *Polystomella*, Sponge spicules, T.S of *Ascaris, Miracidium, Cercaria* larvae of Liver fluke, T.S. of Leech (Through crop region). T.S. of Earth worm (through pharynx, gizzard and intestine). Mouth parts of mosquitoes, Larvae of *Glochidium* and Echinodermata (*Bipennaria*)	**22**
III	1. Demonstration/ dissection of the following systems of invertebrate animals (any one) a) Digestive system of Cockroach b) Nervous system of Pila c) Nervous system of Prawn d) Urogenital system of Leech 2. Mounting temporary slide of the following organ/parts- Setae of Earthworm, Salivary gland of Cockroach, Redulla of Pila, Mouthparts of Mosquito and honey bee.	**22**
IV	1. To examine the nematode diversity from soil sample collected from different places. 2. To study the social behaviours of ants/honey bee/termites/wasp. 3. To study about two ecto and endo parasites	**22**
TOTAL		**90**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**

-	**90 hrs**	-

Textbooks:

1. Young, J. Z. (2004). The Life of Vertebrates. 3rd Edition. Oxford University Press.
2. Lal, S. S. (2020). Practical Zoology Invertebrates. (12th Ed), Rastogi Publications

References:

1. Barnes, R. S. K., Calow, P. P., Olive, P. J., Golding, D. W., & Spicer, J. I. (2009). The invertebrates: a synthesis. (3rd Ed). John Wiley & Sons.
2. Practical, Sukla, J. P., & Pandey, K. (2017). Non-Chordates (Invertebrate) Zoology. Himalaya publishing House.
3. Das, D. (2017). Essential practical handbook of cell biology & genetics, biometry & microbiology: a laboratory manual. (1st Ed). Academic Publishers.
4. Gupta, A., Sati, B. K., & Lambert, L. A. P. Practical laboratory Manual- Cell Biology. Academic Publishing

SEMESTER-I
Subject Name: Animal Diversity- Non-Chordates **Type of course: Minor** **Paper Code: ZOO142N101** **Course Level: 100** **Credit: 3** **L-T-P-C- 3-0-0-3** **Scheme of Evaluation: Theory**

Course Objectives: This course is designed to introduce the students to the diversity of Chordates, their systemic classification, phylogeny, characteristics, affinities and significance.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and identify the diverse invertebrate life forms	BT 1
CO 2	Demonstrate an understanding of the major phyla with respect to their general characteristics	BT 2
CO 3	Apply knowledge of non-chordate anatomy and morphological features to identify the relationships between various phyla and their distinct features.	BT 3
CO 4	Analyze taxonomic keys and classification techniques for identification.	BT 4

Detailed syllabus:

Module	Course Contents	Periods
I	General characters and outline classification up to class: Protozoa, Porifera, Cnidaria Annelida, Arthropoda	15
II	Locomotion in Protozoans; Canal system in Porifera; Excretion in Annelida; Vision in Arthropoda.	15
III	General characters and outline classification up to class: Platyhelminthes, Aschelminthes, Life cycle of *Fasciola hepatica* and *Ascaris lumbricoides.*	15
IV	General characters and outline classification up to class: Molluscs, Echinodermata. Pearl formation in Molluscs. Brief introduction on Protochordates and Agnatha,	15
	TOTAL	60

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs**
		Assignment, case study, critical analysis, quiz

Textbooks:

1. Ruppert, E.E., Fox R.S., and Barnes R. (2004). Invertebrate Zoology. (7th ed), Holt Saunders International Edition. Thompson- Brooks/ Cole
2. Parker, T.J. and Haswell, W.A. (2021). Textbook of Zoology: Invertebrates. (8th Ed), Vol. I. Macmillan education, U.K.

References:

1. Solomon, E.P., Martin, E.C., Martin, D.W., Berg, L.R. (2019). Biology. (11th Ed). Cengage.
2. Miller, S.A., & Harley, J.P. (2016). Zoology. (10th ed). Mcgraw-Hill.
3. Royston, A. (2015). Invertebrates. Heinemann
4. Kardong, K.V. (2008). Vertebrates: Comparative Anatomy, Function, Evolution. (5th Ed). McGraw-Hill.

Semester – I

Subject Name: Introduction to Indian Knowledge System - I
Type of course: IDC **Paper Code: IKS992I101**
Course Level: 100 **Credit: 3** **L-T-P-C- 2-1-0-3**
Scheme of Evaluation: Theory

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course students will be able to –

CO	Contents	BT Level
CO1	**Recall** the rich heritage of Indian knowledge systems	BT 1
CO2	**Describe** the contribution of Indian knowledge systems to the world	BT 2
CO3	**Demonstrate** knowledge of sociocultural and ethnolinguistic diversity that constitutes the soul of Bharatvarsha	BT 2
CO4	**Apply** traditional knowledge and techniques in day-to-day life	BT 3
CO5	**Distinguish** knowledge traditions that originated in the Indian subcontinent	BT 3

Module	Course Contents	Periods

I	**<u>Introduction to Indian Knowledge Systems (IKS)</u>:** -What is the Indian Knowledge System? -Definition of Indigenous/ Traditional Knowledge -Scope, and Importance of Traditional Knowledge. **<u>Ancient India- Bharat Varsha:</u>** -People of Ancient Bharat Varsha -Our great natural heritage: The great Himalayas and the rivers. - The civilizations of the Sindhu-Ganga valley, and the Brahmaputra valley. -Our coastal plains. -Our Nature: Forests and Minerals -Ancient Indian Traditional Knowledge and Wisdom about nature and climate.	15
II	**<u>Indian Heritage of Knowledge</u>:** -Ancient Indian Knowledge: The *Vedas* and its components-the *Vedangas* -Ancient Indian books and treaties: The *Sastras*. -The Great Indian Epics: The Ramayana and The Mahabharata,	15

	-Epics and religious treaties of ancient Assam: Introduction to Madhav Kandali's *Ramayan* and Srimanta Sankardev's *Dasam Skandha Bhagavat* of the Puranas. -Ancient Traditional Knowledge-The *Agamas* -The ancient Buddhist knowledge: *Tripitaka: Vinaya, Sutta* and *Abhidhamma Pitaka* **Languages and language studies in India**: -What is linguistics? -Script and Language -Alphabet of the Indian languages *Varnamala:* Origin, Evolution, and phonetic features. -Languages of India -Important texts of Indian languages: Skills *Siksha,* Expression/Prounciation-*Nirukta,* Grammer-*Vyakarana,* Poetic rhythm-*Chandas.* -Paninian Grammar: A Brief Introduction **Introduction to Fine Arts and Performing Arts of India:** -Ancient Indian classical music and dance forms: The Science of Dramas-*Natyasastra* and the Science of Music-*Gandharva-Veda.* -Aesthetics in Indian Art and Culture. -Folk music and traditional dance forms of the Northeast.	

III	**<u>Indian Science & Technology</u>** -Ancient India's contribution to Mathematics- Number System. Algebra and Arithmetic, Geometry and Trigonometry. -Origin of Decimal system in India; nomenclature of numbers in the Vedas. Zero and Infinity. Sulba-sutras. Contribution of Brahmagupta and Sridhar Acharya to Mathematics. Important texts of Indian mathematics. • **<u>Indian Astronomy</u>:** Planetary System. Motion of the Planets. Velocity of Light. Eclipse. Astronomy. Navagrahas. Important works in Indian Astronomy. Aryabhata and Nilakantha: Contribution to Astronomical Studies	15

	• **<u>Indian Metal Works</u>:** Mining Techniques. Types of Metals. Tools & Techniques for Metal Smelting with examples. Metalworks in pre-modern India: Special reference to NE India.	
IV	**<u>Contribution of Ancient India to Health Sciences</u>:** -Traditional Indigenous systems of medicines in India: - *Ayurveda* and *Yoga:* Elements of *Ayurveda: Gunas* and *Doshas*, *Pancha Mahabhuta* and *Sapta-dhatu*. -Concept of disease in Ayurveda -Ayurvedic lifestyle practices: *Dinacharya* and *Ritucharya.* -Important Ayurvedic Texts -Hospitals in Ancient India • -*Ayurveda*: Gift of India to the modern world.	15

EL	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems. • Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems. • Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	30
	Total	90

Textbooks Books:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications.* PHI Learning Private Ltd.
2. Mukul Chandra Bora*, Foundations of Bharatiya Knowledge System.* Khanna Book Publishing

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy

Studies, Chennai, 1995, pp. 63-84.

Semester-I
AEC-1/Subject Name: Communicative English- I: Developing Oral Communication and Listenir Skills
Subject Code: CEN982A101
L-T-P-C – 1-0-0-1
Credit Units: 1
Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech

Course Objective: To understand the four major aspects of communication by closely examining the processes and outlining the most effective ways to communicate with interactive activities.

Course Outcomes: On successful completion of the course the students will be able to-

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**List** the elements and processes that make for successful communication and **recognise** everyday activities that deserve closer attention in order to improve communication skills	**BT 1**
CO 2	**Contrast** situations that create barriers to effective communication and **relate** them to methods that are consciously devised to overcome such hindrance	**BT 2**
CO 3	**Apply** language, gestures, and para-language effectively to avoid miscommunication and **articulate** one's thoughts and build arguments more effectively	**BT 3**

Detailed Syllabus:

Detailed Syllabus		
Module	**Course Contents**	**Periods**
I	Introduction to Effective Communication • Listening Skills o The Art of Listening o Factors that affect Listening o Characteristics of Effective Listening o Guidelines for improving Listening skills	**5**

II	• Speaking Skills o The Art of Speaking o Styles of Speaking o Guidelines for improving Speaking skills o Oral Communication: importance, guidelines, and barriers	**5**
III	• Reading Skills o The Art of Reading o Styles of Reading: skimming, surveying, scanning o Guidelines for developing Reading skills	**5**
IV	• Writing Skills o The Art of Writing o Purpose and Clarity in Writing o Principles of Effective Writing	**5**

Credit Distribution		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
15 hours	-	10 hours - Movie/ Documentary /Podcasts screening - Peer teaching

Textbooks:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.

References:

1. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University.

Semester I
Subject Name: Behavioural Sciences -I **Type of course: AEC Paper Code: BHS982A102** **Course Level: 100 Credit: 3 L-T-P-C- 1-0-0-1** **Scheme of Evaluation: Theory**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course Outcomes: On completion of the course the students will be able to

Course	**Course Outcome**	**Bloom's**

Outcome		Taxonomy Level
CO 1	Understand self & process of self-exploration	BT 1
CO 2	Learn about strategies for development of a healthy self-esteem.	BT 2
CO 3	Apply the concepts to build emotional competencies	BT 3

Modules	Course Contents	Periods
I	**Introduction to Behavioral Science** Definition and need of Behavioral Science,Self: Definition components, Importance of knowing self, Identity Crisis,Gender and Identity, Peer Pressure, Self-image: Self Esteem, Johari Window, Erikson's model.	4
II	**Foundations of individual behavior** Personality- structure, determinants, types of personalities. Perception: Attribution, Errors in perception. Learning- Theories of learning: Classical, Operant and Social	4
III	**Behaviour and communication.** Defining Communication, types of communication, barriers to communication, ways to overcome barriers to Communication, Importance of Non-Verbal Communication/Kinesics, Understanding Kinesics, Relation between behaviour and communication.	4
IV	**Time and Stress Management** Time management: Introduction-the 80:20, sense of time management, Secrets of time management, Effective scheduling. Stress management: effects of stress, kinds of stress-sources of stress, Coping Mechanisms. Relation between Time and Stress.	4
Total		**16**

Text books

1. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc
2. K. Alex, Soft skills; S.Chand.

References

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company.

Semester I
Subject Name: Vermiculture

Type of course: SEC	Paper Code: ZOO142S121	
Course Level: 100	Credit: 3	L-T-P-C- 0-0-6-3
Scheme of Evaluation: Practical		

Course Objective: This course is designed to introduce the students to the basic processes and practice of vermiculture, its scope and economic advantages.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and describe the basic principles of vermicomposting, including the role of earthworms in the decomposition process.	BT 1
CO 2	Explain the importance of vermicomposting in organic waste management and its benefits for soil health and plant growth.	BT 2
CO 3	Apply vermicomposting techniques to set up and maintain a functional vermicompost system, selecting suitable earthworm species.	BT 3
CO 4	Analyze the impact of vermicompost on soil quality and plant growth	BT 4

Detailed Syllabus:

Modules	Course Contents	Periods
I	**Introduction:** Definition, Choosing the right worm. Useful species of earthworms. Maintenance of soil structure.	12
II	**Scope of Vermiculture:** Scope and advantages of vermiculture in India, Employment potential and income generation;	12
III	**Vermicomposting:** Method and techniques of preparing vermicompost,	12
IV	**Application and advantages of vermiculture,** Vermicomposting for Organic Farming - an Eco-Friendly	12
Total		48

Credit Distribution

Lecture/ Tutorial	Practicum	EL
-	60 hrs	30 hrs
		Project, Assignment, hands-on, quiz

Textbooks:

1. Edwards, Norman and Rhonda. (2010). Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management.
2. Sultan (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.

Reference:

1. Bhatnagar & Patla (2007). Earthworm vermiculture and vermin-composting. Kalyani Publishers, New Delhi.

Semester-II
Subject Name: Chordates **Type of course: Major Paper Code: ZOO142M201** **Course Level: 100 Credit: 3 L-T-P-C- 3-0-0-3** **Scheme of Evaluation: Theory**

Course Objective: This course is designed to acquaint students on comparative anatomy of higher Chordates- their systemic classification, phylogeny, characteristics, affinities and significance and provide a detailed account of the mechanisms behind different physiological processes.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify and describe the major characteristics that define chordates, such as the presence of a notochord.	BT 1
CO 2	Explain the evolutionary significance of notochords and dorsal nerve cords in the development of chordates.	BT 2
CO 3	Apply knowledge of chordate characteristics to classify different chordate species based on shared features.	BT 3
CO 4	Analyze evolutionary behaviour, taxonomic hierarchy, Chordate relationships and anatomical comparisons.	BT 4

Detailed syllabus:

Modules	Course contents	Periods
I	**Introduction to Chordates:** Evolution and phylogeny of chordates;	15

	Defining characteristics of chordates: notochord, dorsal nerve cord, pharyngeal slits, and post-anal tail; Chordates and Protochordates- characters and classification.	
II	**General features and classification** of some major classes such as Pisces, Amphibia, Reptiles, Aves and Mammals.	**15**
III	**Origin and evolution of terrestrial species**- ectotherms. parental care in higher animals, poison apparatus and biting mechanism in snakes. Flight adaptations. Mechanism of flight and migration of birds. Ecological and economic significance of chordates	**15**
IV	**Ecology and behaviour of Chordates**- Chordate habitats and ecological roles. behaviour patterns: feeding, mating, and social behaviour in chordates. Threats to chordate species: habitat destruction, climate change, pollution	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs**
		Field visit in Zoo, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Kardong, K.V. (2019). Vertebrates: Comparative Anatomy, Function, Evolution. (8th ed). McGraw-Hill.
2. Jordan, E. L. & Verma, P.S. (2013). *Chordate Zoology*. S. Chand Publishers.

References:

1. Solomon, E.P., Martin, E.C., Martin, D.W., Berg, L.R. (2019). Biology (11th Ed). Cengage.
2. Miller, S.A. & Harley, J.P. (2016). Zoology. (10th ed). Mcgraw-Hill.
3. Campbell, N.A., & Reece, J.B. (2005). Biology. (7th ed). Pearson Benjamin Cummings.
4. Leiem, C.F., Bermis, Walker, W.E, W.F., & Grande, L. (2001). Functional anatomy of vertebrates: An evolutionary perspective. (3rd Ed). Brookes/Cole, Cengage Learning.

Semester-II
Subject Name: Chordates (Practical) **Type of course: Major Paper Code: ZOO142M211** **Course Level: 100 Credit: 3 L-T-P-C- 0-0-6-3** **Scheme of Evaluation: Practical**

Course Objective: This syllabus is designed to provide a comprehensive understanding of the biology of chordates, including their evolution, anatomy, physiology, behavior, ecology, and conservation. It encourages students to apply their learning through practical laboratory work and field observations.

Course outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify and label the major external anatomical features of various chordate specimens.	BT 1
CO 2	Describe the functional significance of specific anatomical structures in chordate organisms.	BT 2
CO 3	Apply dissection techniques to examine the internal organ systems of chordate specimens and compare them.	BT 3
CO 4	Analyze Chordate relationships by comparing anatomical differences between various phyla	BT 4

Detailed Course:

Modules	Course Contents	Periods
I	**Protochordata:** 1. To study characteristic features of *Balanoglossus, Herdmania, Branchiostoma, Ciona, Salpa, Doliolum*. 2. To study characteristic features of *Balanoglossus* sections through Probosis, Collar, branchiogenital & hepatic region. 3. To study characteristic features of *Amphioxus*- oral hood, Whole Mount sections through pharyngeal, intestinal & caudal regions.	**24**
II	**Pisces:** 1. To study characteristic features of *Petromyzon, Scoliodon,*	**22**

	Sphyrna, Pristis, Trygon, Torpedo, Chimaera, Notopterus, Labeo, Catla, Cirrihina, Heteropneustes, Mystus, Exocoetus. 2. To study characteristic features of Afferent branchial system, V, VII, IX and Xth Cranial nerves of *Scoliodon* and weberian ossicles of *Mystus* through models 3. To prepare temporary mounting for the following scales of fishes: placoid, cycloid ctenoid, **Amphibia:** 4. To study characteristic features of *Uraeotyphlus, Necturus, Salamander, Bufo, Hyla, Rhacophorus*.	
III	**Reptiles:** 1. To study characteristic features of *Chelone, Testuda, Kachuga, Hemidactytus, Varanus, Uromastix, Ophiosaurus, Chameoleon, Draco, Hydrophis, Bungarus, Viper, Krait, Coral snakes, Crocodiles*. **Aves:** 3. To study characteristic features of six common birds from different orders. 4. To study different types of beaks and claws. **Mammals:** 5. To study characteristic features of Sorex, Shrew, Hedgehog, Bat through models	**22**
IV	1. To study and record feeding/social behavior in birds/mammals. 2. Study of gill deformities in fishes isolated from polluted area. 3. To analyze adaptations of desert reptiles (Uromastix) vs. aquatic snakes (Hydrophis). 4. Group projects on threats to migratory birds (climate change/habitat loss). 5. Field Visit (Zoo/Wetland/any others areas suitable for the study)	**22**
TOTAL		**90**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
-	**90 hrs**	

Textbooks:

1. Mali, R.P. (2015). A Practical Manual on Innovative Animal Physiology. (1st Ed), Oxford Book Company
2. Lal, S. S. (2020). Practical Zoology- Vertebrates, (12th Ed). Rastogi Publications

Reference:

1. McGowan, C. (1999). A practical guide to vertebrate mechanics. Cambridge University Press.

Semester-II
Subject Name: Animal Diversity: Chordates **Type of course: Minor Paper Code: ZOO142N201** **Course Level: 100 Credit: 3 L-T-P-C- 3-0-0-3** **Scheme of Evaluation: Theory**

Course Objective: The objective of the course is to briefly equip students who opt this minor paper with a basic knowledge of chordates. The aim is to provide students with a fair understanding of chordate biology and its significance in the broader field of zoology.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and list the major characteristics that define chordates	BT 1
CO 2	Explain the evolutionary significance of notochords and dorsal nerve cords in the development of chordates.	BT 2
CO 3	Apply knowledge of chordate characteristics to identify and classify different chordate species.	BT 3
CO 4	Analyze taxonomic hierarchy and chordate relationships	BT 4

Detailed syllabus

Modules	Course Contents	Periods
1	**Introduction to Vertebrates:** Overview of vertebrate diversity and classification; Evolutionary history of vertebrates; Characteristics and adaptations of vertebrates	**12**
2	**An overview of primitive chordates**: General characters and classification up to order level for Hemichordate, Urochordate, Cephalochordate and Cyclostoimata	**12**
3	**Behaviour and Ecology of Vertebrates**: Observing and documenting vertebrate behaviour in their natural habitats. Behavioural adaptations and social structures in different vertebrate species	**12**
4	**Lower and Higher Chordates**- General characters and classification up to order level for Fishes, Amphibians, Reptiles, Aves and Mammals. **Adaption in mammals:** What's so special about mammals? Are mammals the most successful animal group on earth?	**12**
Total		**48**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks-

1. Gerald, K., Janet, I., & Wallace, M. (2020). Karp's Cell and Molecular Biology (9th ed). Wiley.
2. Hardin J & Bertoni G (2018). Becker's World of the Cell. 9th Ed, Pearson Education.

References-

1. Stephen R. Bolsover S.R, Jeremy S. Hyams J.S, Elizabeth A. Shephard E.A & Hugh A. White H.A (2011). Cell Biology: A Short Course. 3rd Ed, John Wiley & Sons.
2. Cooper G.M (2019). The Cell: A Molecular Approach. 8th Ed, Sinauer Associates.

Semester – I
Subject Name: Introduction to Indian Knowledge System - II **Type of course: IDC** **Paper Code: IKS992I201** **Course Level: 100** **Credit: 3** **L-T-P-C- 2-1-0-3** **Scheme of Evaluation: Theory**

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course students will be able to –

CO	Contents	BT Level
CO1	**Recall** traditional Indian knowledge traditions constituting Indian culture	BT 1
CO2	**Summarize differences** between classical literature in Sanskrit and other Indian languages	BT 2
CO3	**Compare** knowledge traditions originating in NE India	BT 2
CO4	**Appreciate** the contribution of Indian Knowledge Systems to the world	BT 3
CO5	**Recall** traditional Indian knowledge traditions constituting Indian culture	BT 3

Module	Course Contents	Periods
I	**Indian Classical Literature** Indian Classical Literature: A Brief Introduction.	15

	- Ancient Indian Spritual Poetics-*Kavya*: Contribution of Kalidasa **Diversity and Indian Culture**: - Diversity and Indian Culture -Indigenous Faith and Religion -Preservation of culture and indigenous knowledge **The Purpose of** Knowledge - Understanding Self-Awareness and Spirituality. -Indian concept and purpose of Knowledge and Education - Understanding Spirituality and Materialism: *Para* and *Apara Vidya*	
II	**Methodology of Indian Knowledge System**: - *Shruti* and *Smriti* traditions. -Intoduction to *Shastras.* -Manuscriptology: The art and science of documenting knowledge. - Repositories of ancient manuscripts with special reference to the Norteast India. **Indian Architecture and Town Planning**: - Introduction ancient Indian architecture. - *Sthapatya-Veda*: An Introduction - Indigenous tools & techniques for town planning & Temple Architecture. Lothal, Mohan Jo Daro. - Temple Art: Lepakshi Temple, Jagannath Puri Temple, Konark Sun Temple. - Vernacular architecture of Assam: Special reference to Brahmaputra Valley	15
III	**Indian Agriculture**: - Agriculture: Significance in Human Civilization. - Sustainable Agriculture. - Historical significance of agriculture and sustainable farming in India. - Step Cultivation of India: Special reference to Northeast India. - Wet rice cultivation of Assam. **Indian Textiles**: What is Textile?	15

	- Tradition of cotton and silk textiles in India. - The historical contribution of textile and weaving to the Indian economy. - Varieties of textiles and dyes developed in different regions of India with special reference to Northeast India	
IV	**Indian Polity and Economy**: - Understanding Kingdom and Chiefdom - Role of a king - The Indian idea of a well-organized polity and flourishing economy. - The *Chakravarti* System: Administrative System of Ancient Bharatvarsha. - Village administrative system: Northeast India. - *Arthashastra*: Brief synopsis **The outreach of Indian Knowledge System across Geographical Boundaries** - Indian Languages. - Scripts. - Linguistics. - Ayurveda. - Yoga and Meditation. - Textile - Decimal value place system-based arithmetic, Algebra and Astronomy	15
EL	The experiential learning sessions may include: • Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems. • Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge. • Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System. • Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems.	30

	• Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.	
	Total	90

Textbooks Books:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications.* PHI Learning Private Ltd.
2. Mukul Chandra Bora*, Foundations of Bharatiya Knowledge System.* Khanna Book Publishing

Reference Books:

1. Baladev Upadhyaya, *Samskrta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śarīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrotthana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy and Polity in Eighteenth century Chengalpattu*, in J. K. Bajaj ed., Indian Economy and Polity, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

Semester II
AEC- 2/ Subject Name: Communicative English- II: Conversation and Public Speaking
Subject Code: CEN982A201
L-T-P-C – 1-0-0-1
Credit Units: 1
Scheme of Evaluation: Theory + Viva-Voce + Extempore Speech

Course Objectives

To introduce the students to the various forms of technical communication and enhance their knowledge in the application of both verbal and non-verbal skills in communicative processes.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**List** the different types of technical communication, their characteristics, their advantages and disadvantages.	**BT 1**
CO 2	**Explain** the barriers to communication and ways to overcome them.	**BT 2**
CO 3	**Identify** the means to enhance conversation skills.	**BT 3**
CO 4	**Determine** the different types of non-verbal communication and their significance.	**BT 4**

Detailed Syllabus

Modules	Course Contents	Periods
I	**Technology Enabled Communication** Communicating about technical or specialized topics, Different forms of technology-enabled communication tools used in organizations Telephone, Teleconferencing, Fax, Email, Instant messaging, Blog, Podcast, Videos, videoconferencing, social media	**4**
II	**Communication Barriers** Types of barriers: Semantic, Psychological, Organisational, Cultural, Physical, Physiological, Methods to overcome barriers to communication.	**4**
III	**Conversation skills/Verbal Communication** Conversation – Types of Conversation, Strategies for Effectiveness, Conversation Practice, Persuasive Functions in Conversation, Telephonic Conversation and Etiquette Dialogue Writing, Conversation Control.	**4**
IV	**Non-verbal Communication** Body language- Personal Appearance, Postures, Gestures, Eye Contact, Facial expressions Paralinguistic Features-Rate, Pause, Volume, Pitch/Intonation/ Voice/Modulation, Proxemics, Haptics, Artifacts, Chronemics,	**4**
	Total	**16**

Texts:

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication.* Pearson.

References:

1. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

Semester II
Subject Name: Behavioural Sciences -II **Type of course: AEC** **Paper Code: BHS982A202** **Course Level: 100** **Credit: 3** **L-T-P-C- 1-0-0-1**

Scheme of Evaluation: Theory

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course Outcomes: On completion of the course the students will be able to

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Develop an elementary level of understanding of culture and its implications on personality of people	BT 1
CO 2	Understand the concept of leadership spirit and to know its impact on performance of employees	BT 2
CO 3	Understand and apply the concept of Motivation in real life	BT 3

Modules	Course Contents	Periods
I	**Culture and Personality** Culture: Definition, Effect, relation with Personality, Cultural Iceberg, Overview of Hofstede's Framework, Discussion of the four dimensions of Hofstede's Framework.	4
II	**Attitudes and Values** Attitude's definition: changing our own attitudes, Process of cognitive dissonance Types of Values, Value conflicts, Merging personal and Organizational values.	4
III	**Motivation** Definition of motivation with example, Theories of Motivation (Maslow, McClelland's theory& Theory X and Y).	4
IV	**Leadership** Definition of leadership, Leadership continuum, types of leadership, Importance of Leadership, New age leaderships: Transformational & transactional Leadership, Leaders as role models.	4
Total		16

Text books

1. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc
2. Organizational Behaviour by Kavita Singh (Vikas publishers, 3rd Edition).

References

2. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company.

Semester II
Subject Name: Sericulture
Type of course: SEC Paper Code: ZOO142S221
Course Level: 100 Credit: 3 L-T-P-C- 0-0-6-3

Scheme of Evaluation: Practical

Course Objective: The objective of the course is to introduce the students to the entrepreneurial scope, economic advantages and basic practices involved in sericulture.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and describe the basic principles of sericulture, including the life cycle of silkworms.	BT 1
CO 2	Explain the significance of sericulture in the textile industry and its economic importance.	BT 2
CO 3	Apply sericulture techniques to raise and manage silkworms, and harvest silk for silk production.	BT 3
CO 4	Analyze the factors influencing silk quality and the economic impact of sericulture.	BT 4

Detailed Syllabus:

Modules	Course Contents	Periods
I	**Introduction:** Insect and non-insect fauna producing silk; types of silk produced in India; host plants of mulberry and non-mulberry silkworms	15
II	**Scope of Sericulture:** Advantages of sericulture; scope of sericulture in India employment potential and income generation; role of women in sericulture	15
III	**Concepts of Moriculture:** Host plants of mulberry and non-mulberry silkworms. Mulberry cultivation.	15
IV	**Concepts of Sericulture:** Life cycle of Bombyx mori; rearing houses and equipment's; disinfection and hygiene. Rearing operations and cocoon harvesting. Diseases in silkworms.	15
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
-	**60 hrs**	**30 hrs** Field visit to Sericulture

		farm, assignment, quiz, project, hand-on rearing of silkworm

Textbooks:

1. Charsley, S.R. (1982). Culture and Sericulture. Academic Press Inc., New York, U.S.A
2. Masood, M. A., and Kamili, A. S. (2000). Principles of Temperate Sericulture. Kalyani Publisher.

References:

1. Devaiah, M.C et al. (2001); Advances in Mulberry Sericulture. Dept. of Sericulture, UAS, Bangalore.
2. Rao, M.M. (1999) Comprehensive Sericulture Manual. P.S Publications, Hyderabad.

SEMESTER-III
Subject Name: Comparative Anatomy of Animals **Course Code: Major** **Subject Code:** ZOO142M301 **L-T-P-C**: 3-1-0-4 **Credit Units:** 4 **Scheme of Evaluation:** Theory

Course Objective: This course is designed to enhance the comprehension of anatomical characteristics of different organs, their function and elucidate their comparative study in different classes of vertebrates concerning skeletal system, digestive system, cardiovascular system, respiratory system, excretory system and nervous system.

Course Outcomes:

On completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall the fundamental structure and significance of integument and their derivatives. Skeletal arrangement of pectoral girdle and pelvic girdle of vertebrates.	BT 1
CO 2	Brief account of gastro intestinal tract, digestive glands and their function. Respiratory apparatus, their physiology in different vertebrates.	BT 2
CO 3	Brief knowledge of blood vascular system Evolution of heart, aortic arches, kidney and urinogenital ducts.	BT 3

CO 4	Concept of nervous system, brain and sense organs and receptors in different vertebrates.	BT 4

Detailed Syllabus:

Module	Course Contents	Periods
I	Integumentary System: General structure of skin, Function of skin. Comparative study of integument in different classes of vertebrates, Derivatives of integument in different vertebrates. Skeletal System in vertebrates: Comparative study of pectoral girdle and pelvic girdle of vertebrates	15
II	Digestive System: Brief account of alimentary canal, Stomach, intestine and digestive glands in different vertebrates Respiratory System in different vertebrates: Brief account of Gills, lungs, air sacs and swim bladder	15
III	Circulatory System: Evolution of heart and aortic arches in different vertebrates Urinogenital System in different vertebrates: Succession of kidney, Evolution of urinogenital ducts	15
IV	Nervous System: Comparative account of brain in different vertebrates Sense Organs: Ear, Eye in different vertebrates, Types of receptors in different vertebrates	15
	Total	60

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**60 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Text book

1. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
3. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.

References:

1. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
2. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts,USA.
3. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
4. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.

SEMESTER- III
Subject Name: Comparative anatomy of Animals (Practical)
Course Code: Major Subject Code: ZOO142M311
L-T-P-C- 0-0-8-4
Credit Units: 4
Scheme of Evaluation: Practical

Course Objective: The course is designed to enhance the knowledge of students in animal physiology and various techniques to assess several important physiological phenomena.
Course Outcomes: Upon completion of the course, students should be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify various tissues in the body structurally and morphologically.	BT 1
CO 2	Interpret the results of various techniques used to analyse physiological health	BT 2
CO 3	Determine quantitatively and qualitatively the blood types in vertebrates.	BT 3
CO 4	Correlate among different biological systems	BT 4

	physiologically	

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	**Osteology:** 1. To study the Skull of herbivorous and carnivorous animal 2. To study the skull of Pigeon 3. To study and compare between Skull of Poisonous and non-poisonous snakes.	**30**
II	1. To study the disarticulated skeleton of Foul, Toad/Frog and Rabbit/Guineapig 2. To study the Carapace and Plastron of Tortoise 3. Study of comparative anatomy of heart of Pisces, Amphibia, Reptiles, Aves and mammal.	**30**
III	1. Comparative study of blood cells in vertebrates 2. Comparative study of brain in different classes of vertebrates. 3. Comparison of herbivorous teeth and carnivorous teeth.	**30**
IV	1. Preparation of permanent slides of placoid, cycloid and ctenoid scales of fishes. 2. Study of beaks of different birds. 3. Study of claws of different birds.	**30**
Total		**120**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
120 hrs	**-**	**-**

Textbooks:

1. Textbook of Practical Zoology, S.S. Lal.

References:

1. Comparative Anatomy of Vertebrates with Practical (2021), Mishra T., Mishra, D., and Srivastav, S.

Semester-III
Subject Name: Human Biology **Type of course: Paper Code: ZOO142N301** **Course Level: 100 Credit: 4 L-T-P-C- 3-1-0-4** **Scheme of Evaluation: Theory**

Course Objectives:

1. Understand the basic principles of human biology.
2. Learn about the structure and function of the human body.
3. Develop an understanding of the relationship between the human body and its environment.
4. This course provides a basic understanding of the human body, its structure, functions, and the biological processes that govern it.

Course outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall and list the major characteristics that define various aspects of Human Biology	BT 1
CO 2	Explain the evolutionary significance of Human Biology and dorsal nerve cords in the development of chordates.	BT 2
CO 3	Apply knowledge of chordate characteristics to identify and classify different chordate species.	BT 3
CO 4	Analyze taxonomic hierarchy and chordate relationships	BT 4

Detailed syllabus

Module	Course Content	Periods
I	**Introduction to Human Biology** • Overview of Human Biology: Basic biological principles, • Levels of Organization: Levels of organization in the human body • Overview of homeostasis, Glucose homeostasis and thermoregulation, Mechanism of homeostasis.	**15**

II	**Cell Biology and Genetics** • Cell Structure and Function • Cellular components: DNA, genes, and chromosomes. • Cell Division and Growth, Overview of cell cycle.	**15**
III	**Human Anatomy and Physiology** • Basics of Human Anatomy (Skeletal System, Muscular System, Nervous System, Digestive System). • Basics of Human Physiology (Respiratory Physiology, Digestive Physiology).	**15**
IV	**Human Health and Disease** • Nutrition and Health • Common Diseases and Disorders • Immunity and Vaccination	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**60 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

References-

1. Essential Human Biology: Cells and Tissues by Ann Fullick

Textbooks-

2. Human Biology by Sylvia S. Mader
3. Principles of Anatomy and Physiology by Gerard J. Tortora

Semester-III
Subject Name: Understanding of Life Processes **Type of course: IDC Paper Code: ZOO142I301** **Course Level: 200** **Credit:3 L-T-P-C: 3-0-0-3**

Scheme of Evaluation: Theory

Course objective: The objective of this course is to provide an understanding of fundamental biological functions, including metabolism, genetics, organ systems, reproduction, evolution, and ecological interactions, fostering scientific inquiry and critical thinking.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify living beings' characteristics, biodiversity, digestive system, food types, respiratory system parts, circulatory components, reproductive systems, and gametogenesis stages.	BT 1
CO 2	Understanding: Describe living beings' organizational levels and binomial nomenclature, digestion process and absorption, breathing mechanism, blood group functions, blood pressure regulation, fertilization, and menstrual cycle.	BT 2
CO 3	Classify organisms with binomial nomenclature, citing zoo and garden species. Track food's path through digestion, note nutritional deficiency diseases. Show lung gas exchange, calculate respiratory capacities. Map blood circulation, measure blood pressure. Diagram sperm, ovum, and menstrual cycle stages.	BT 3
CO 4	Compare levels of organization in beings, assess biodiversity conservation. Analyze digestive organs, food impact on health. Evaluate gas transport, respiratory disorders. Compare blood and lymph roles, circulatory disorders. Examine hormonal reproductive regulation, fertility factors.	BT 4

Detailed syllabus:

Modules	Course contents	Periods
I	**The Living World:** Characteristic of Living Beings, Diversity of Living World, Levels of Organization for Living Beings, Bionomial Nomenclature – Rules of Nomenclature, Zoological Parks and Botanical Gardens	**15**
II	**Digestion and Absorption:** Digestive system of Human, Process of digestion in mouth, stomach and small intestine, Absorption of digested products, Food and its types, Diseases due to nutritional deficiency	**15**
III	**Respiration:** Respiratory systems of Human, Mechanism of breathing in Human, Transport of gases- transport of Oxygen and Carbon dioxide, Respiratory volume and capacities, Some respiratory disorders	**15**

	Circulation: Circulatory system of human, body fluid- blood and lymph, blood groups, Blood Pressure, Some disorders of circulatory system	
IV	**Reproduction:** Male reproductive system of human, Female reproductive system of human, Gametogenesis, human sperm and human ovum, Menstrual cycle, Fertilization	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	-	60 hrs
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Biology by Neil A. Campbell and Jane B. Reece
2. Human Biology by Sylvia S. Mader and Michael Windelspecht
3. Principles of Anatomy and Physiology by Gerard J. Tortora and Bryan H. Derrickson
4. The Diversity of Life" by Edward O. Wilson
5. Kotpal, R.L. (2015). Modern textbook of Zoology: Invertebrates. (11th ed). Rastogi publications.

References:

1. "Human Anatomy & Physiology" by Elaine N. Marieb and Katja N. Hoehn

2. "Biology: The Unity and Diversity of Life" by Cecie Starr, Ralph Taggart, Christine Evers, and Lisa Starr

Semester-III
Subject Name: CEN III – Fundamentals of Business Communication **Type of course: AEC Paper Code: CEN982A301** **Course Level: 200** **Credit:3 L-T-P-C: 1-0-0-1** **Scheme of Evaluation: Theory**

Course Objective: The aim of the course is to develop essential business communication skills, including effective writing, speaking, and interpersonal communication, to enhance professional interactions, collaboration, and successful communication strategies within diverse corporate environments.

Course Outcomes: On successful completion of the course the students will be able to:

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**Define and list** business documents using appropriate formats and styles, demonstrating proficiency in written communication for various business contexts.	BT1
CO 2	**Demonstrate** confident verbal communication skills through persuasive presentations, active listening, and clear articulation to engage and influence diverse stakeholders.	BT2
CO3	**Apply** effective interpersonal communication strategies, including conflict resolution and active teamwork, to foster positive relationships and contribute to successful organizational communication dynamics	BT3

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	**Business Communication: Spoken and Written** • The Role of Business Communication • Classification and Purpose of Business Communication • The Importance of Communication in Management • Communication Training for Managers • Communication Structures in Organizations • Information to be Communicated at the Workplace • Writing Business Letters, Notice, Agenda and Minutes	5

II	**Negotiation Skills in Business Communication**
	• The Nature and Need for Negotiation
	  o Situations requiring and not requiring negotiations
	• Factors Affecting Negotiation
	  o Location, Timing, Subjective Factors
	• Stages in the Negotiation Process
	  o Preparation, Negotiation, Implementation
	• Negotiation Strategies
		5

III	**Ethics in Business Communication** • Ethical Communication • Values, Ethics and Communication • Ethical Dilemmas Facing Managers • A Strategic Approach to Business Ethics • Ethical Communication on the Internet • Ethics in Advertising	**5**
IV	**Business Etiquettes and Professionalism** • Introduction to Business Etiquette • Interview Etiquette • Social Etiquette • Workplace Etiquette • Netiquette	**5**

Textbooks:

1. *Business Communication* by Shalini Verma
2. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma

References:

1. *Business Communication* by P.D. Chaturvedi and Mukesh Chaturvedi.

Semester-III
Subject Name: Behavioural Sciences -III **Type of course: AEC Paper Code: BHS982A302** **Course Level: 200** **Credit:3 L-T-P-C: 1-0-0-1** **Scheme of Evaluation: Theory**

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations. To enable the students to understand the process of problem solving and creative thinking.

Course outcomes: On completion of the course the students will be able to: CO1: Understand the process of problem solving and creative thinking- BT 1 CO2: Develop and enhance of skills required for decision-making- BT 2

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	Understand the process of problem solving and creative thinking.	**BT1**
CO 2	Develop and enhance of skills required for decision-making	**BT2**

Detailed syllabus

Modules	Course Contents	Periods
I	**Problem Solving Process** Defining problem, the process of problem solving, Barriers to problem solving(Perception, Expression, Emotions, Intellect ,surrounding environment)	**4**
II	**Thinking as a tool for Problem Solving** What is thinking: The Mind/Brain/Behaviour Critical Thinking and Learning: -Making Predictions and Reasoning. -Memory and Critical Thinking. - Emotions and Critical Thinking.	**4**
III	**Creative Thinking** - Definition and meaning of creativity, - The nature of creative thinking :Convergent and Divergent thinking, - Idea generation and evaluation (Brain Storming) - Image generation and evaluation. - The six-phase model of Creative Thinking: ICEDIP model	**4**
IV	**Building Emotional Competence** Emotional Intelligence – Meaning, components, Importance and Relevance Positive and Negative emotions Healthy and Unhealthy expression of emotions	**4**
Total		**16**

Text books:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company

References:

1. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

SEMESTER-III
Subject Name: Wildlife Photography and Ecotourism **Course Code: SEC** **Subject Code:** ZOO142S321 **L-T-P-C**: 0-0-6-3 **Credit Units:** 3 **Scheme of Evaluation:** Practical

Course Objective: The idea is to spark an entrepreneurial side in our final year students. To introduce photography and nature tourism as a skill

Course Outcome: Post learning this course, we can expect following outcomes-

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Have a knowledge of basics of photography and settings of camera	BT 1
CO 2	Compare the various tools and technique of photography	BT 2
CO 3	To analyse the scope of ecotourism in India	BT 3
CO 4	Summarise and evaluate the available career options in wildlife photography and ecotourism (BT4)	BT 4

Detailed Syllabus:

Module	Topics (if applicable) & Course Contents	Periods
I	**Introduction to Photography:** Introduction of Photography; A brief history. Revaluation of Cameras. Basic settings of Camera. Types of cameras used in wildlife photography (underwater, drone, camera trap, GoPro, etc.).	20
II	**Tools and Technique of Photography:** Still & Video Photography. To develop expertise in Photography. Photography in different periods (Light and Dark), seasons and places (Wetlands, Wildlife sanctuaries, National parks, Industrial sites etc.). Camera trapping method for wildlife conservation and management.	25
III	**Eco-tourism:** Introduction of Eco-tourism. Scope of Eco-tourism with special reference to Northeast region of India. Management of Eco-tourism & hospitality	20
IV	**Wildlife Photography and Ecotourism**: Nature guides as a profession with reference to bird tourism. Development of Eco-tourism with innovative, Eco-restoration ideas. Submission of a photography and report.	25
	Total	90

Credit Distribution

Lecture/ Tutorial	Practicum	EL
-	60 hrs	30 hrs
		Field visit to, assignment, quiz, project

Textbooks:

1. Ken Milburn & Ron Rockwell (2002). Digital photography bible (2nd Ed), Wiley.
2. Julie Adair King (2003). Shoot Like a Pro! Digital Photography Techniques (1st Ed), McGraw-Hill Osborne Media.

References:

1. Ballantyne R. & Packer J (2013). International Handbook on Ecotourism. Edward Elgar Publishing Limited, UK.
2. Fennell DA (2014). Ecotourism. An Introduction. Routledge, London, UK.
3. Joshi, R. (2010). Eco-tourism as a viable option for wildlife conservation: need for policy initiative in Rajaji National Park, North-West India. Global Journal of Human Social Science Research, 10(5), 19-30.
4. Basnet, D., Jianmei, Y., Dorji, T., Qianli, X., Lama, A.K., Maowei, Y., Ning, W., Yantao, W., Gurung, K., Rujun, L. and Gupta, N., 2021. Bird photography tourism, sustainable livelihoods, and biodiversity conservation: a case study from China. Mountain Research and Development, 41(2), p.D1.
5. Dixit, S. (2018). An assessment of wildlife tourism photography in nature and ecotourism destination - a case of India. Amity Journal of Management, Vol. VI, No. 1, 1-13.
6. Hanisch, E., Johnston, R., & Longnecker, N. (2019). Cameras for conservation: wildlife photography and emotional engagement with biodiversity and nature. Human Dimensions of Wildlife, 24(3), 267-284.

SEMESTER-IV
Subject Name: Cell Biology **Course Code: Major** **Subject Code: ZOO142M401** **L-T-P-C: 3-1-0-4** **Credit Units: 4** **Scheme of Evaluation: Theory**

Course Objective:

To help the students learn and develop an understanding of the cell as a basic unit of life, the functions of cellular organelles, how a cell carries out and regulates cellular functions and their role in disease condition due to malfunctioning of cellular processes.

Course Outcomes:

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

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify the different structural and functional components of the cell.	BT 1
CO 2	Explain the structure and functions of cell organelles involved in diverse cellular processes.	BT 2
CO 3	Apply the knowledge of cellular process and its regulation in understanding the process of cancer and microbial physiology.	BT 3
CO 4	Point out the roles of various genes responsible for various kinds of cell signalling processes.	BT 4

Course Outline

Modules	Topics & Course Contents	Periods
I	Structure and differences between prokaryotic and eukaryotic cells. **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps. Chromatin structure- Euchromatin and Heterochromatin- Constitutive and Facultative heterochromatin. **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	**15**
II	**Cytoskeleton:** Molecular organization of microtubules, microfilaments and intermediary filaments. **Cellular communication:** General principles of cell communication,	**15**

	Cell junction and cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission.	
III	**Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle in yeast and multicellular organism, apoptosis. **Cancer:** Introduction to normal and cancerous cell, tumor suppressor genes and oncogenes, cancer causing viruses.	**15**
IV	**Basics of Cell signaling:** Autocrine, endocrine, paracrine and juxtracrine signaling, signaling molecules and receptors. **Cell signaling:** Hormones and receptors, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of GPCR signaling pathways.	**15**
TOTAL		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**60 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Lodish H, Berk A, Kaiser C.A, Krieger M, Bretscher A, Ploegh H, Amon A, Martin K.C (2016). Molecular Cell Biology, 8th Ed, W. H. Freeman.
2. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P (2018). Molecular biology of the cell. 6th Ed, Garland Science.
3. Hardin J & Bertoni G (2018). Becker's World of the Cell. 9th Ed, Pearson Education.

References:

1. Stephen R. Bolsover S.R, Jeremy S. Hyams J.S, Elizabeth A. Shephard E.A & Hugh A. White H.A (2011). CELL BIOLOGY: A Short Course. 3rd Ed, John Wiley & Sons.
2. Cooper G.M (2019). The Cell: A Molecular Approach. 8th Ed, Sinauer Associates.
3. Iwasa J & Marshall W (2016). Karp's Cell and Molecular Biology: Concepts and Experiments. 8th Ed, John Wiley & Sons.

Semester-IV
Paper I/Subject Name: Animal Physiology and Endocrinology **Course Code: Major Subject Code: ZOO142M402** **L-T-P-C- 3-1-0-4** **Credit Units: 4** **Scheme of Evaluation: Theory**

Course Objective: This course is designed to enhance comprehension of the anatomical characteristics of organs and elucidate their functioning at the organ level concerning processes such as nervous, respiratory, cardiovascular, excretory, and digestive systems, among others.

Course Outcomes:

On completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall different procedures that are crucial for grasping the fundamental principles of physiology	BT 1
CO 2	Interpret the diverse approaches that regulate essential life functions including nervous, respiratory, cardiovascular, excretory, and digestive processes, among others.	BT 2
CO 3	Utilize fundamental understanding to analyse the diverse life processes, including the operations of the nervous system, respiratory system, cardiovascular system, excretory system, and digestive system.	BT 3
CO 4	Compare and contrast between different biological system.	BT 4

Detailed syllabus:

Modules	Topics (if applicable) & Course content	Periods
I	**Digestive system:** Comparative account of physiology of digestive system in herbivores and carnivores. Digestion and absorption of various nutrients;	**15**

	Hormonal control of secretion of enzymes in Gastrointestinal tract in humans. Disorders of the digestive system. **Excretory system:** Comparative account of physiology of excretory system; Structure of kidney and its functional unit; Micturition; Urine formation; Disorders of the excretory system.	
II	**Cardiovascular System:** Comparative account of circulation; Lymphatic system; Components of blood and their functions; Haemopoiesis; Structure of mammalian heart; Origin and conduction of cardiac impulses; ECG – its principle and significance. Disorders of the cardiovascular system. **Nervous System:** Comparative account of nervous system; Structure of neuron; Types of neurons, Resting membrane potential, Origin of action potential and its propagation; Synaptic transmission; Reflex action and its types. Disorders of nervous system.	**15**
III	**Respiratory system:** **Structural components of respiratory system;** Mechanism of respiration, Gaseous exchange: CO_2 and O_2 transport, Disassociation curve, respiratory volumes; Comparative account of respiratory systems in animals; Disorders of nervous system. High altitude respiratory adaptations.	**15**
IV	**General endocrinology:** Structure and functions of: Pituitary, thyroid, pancreas and adrenal and their mechanism of action; Classification of hormones; Mode of hormone action; Disorders of endocrine system. **Reproductive endocrinology:** Components of reproductive system; Physiology of male and female reproductive system; Hormonal regulation of reproduction; Disorders of reproductive system; and basics of assisted reproductive technologies.	**15**
Total		**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**60 hrs**

		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

2. Guyton, A.C. & Hall, J.E. (2015). Textbook of Medical Physiology. XIII Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
3. Tortora, G.J. & Grabowski, S. (2017). Principles of Anatomy & Physiology. XI Edition John Wiley & Sons
4. Marieb E.N & Hoehn K.N (2022). Human Anatomy & Physiology. 12th Ed, Pearson Education.

References:

1. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills
2. Dr Ian Kay (1998). Introduction to Animal Physiology. 1st Ed, Garland Science.

SEMESTER-IV
Subject Name: Cell Biology & Animal Physiology and endocrinology (Practical) **Course Code: Major Subject Code: ZOO142M411** **L-T-P-C- 0-0-8-4** **Credit Units: 4** **Scheme of Evaluation: Practical**

Course Objective:

To help the students learn and develop an understanding of the cell as a basic unit of life, the functions of cellular organelles, how a cell carries out and regulates cellular functions and their role in disease condition due to malfunctioning of cellular processes.

Course Outcomes:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Identify the different structural and functional components of the cell.	BT 1
CO 2	Explain the structure and functions of cell organelles involved in diverse cellular processes.	BT 2
CO 3	Apply the knowledge of cellular process and its regulation in understanding the process of cancer and microbial physiology.	BT 3
CO 4	Point out the roles of various genes responsible for	BT 4

	various kinds of cell signalling processes.	

Detailed Syllabus:

Modules	Topics (if applicable) & Course Contents	Periods
I	1. Staining of buccal epithelial cells and blood cell using methylene blue and Leishman stain respectively 2. Effect of hypotonic and hypertonic solution on mammalian RBC 3. Staining of nucleus and nucleolus in mammalian cell 4. Staining of mitochondria using Vital stain 5. Study of eukaryotic and prokaryotic cells and their comparison.	**30**
II	1. To study replication, transcription, and translation using photographs. 2. Study of various stages of mitosis in onion root tip. 3. Study of different stages of meiosis using grass hopper/Sand hopper testes 4. Preparation of polytene chromosome from salivary gland of Chironomus / drosophila larvae	**30**
III	1. Study of permanent slides of mammalian skin, cartilage, bone, spinal cord, liver, lung, kidney, and nerve cell. 2. Demonstration of mammalian internal systems (digestive, circulatory, nervous, reproductive, and excretory) of Frog/ rat. 3. Determination and comparison of RBC count in different vertebrates (human, fish, and frog). 4. Estimation of haemoglobin using Sahli's haemocytometer. 5. Preparation of haemin crystals.	**30**
	1. Recording of blood pressure of human using a sphygmomanometer. 2. To determine the rate of oxygen consumption by terrestrial animal (rat) 3. Study of permanent slides of Pituitary, Pancreas, Testes, Ovary, Adrenal, Thyroid and Parathyroid glands 4. Dissection and display of endocrine glands in albino mice.	**30**

	5. To study the estrous cycle in mammals.	
Total		**120**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
	120 hrs	**-**

Textbooks:

1. Das, D. (2017). Essential practical handbook of cell biology & genetics, biometry & microbiology: a laboratory manual. (1st Ed). Academic Publishers.
2. Gupta, A., Sati, B. K., & Lambert, L. A. P. Practical laboratory Manual- Cell Biology. Academic Publishing

Semester-IV
Subject Name: Aquatic Biology **Type of course: Minor Paper Code: ZOO142N401** **Course Level: 200 L-T-P-C- 3-0-0-3** **Credit: 3** **Scheme of Evaluation: Theory**

Course Objectives: This course provides a comprehensive understanding of the biology of aquatic organisms and the ecosystems they inhabit.

Course outcomes:

Course Outcome	**Course Outcome**	**Bloom's Taxonomy Level**
CO 1	Recall and understanding of various aquatic biomes, including freshwater ecosystems, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone, and coral reefs.	BT 1
CO 2	Explain and understand the origin, classification, and ecosystem of lakes, their morphometry, and physico-chemical characteristics. Learn about nutrient cycles in lakes and the adaptation of hill-stream fishes.	BT 2
CO 3	Apply and Learn about the salinity and density of	BT 3

	seawater, the continental shelf, adaptations of deep-sea organisms, coral reefs, and seaweeds.	
CO 4	Analyze the causes of pollution, including agricultural, industrial, sewage, thermal, and oil spills. Learn about eutrophication, management and conservation strategies, legislations, sewage treatment, and water quality assessment methods like BOD and COD.	BT 4

Detailed Syllabus

Module	Course Content	Periods
I	Aquatic Biomes: Brief introduction of the aquatic biomes: Freshwater ecosystem; lakes, wetlands, streams and rivers, estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs, artificial ecosystem (ponds).	**15**
II	Freshwater Biology: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases; Oxygen, Carbon dioxide. Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous. Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes	**15**
III	Marine Biology: Salinity and density of Sea water, Continental shelf, Adaptations of deep-sea organisms, Coral reefs, Sea weeds.	**15**
IV	Management of Aquatic Resources: Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation; legislations, Sewage treatment Water quality assessment - BOD and COD	**15**
	Total	**60**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Freshwater Ecology: Concepts and Environmental Applications by Walter K. Dodds and Matt R. Whiles. This book provides an in-depth understanding of freshwater ecosystems, how they work, and how to protect and manage them.
2. Marine Biology: Function, Biodiversity, Ecology by Jeffrey S. Levinton. It's a comprehensive book that covers various aspects of marine biology including the function and biodiversity of marine ecosystems.

Reference Books:

1. Aquatic Ecosystems: Interactivity of Dissolved Organic Matter" by Stuart Findlay and Robert L. Sinsabaugh. This book provides information on the role of dissolved organic matter in aquatic ecosystems.
2. Biology of Freshwater Pollution by C.F. Mason. This is a comprehensive guide to the biological aspects of water pollution.

SEMESTER-IV
Subject Name: Economic Zoology
Course Code: Minor **Subject Code:** ZOO142N402
L-T-P-C: 3-0-0-3
Credit Units: 3
Scheme of Evaluation: Practical

Course Objective:

1. To disseminate information on economic aspects of zoology like apiculture, sericulture, dairy science etc.
2. To encourage young learners for self-employment.
3. To impart the practical knowledge and working skill to the students on various aspects of Zoology and to train them for their livelihood.

Course Outcome: Post learning this course, we can expect following outcomes-

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Understands the importance of earthworms in maintaining soil quality and learns that the vermicomposting is an effective organic solid waste management method. Best opportunity for self-	BT 1

	employment and lifelong learning with farmers	
CO 2	Gives knowledge of silk worm rearing, Mulberry cultivation and Various process involved in silk production	BT 2
CO 3	Understands about honey bee and bee rearing. Knowing methods of extraction of honey and implication of Bee economy and entrepreneurship in apiculture	BT 3
CO 4	Understands concepts of Aqua culture systems, prawn culture, pearl culture and induced breeding techniques. Provides knowledge of ornamental fish breeding which is highly professional and attractive avenue for youth	BT 4

Detailed Syllabus:

Module	Course Contents	Periods
I	**Vermiculture:** Scope of Vermiculture, Types of earthworms, Habit categories - epigeic, endogeic and anecic; indigenous and exotic species. Methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of Vermicompost. Advantages of vermicomposting. Diseases and pests of earthworms.	15
II	**Sericulture:** History and present status of sericulture in India, Mulberry and non-mulberry species in Assam and India, Mulberry cultivation, Morphology and life cycle of *Bombyx mori*, Structure of silk gland and secretion of silk, Silkworm rearing techniques: Spinning, harvesting and storage of cocoons, Processing of cocoon, reeling, Silkworm diseases-pests and their control	15
III	**Apiculture:** Introduction and present status of apiculture, Species of honey bees in India, life cycle of *Apis indica*, Colony organization, division of labour and communication, Bee keeping as an agro based industry; methods and equipment's: indigenous methods, extraction appliances, extraction of honey from the comb and processing, Bee pasturage, honey and bees wax and their uses, Pests and diseases of bees and their management.	15
IV	**Aquaculture**: Aquaculture in India: An overview and present status and scope of aquaculture, Types of aquacultures: Pond culture: Construction, maintenance and management, composite fish culture and pearl culture.	15

	Culture of fresh and marine water prawns. Ornamental fish culture: Fresh water ornamental fishes- biology, breeding techniques, Construction and maintenance of fish aquarium, Modern techniques of fish seed production; Induced breeding of fish.	
	Total	60

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
60 hrs	**-**	**30 hrs**
		Field work, Assignment, Reflective thinking, case study, seminar, quiz

Textbooks:

1. Shukla and Upadhyaya (2002). Economic Zoology, Rastogi Publishers
2. YadavManju (2003). Economic Zoology, Discovery Publishing House.
3. Jabde Pradip V (2005). Textbook of applied Zoology, Discovery Publishing House, New Delhi. 10. Cherian &Ramachandran Bee keeping in-South Indian Govt. Press, Madras.

References:

1. Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Roger, M (1990). The ABC and Xyz of Bee Culture: An Encyclopedia of Beekeeping, Kindle Edition.

SEMESTER-IV

Subject Name: CEN IV: Business Communication: Concepts and Skills

Course Code: AEC **Subject Code:** CEN982A401

L-T-P-C: 1-0-0-1

Credit Units: 1

Scheme of Evaluation: Theory

Course Objectives: This course is designed to enhance employability and maximize the students' potential by introducing them to the principles that determine personal and professional success, thereby helping them acquire the skills needed to apply these principles in their lives and careers.

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

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	**Demonstrate** understanding the importance of verbal and non-verbal skills while delivering an effective presentation.	**BT 2**
CO 2	**Develop** professional documents to meet the objectives of the workplace	**BT 3**
CO 3	**Identify** different life skills and internet competencies required in personal and professional life.	**BT 3**

Detailed Syllabus		
Units	**Course Contents**	**Periods**
I	**Presentation Skills** Importance of presentation skills, Essential characteristics of a good presentation, Stages of a presentation, Visual aids in presentation, Effective delivery of a presentation	**5**
II	**Business Writing** Report writing: Importance of reports, Types of reports, Format of reports, Structure of formal reports Proposal writing: Importance of proposal, Types of proposal, structure of formal proposals Technical articles: Types and structure	**5**
III	**Preparing for jobs** Employability and Unemployability, Bridging the Industry-Academia Gap Knowing the four- step employment process, writing resumes, Guidelines for a good resume, Writing cover letters Interviews: Types of interview, what does a job interview assess, strategies of success at interviews, participating in group discussions.	**5**

IV	**Digital Literacy and Life Skills** **Digital literacy:** Digital skills for the '21st century', College students and technology, information management using Webspace, Dropbox, directory, and folder renaming conventions. Social Media Technology and Safety, Web 2.0. **Life Skills**: Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem-solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion. Application of life skills: opening and operating bank accounts, applying for PAN, Passport, online bill payments, ticket booking, gas booking	**5**

Credit Distribution		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
15 hours	-	10 hours Movie/ Documentary screening - Field visits - Peer teaching - Seminars - Library visits

Textbook:

1. *Business Communication* by Shalini Verma

References:

2. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma.

SEMESTER-IV
Subject Name: Behavioural Sciences -IV
Course Code: AEC **Subject Code: BHS982A402**
L-T-P-C: 1-0-0-1
Credit Units: 1
Scheme of Evaluation: Theory

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course outcomes: On completion of the course the students will be able to-

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	Understand the importance of individual differences.	**BT 1**
CO 2	Develop a better understanding of self in relation to society and nation.	**BT 2**
CO 3	Facilitation for a meaningful existence and adjustment in society.	**BT 3**

Modules	Course Contents	Periods
I	**Managing Personal Effectiveness** Setting goals to maintain focus, Dimensions of personal effectiveness (self-disclosure, openness to feedback and perceptiveness), Integration of personal and organizational vision for effectiveness, A healthy balance of work and play. Defining Criticism: Types of Criticism, Destructive vs Constructive Criticism, Handling criticism and interruptions.	**4**
II	**Positive Personal Growth** Understanding & developing positive emotions,Positive approach towards future, Impact of positive thinking, Importance of discipline and hard work, Integrity and accountability, Importance of ethics in achieving personal growth.	**4**
III	**Handling Diversity** Defining Diversity, Affirmation Action and Managing Diversity, Increasing Diversity in Work Force, Barriers and Challenges in Managing Diversity.	**4**
IV	**Developing Negotiation Skills** Meaning and Negotiation approaches (Traditional and Contemporary) Process and strategies of negotiations. Negotiation and interpersonal communication. Rapport Building – NLP.	**4**
Total		**16**

Textbooks:

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer &Company

References:

2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

SEMESTER-V
Subject Name: Biochemistry
Course Code: Major **Subject Code:** ZOO142M501
L-T-P-C: 3-1-0-4
Credit Units: 4
Scheme of Evaluation: Theory

Course Objectives:

This course is designed to refresh important concepts of chemistry, whose understanding is critical for proper and effective learning of biochemistry. It is also augmented with other basic concepts and fundamental principles in biochemistry to equip students with knowledge and hands-on experience in classical and modern biochemistry across multiple domains.

Learning Outcomes:

Upon successful completion of this course, students are able to:

CO	Course Outcome	Bloom's Taxonomy Level (BT)
CO1	Define various terminologies that are frequently used in the field of biochemistry and also be able to explain structural and functional properties of different molecules and their interactions with other molecules.	BT1
CO2	Implement their understanding to decode deeper concepts of biochemical reactions.	BT2
CO3	Analyse structural and functional complexities of various biomolecules and their physiological roles.	BT3
CO4	Explain the complex biomolecular interactions in regulating various biochemical processes in the body.	BT4

Detailed syllabus

Module	Course content	Teaching hours
I	**Fundamentals of Biochemistry:** **Chemical Bonding & Molecular Geometry:** Bond types: Covalent (polar/nonpolar), hydrogen bonds (role in protein/DNA structure). **Thermodynamics for Biochemistry:** Laws of thermodynamics and their biological significance, Gibbs free energy (ΔG) **Isomerism:** Optical isomerism: Chiral carbon atoms and their role in biomolecules (e.g., amino acids, sugars), Enantiomers vs.	16

	diastereomers (biological relevance: enzyme specificity, drug action). **Redox Reactions in Biology**: Oxidation-reduction, role in electron transport chain ($NADH/FADH_2$), Iron in haemoglobin (Fe^{2+} vs. Fe^{3+}, oxygen binding).	
II	**Introduction to Carbohydrates**: **Monosaccharides:** Aldoses, ketoses, Chirality: D/L configuration, epimers, Cyclic Forms: Pyranose/furanose (Haworth projections), α/β anomers (mutarotation). **Polysaccharides:** Homopolysaccharides: Starch, glycogen, Cellulose and its role structural role in plant cell walls, chitin, fungal cell walls; Heteropolysaccharides: Agar and peptidoglycan. **Glycoconjugates:** Glycoproteins, Glycolipids and Proteoglycans **Lipids:** Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.	16
III	**Amino acids:** Structure, classification and general properties of α-amino acids; physiological importance of essential and non-essential α- amino acids, bonds stabilizing protein structure; levels of organization in proteins. **Nucleic Acids:** Nucleotide Composition: Purines (adenine, guanine) vs. pyrimidines (cytosine, thymine, uracil); Sugar-phosphate backbone (ribose/deoxyribose), phosphodiester bonds; DNA vs. RNA: Structural differences (2′-OH in RNA, stability, base pairing). **Vitamins: Water-Soluble** Vitamins: B-complex: Thiamine (B1) in TPP, B12 in methylation reactions; Vitamin C: Collagen synthesis, antioxidant role; **Fat-Soluble Vitamins:** Vitamin D: Calcium homeostasis, receptor signalling; Vitamin K: Blood clotting (carboxylation of clotting factors). **Macro minerals**: Calcium: Bone health, muscle contraction, signalling (calmodulin), Phosphorus: ATP, nucleic acids, bone mineralization. **Trace Elements**: Iron: Haemoglobin, electron transport chain (cytochromes); Zinc: Enzyme cofactor (carbonic anhydrase, DNA polymerase).	16
IV	**Enzymes:** Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; **Enzyme kinetics:** Factors affecting rate of enzyme-catalysed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Regulation of enzyme action and Different types of Enzyme Inhibition (Competitive, Non-competitive and Uncompetitive Inhibition).	16
Total		64

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
64 hrs	**-**	**54 hrs**
		Reviewing of case studies, project on visit to online domians to prepare report, assignment, seminar, quiz

Text Books:

1. Elil E. L and Wilen S. H (2008). Stereochemistry of organic compounds. John Wiley & Sons.
2. Wade L. G (2012). Organic chemistry. 9th Ed, Pearson Education.
3. Atkins P, de Paula J and Keeler J (2023). Atkin's Physical chemistry. 12th Ed, Oxford University Press.

References:

1. Nelson D.L and Cox M.M (2008). Lehninger principles of biochemistry. 5th Ed, W.H. Freeman.
2. Voet D, Voet J.G and Pratt C.W (2016). Fundamentals of biochemistry: Life at the molecular level. 5th Ed, Wiley.
3. Kennelly P.J, Botham K.M, McGuinness O, Rodwell V.W & Weil P.A (2022). Harper's Illustrated Biochemistry. 32nd Ed, McGraw Hill, New York, USA.

Semester-V
Subject Name: Evolutionary Biology
Course Code: Major **Subject Code:** ZOO142M502
L-T-P-C: 3-1-0-4
Credit Units: 4
Scheme of Evaluation: Theory

Course Objective: Gain a comprehensive understanding of evolutionary biology, analyze relationships, assess their impact on biodiversity and adaptation, and apply these concepts in practical settings like conservation and biological understanding.

Course Outcomes:

On completion of the course the students will be able to:

CO	Course Outcome	Bloom's Taxonomy Level
CO 1	Understand evolutionary relationships and patterns	BT 2

CO 2	Understand fundamental principles of evolution	BT 3
CO 3	Apply the concepts of evolutionary relationship and patterns to interpret evolutionary processes	BT 3
CO 4	Analyze evolutionary concepts in real-world scenarios	BT 4

Detailed syllabus:

Modules	Course content	Periods
I	**Foundations of Evolutionary Processes** Origin of life (Pre-Darwinian and Darwin's ideas about evolution); Microevolution: genetic variation, mutation, and heritability, Forces of microevolution (natural selection, genetic drift, gene flow, and mutation); Heritability, selection differential, and response to selection; Hardy-Weinberg equilibrium	**16**
II	**Macroevolution and Phylogenetics** Species concepts and speciation; Construction and interpretation of phylogenetic trees, Evidence for evolution (fossils, comparative anatomy, embryology, molecular biology); Patterns of macroevolution: adaptive radiation, convergent evolution, coevolution; Trends in macro and mega-evolution; Biogeography.	**16**
III	**Adaptation** Definition and types of adaptations, Mimicry, Batesian and Mullerian mimicry, Co-adaptation, Animal association adaptations, Biotic and organismic adaptations, Preadaptation and post-adaptations, r-adaptations and k- adaptations.	**16**
IV	**Origin and Evolution of Horse:** Place and time of origin, Evolutionary trends, characteristics of modern horse. **Origin and Evolution of Man:** Time and origin of primates and man, Place of origin of Man, Primate heritage, special features of primates, evolution and adaptive radiation in primates, compelling causes of evolution of Man, Impact of the Descent from Trees on Primate organization, Evolutionary trends during human evolution, Evidence from molecular biology in hominid evolution from Apes, Common ancestors of Apes and Man in different geological time scale, cultural evlution of human, Impact of evolution on human brain, Human races, punctuated equilibrium in human evolution.	**16**
Total		**64**

Credit Distribution

Lecture/ Tutorial	Practicum	EL
64 hrs	-	54 hrs
		Reviewing of case studies, project on visit to online domians to prepare report, assignment, seminar, quiz

Textbooks:

1. Freeman, S., & Herron, J. C. (2014). Evolutionary analysis. Pearson. (Another excellent, detailed text with a strong focus on data analysis.)
2. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
3. Losos, J. B., Baum, D. A., & Larson, A. (2020). Evolution: A very short introduction. Oxford University Press. (A concise and accessible overview of the field.)
4. Zimmer, C., & Emlen, D. J. (2018). Evolution: The triumph of an idea. Harper Perennial. (A more narrative and engaging introduction to evolution.)
5. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell
6. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.

Reference Books:

1. Grant, P. R., & Grant, B. R. (2008). *How and why species multiply: The radiation of Darwin's finches*. Princeton University Press. (A detailed case study of speciation and adaptive radiation.)
2. Dawkins, R. (1976). *The selfish gene*. Oxford University Press. (A classic exploring gene-centric evolution; can be challenging but thought-provoking.)

Semester-V
Subject Name: Biochemistry and Evolutionary Biology (Practical)
Course Code: Major **Subject Code:** ZOO142M511
L-T-P-C: 0-0-8-4
Credit Units: 4
Scheme of Evaluation: Practical

Course outcome:

This course is designed to give hands on concepts of chemistry, whose understanding is critical for proper and effective learning of biochemistry.

Course Outcomes:

Upon successful completion of this course, students are able to:

CO	Course Outcome	Bloom's Taxonomy Level (BT)

CO1	Understand the basics of chemical reactions in metabolism.	BT1
CO2	Implement their understanding to decode deeper concepts of biochemical reactions.	BT2
CO3	Analyse structural and functional complexities of various biomolecules and their physiological roles.	BT3
CO4	Explain the complex biomolecular interactions in regulating various biochemical processes in the body.	BT4

Detailed syllabus:

Modules	Course content	Periods
I	1. Qualitative detection of carbohydrates (Benedict test for reducing sugars and Iodine test for starch), lipids and proteins. 2. Quantitative estimation of carbohydrate using spectrophotometric method. 3. Estimation of total protein in given solutions by Lowry'smethod.	**30**
II	1. Study of activity of salivary amylase under optimum conditions 2. Detection of ninhydrin test for amino acids through paper chromatography. 3. Estimation of Alkaline Phosphatase and LDH from serum/tissue.	**30**
III	1. Comparison of homologous (common ancestry) and analogous (convergent evolution) structures in vertebrates and invertebrates. 2. Analysis of allelic and genotypic frequencies in a hypothetical population using hardy Weinberg principle 3. Construct phylogenetic trees using molecular sequences	**30**
IV	1. Demonstration of selection pressure by growing bacteria with and without antibiotics. 2. Comparation of nesting or foraging behaviors of different bird species to understand behavioural evolution. 3. Analysis of occurrence of multiple alleles (A, B, O) in population.	**30**
	Total	**120**

Semester-V
Subject Name: Animal Parasites **Course Code: Minor** **Subject Code:** ZOO142N501 **L-T-P-C**: 3-1-0-4 **Credit Units:** 4 **Scheme of Evaluation:** Theory

Course Objective: This course introduces students to animal parasites, their diversity, life cycles, host interactions, and impact on health. Students will learn parasite identification, transmission strategies, diagnostic techniques, and control measures. Through hands-on activities, they will analyze parasite-related challenges, including drug resistance and climate change, preparing them for careers in parasitology, public health, and research.

Course Outcomes:

On completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall key concepts, terminologies, and fundamental principles of parasitology, including parasite-host relationships, transmission, and adaptations.	BT 1
CO 2	Interpret the diversity of parasites, their life cycles, host specificity, and transmission strategies to understand their role in ecosystems and human health.	BT 2
CO 3	Utilize fundamental knowledge to analyze the impact of parasitic infections, diagnose parasites using laboratory techniques, and apply control measures.	BT 3
CO 4	Compare and contrast different parasite-host interactions, evaluate emerging parasitic threats, and critically assess ethical concerns in parasite control and management.	BT 4

Detailed syllabus:

Modules	Course content	Periods
I	**Introduction to Parasitology** Definition and scope of parasitology; Animal associations (phoresy, symbiosis, mutualism, commensalism, parasitism) Types of hosts and parasites: Host types, Parasite types, host specificity, Parasitic adaptations, Impact of parasite on human health, agriculture, emerging challenges.	**16**
II	**Parasite Diversity and Life Cycles** Overview of major parasitic groups: Protozoa, Platyhelminthes, Nematodes, Arthropods; Life cycle patterns of parasites (Direct vs. indirect life cycles, complex life cycles) **Transmission strategies:** Vectors, environmental transmission, host manipulation **Host-parasite interactions:** Immune evasion, host immune responses, co-evolutionary dynamics	**16**

III	**Pathogenesis, Diagnosis, and Control** **Pathological effects:** Mechanisms of pathogenesis, chronic vs. acute infections, immunopathology Methods of parasite identification: Microscopy, serology, molecular techniques, point of care diagnostics Control strategies: Chemotherapy, vaccines, biological control, public health measures Case studies of significant parasitic diseases (e.g., malaria, schistosomiasis, emerging diseases)	**16**
IV	**Host-Parasite Dynamics** Co-evolution of parasites and hosts; Impact of climate change on parasitic diseases (Range shifts, vector-borne diseases, predictive modeling, case studies); Drug resistance in parasites. **Ethical and ecological aspects of parasite management**: Ethical dilemmas, ecological impact, sustainable strategies; Host behavior manipulation	**16**
Total		**64**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
80 hrs	**-**	**40 hrs** Field Visit to Veterinary or Public Health Lab, Case Study Analysis on Parasitic Diseases, Project on Emerging Parasitic Diseases, Field work, Assignment, seminar, quiz

Textbooks:

1. Roberts, L., Janovy, J. and Adler, S. (2015). Foundations of Parasitology. 10th Edition. McGraw-Hill.
2. Gunn, A. and Pitt, S. J. (2012). Parasitology: An Integrated Approach. John Wiley & Sons, Ltd
3. Garcia, M. S. (2007). Diagnostic Medical Parasitology. ASM Press
4. Cox, F.E.G. (2002). Modern Parasitology: A Textbook of Parasitology. 2nd Edition. Wiley-Blackwell.

References:

1. Elsheikha H. M. and Jarroll E. L. (2017). Illustrated Dictionary of Parasitology in the Post-Genomic Era. Caister Academic Press
2. Clark C. G., Johnson P. J. and Adam R. D. (2010). Anaerobic Parasitic Protozoa: Genomics and Molecular Biology. Caister Academic Press
3. Poulin, R. (2007). Evolutionary Ecology of Parasites. 2nd Edition. Princeton University Press.

Subject Name: Molecular Biology

Course Code: Major **Subject Code:** ZOO142M601

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objectives:

This course introduces undergraduate students to the fundamental principles of molecular biology, including nucleic acid structure, DNA replication, gene expression, and protein synthesis. It emphasizes the mechanisms of transcription, translation, gene regulation, and DNA repair, providing students with essential knowledge to understand molecular processes governing cellular functions and genetic inheritance.

Learning Outcomes:

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Recall and describe the fundamental concepts of DNA and RNA structure, nucleosome organization, and the process of DNA replication	BT1
CO2	Explain the mechanisms of mutations, DNA repair, chromatin remodelling, and their role in gene regulation.	BT2
CO3	Apply knowledge of transcription, post-transcriptional modifications, and gene regulation to interpret molecular processes in prokaryotes and eukaryotes.	BT3
CO4	Analyse the translation process, including the genetic code, ribosomal function, post-translational modifications, and regulation of protein synthesis.	BT4

Detailed syllabus

Module	**Course content**	**Teaching hours**
Module 1	**Historical Perspective:** Discovery of DNA as genetic material (Griffith's experiment, Avery-Macleod-McCarty experiment, Hershey-Chase experiment). **DNA and RNA Structure:** Chemical composition and double-helical structure of DNA (Watson and Crick model). Types of RNA (mRNA, tRNA, rRNA) and their roles. **Chromatin Organization in Prokaryotes and Eukaryotes:** Packaging of DNA: Nucleosomes, histones, euchromatin, heterochromatin.	16

	DNA Replication: Semi-conservative replication (Meselson-Stahl experiment). Enzymes involved in replication (DNA polymerases, helicases, ligases). Prokaryotic vs. eukaryotic replication.	
Module 2	**Mutations and Their Types:** Point mutations, frameshift mutations, silent, missense, and nonsense mutations. Causes of mutations: Spontaneous vs. induced mutations. **DNA Damage and Repair Mechanisms:** Base excision repair, nucleotide excision repair, mismatch repair. **DNA -binding proteins:** Transcription factors, nucleases, histones**.** **Epigenetic modifications:** Histone acetylation, methylation, and chromatin remodelling. Role of chromatin structure in gene regulation.	16
Module 3	**Transcription in Prokaryotes and Eukaryotes:** RNA polymerase and promoter recognition. Initiation, elongation, and termination of transcription. **Post-Transcriptional Modifications:** RNA splicing (introns and exons), alternative splicing. 5' capping and 3' polyadenylation in eukaryotes. **Regulation of Gene Expression:** Operon concept: Lac operon and Trp operon. Transcription factors and enhancers in eukaryotic gene regulation.	16
Module 4	**Genetic Code:** Properties and significance (degeneracy, wobble hypothesis). Ribosome Structure and Function in Prokaryotes and Eukaryotes. **Process of Translation:** Initiation, elongation, and termination. Role of tRNA, rRNA, and ribosomes. **Post-Translational Modifications:** Protein folding and chaperones. Protein degradation (Ubiquitin-proteasome system). **Regulation of Translation:** Role of microRNAs and RNA interference (RNAi).	16
	Total	64

Text Books:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R. (2017). *Molecular Biology of the Gene*. 7th Ed., Pearson
2. Lodish H, Berk A, Kaiser C.A, Krieger M, Bretscher A, Ploegh H, Amon A, Martin K.C (2016). *Molecular Cell Biology*, 8th Ed, W. H. Freeman.

Reference Books:

1. Malacinski, G.M. (2017). *Essentials of Molecular Biology*. 4th Ed., Jones & Bartlett Learning.

2. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.

Subject Name: Biotechnology
Course Code: Major **Subject Code:** ZOO142M602
L-T-P-C: 3-1-0-4
Credit Units: 4
Scheme of Evaluation: Theory

Course Objectives:

The objectives of the B.Sc. Biotechnology programme are to empower the students from the basics of interdisciplinary life-sciences to the recent trends in Biotechnology and its applications for the benefit of the society.

Learning Outcomes:

Upon successful completion of this course, students are able to:

Course Outcome		Bloom's Taxonomy Level (BT)
CO1	Define various terminologies that are frequently used in the field of biotechnology and also be able to demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology and molecular biology.	BT2
CO2	Implement their understanding to decode deeper concepts of biotechnological techniques like identification and isolation of DNA.	BT3
CO3	Analyse and apply various genetical tools that are largely in practice in gene cloning and DNA manipulation.	BT4
CO4	Explain the various techniques used in biotechnology for innovation and research	BT5

Detailed syllabus

Module	Course content	Teaching hours
Module 1	**INTRODUCTION TO BIOTECHNOLOGY:** Definition and scope of biotechnology; Plants, animals and microbial biotechnology, industrial biotechnology, environmental biotechnology and pharmaceutical biotechnology. Recent advancements in biotechnological research.	16
Module 2	**ISOLATION & IDENTIFICATION OF GENES:** Isolation of DNA: From plant, animal and bacterial sources.	16

	Methods for obtaining a clone of a specific gene, Methods for screening of clone identification.	
Module 3	**MOLECULAR GENETIC TOOLS:** **Restriction enzymes:** Type I, II and III, Mode of action of RE; Cohesive and blunt end restriction, Isoschizomers. Ligases, T4 kinase, Dnase-I, RNase H. **Cloning vectors:** Plasmids; Nature and properties, pUC18, pUC8, pBR322. Bacteriophages; Properties and infection cycles, M13 and High-capacity vectors (BAC, YAC), Marker genes. Gene transfer techniques.	16
Module 4	**TECHNIQUES USED IN BIOTECHNOLOGY:** **Chromatography:** Paper, TLC, Column, Affinity, Ion exchange and HPLC (High performance liquid chromatography). **PCR and its type:** Multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR. **Electrophoresis:** Agarose gel electrophoresis, SDS-PAGE, 1-D & 2-D gel electrophoresis, capillary electrophoresis and isoelectric focusing. **Blotting technique:** Southern, Northern, Western blotting and hybridization.	16
	Total	64

Text Books:

4. Brown T. A (2020). Gene Cloning and DNA Analysis: An Introduction. 8th Ed, Wiley-Blackwell.
5. Primrose S. B and Twyman R (2006). Principles of Gene Manipulation and Genomics. 7th Ed, Blackwell Publishing.
6. Glick B. R, Pasternak J. J and Patten C. L (2009). Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Ed, ASM Press.

References:

4. Brown T. A (2018). Genome 4. 4th Ed, Garland Science.
5. Sambrook J and Russell D. W (2001). Molecular Cloning: A Laboratory Manual. 3rd Ed, CSHL Press.
6. Saferstein R (2021). Criminalistics: Introduction to Forensic Science. 13th Ed, Pearson.

Subject Name: Ecology

Course Code: Major **Subject Code:** ZOO142M603

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objective: This Ecology course aims to equip students with a robust understanding of ecological principles, enabling them to analyze ecosystem dynamics

and apply ecological theories to solve environmental issues. Students will learn to critically evaluate human impacts, design ecological investigations, and communicate findings effectively. Emphasizing biodiversity and sustainable management, the course fosters a holistic understanding of ecological systems.

Course Outcomes:

On completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall the factors to drive the ecosystem	BT 1
CO 2	Understand basic concepts of ecological principles	BT 2
CO 3	Apply principles of ecology to understand the functioning of ecosystem	BT 3
CO 4	Analyze the role of ecosystem dynamics to solve environmental issues	BT 4

Detailed syllabus:

Modules	Course content	Periods
I	**Fundamentals of Ecology:** • Introduction to Ecology: Definitions, scope, and history. • Levels of Ecological Organization: Individual, population, community, ecosystem, and biosphere. • Basic Ecological Principles: Limiting factors, carrying capacity, and ecological niches. • Biogeochemical Cycles: Carbon, nitrogen, and water cycles.	**16**
II	**Population and Community Dynamics:** • Population Ecology: Characteristics of population, Growth models (exponential and logistic), age structure, and population regulation. • Interactions within Communities: Competition, predation, parasitism, and mutualism. • Community Structure and Dynamics: Succession, species diversity, and food webs. • Ecosystem Energy Flow: Primary and secondary productivity, trophic levels, and ecological pyramids.	**16**

III	**Applied Ecology and Conservation:** • Hotspots of biodiversity and its importance in conservation. • Conservation and Environmental Policy in Ecology: Focuses on climate change impacts, roles of IUCN, WWF, WTI key conservation laws, and community-based biodiversity management through BMCs under the Biodiversity Act. Ecological Restoration: Methods and case studies.	**16**
IV	**Advanced Applications and Applied Level Ecology:** • Landscape Ecology: Spatial patterns and processes, species distribution models. • Ecotoxicology and Data Analysis: Effects of pollutants on ecosystems and ecological risk assessment. • Sustainable Resource Management: Scared groves, challenges of urban ecology and sustainable urban planning. • Biodiversity: importance, threats, conservation strategies (in-situ, ex-situ) in protected areas of Northeast India.	**16**
Total		**64**

Credit Distribution		
Lecture/ Tutorial	**Practicum**	**EL**
64 hrs	**-**	**56 hrs** Field visit to natural sites for documentation of local flora and fauna, case study analysis on wildlife conservation, project on visit to, field work, assignment, seminar, quiz

Textbooks:

1. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of ecology. Cengage Learning.
2. Sharma, P. D. (2010). Ecology and environment. Rastogi Publications.
3. Smith, R. L., & Smith, T. M. (2015). Elements of ecology. Pearson.
4. Krebs, C. J. (Various Editions). Ecological Methodology. A classic text covering many fundamental ecological sampling and analysis techniques.
5. Kormondy E.J& Edward J (2017). Concepts of Ecology, 4th Ed. Pearson Education.

References:

1. Barrick, Barrett and Odum (2005). Fundamentals of Ecology. 5th Ed, Cengage Publication.
2. Alcock, J. (Various Editions). Animal Behavior: An Evolutionary Approach. A standard textbook on animal behavior.

Semester-VI
Subject Name: Molecular Biology, Biotechnology and Ecology (Practical) **Course Code: Major** **Subject Code:** ZOO142M611 **L-T-P-C**: 0-0-8-4 **Credit Units:** 4 Scheme of Evaluation: Practical

Course Objective: This course introduces students to Utilize ecological principles in field studies, collect, analyze, and interpret data, assess environmental impact on biotic communities, and develop skills in ecological research and conservation.

Course Outcomes:
On completion of the course the students will be able to:

Course Outcome	Course Outcome	Bloom's Taxonomy Level
CO 1	Recall the basic principles and terminology related to molecular biology, biotechnology, and ecological techniques	BT 1
CO 2	Explain the working principles and purposes of techniques like DNA extraction, microbial culture, and ecological sampling.	BT 2
CO 3	Apply standard laboratory protocols to conduct experiments such as gel electrophoresis, bacterial transformation, and biodiversity assessment.	BT 3
CO 4	Analyze experimental data obtained from molecular, biotechnological, and ecological practicals to draw valid conclusions	BT 4

Detailed syllabus:

Modules	Course content	Periods
I	1. Isolation of genomic DNA from plant leaves (e.g., spinach, banana) or animal tissues (e.g., chicken liver). 2. Determination of the concentration and purity of isolated DNA using a spectrophotometer 3. Separation of DNA fragments based on size using agarose gel electrophoresis. 4. Amplification of a specific DNA fragment using PCR	**30**

II	1. Preparation of agarose and polyacrylamide gel. 2. Isolation of DNA from human blood. 3. Separation of mixtures of amino acid by Paper chromatography. 4. Demonstration of preparation of wine from fruit juice.	**30**
III	1. Introduction to ecological sampling methods and experimental design. 2. Use of basic ecological tools (quadrat, transect, compass, GPS). 3. Field observation and documentation of local habitats and their characteristic flora and fauna using various traps and methods. 4. Using citizen science apps (iNaturalist, Indian Biodiversity Portal) to collect and identify species in the field and contribute to biodiversity databases.	**30**
IV	1. Calculation of diversity indices (Shannon-Wiener, Simpson's) for plant and/or animal communities. 2. Analysis of physiochemical properties (pH, dissolved oxygen, carbon dioxide) of water/soil. 3. Mapping of a local area using GPS and Google Earth to understand application in wildlife conservation. 4. Design of a small-scale ecological restoration project for a degraded area.	**30**
Total		**120**

Semester-VI
Subject Name: Entomology **Course Code: Minor** **Subject Code:** ZOO142N601 **L-T-P-C**: 3-1-0-4 **Credit Units:** 4 Scheme of Evaluation: Theory

Course Objectives:

Equip students with knowledge and hands-on experience in classical and modern research tools and techniques used in biosystematics and taxonomy across multiple domains.

Learning Outcomes:

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

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Understand principles of insect classification to identify insects up to the order level with examples.	BT2
CO2	Apply knowledge of vector-borne diseases to explain the methods of transmission of parasitic agents by insect vectors, with special reference to mosquitoes and	BT3

	houseflies.	
CO3	Analyze the biology and management of beneficial insects such as honey bees, silk worms and lac insects.	BT4
CO4	Apply principles and methods of pest suppression, including natural, cultural, mechanical, physical, chemical, and biological methods.	BT5

Detailed syllabus

Module	Course content	Teaching hours
Module 1	**Introduction and Insect Morphology** Definition and scope of entomology; Classification of insects up to order with examples; External anatomy: Head, thorax, abdomen; Insect mouthparts, wings, and legs; Sensory organs and their functions	16
Module 2	**Overview on beneficial insects** Beneficial insects; Importance of beneficial insects in ecosystems; Overview of ecosystem services provided by beneficial insects; Pollinators: Bees, butterflies, moths, beetles, and flies; Decomposers: Beetles, flies, ants, and termites; Economically important insects viz honey bee, lac insects and silkworms	16
Module 3	**Types of Injuries and Loss Caused to Plants** Direct Injury: Feeding on leaves, stems, roots, and fruits, causing physical damage. Examples: Chewing insects (caterpillars, beetles), sucking insects (aphids, whiteflies); Indirect Injury: Transmission of diseases such as bacterial, viral, or fungal infections. Examples: Aphids transmitting viral diseases, beetles spreading bacterial wilt; Factors Governing the Outbreak of Pests; Principles and Methods of Pest Suppression: Natural, Cultural, mechanical, physical, chemical, biological and IPM.	16
Module 4	**Insects as vectors** Transmission processes, diseases transmitted and key species of Mosquitoes and houseflies. Other lesser-known Insect Vectors (Fleas, ticks and sand flies) and their role in disease transimission.	16
	Total	64

Textbooks:

1. Entomology and Pest Management by Larry P. Pedigo, Marlin E. Rice, and Rayda K. Krell
2. Insect Pest Management by David Dent

Reference Books:

1. Pest and Vector Control by H. F. van Emden and M. W. Service
2. The Biology of Disease Vectors edited by B. J. Beaty and W. C. Marquardt

Subject Name: Genetics and Genomics

Course Code: Major **Subject Code:** ZOO142M701

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objective:

This course is an introduction of the basic genetics concepts that permeate several other fields in the biological sciences from biochemistry to cell biology.

Course Outcomes: On completion of this course students will be able to:

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Identify and summarize the concept of gene & gene interaction, and sex- linked inheritance	BT1 & BT2
CO2	Interpret the understanding of topics like mutations, eugenics, genetic counselling, euthenics, euphenics and gene regulation, cytoplasmic inheritance in animals	BT3
CO3	Develop the knowledge of how the genome is transcriptionally regulated (genetically and epigenetically) to yield genetic variation at the level of the phenotype.	BT4

Detailed Syllabus:

Modules	**Course Contents**	**Periods**
I	**Mendelian Genetics and its Extension:** Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Isoallele (White eye mutations), Pseudoallele (Lozenge Locus) & Cis-trans test for allelism, Lethal alleles, Pleiotropy, Penetrance & Expressivity	**12**
II	**Linkage, Crossing Over and Linkage Mapping**: Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence Sex linkage in Drosophila (White eye locus) & Human (Haemophilia), Sex chromosome systems: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types, Genetic disorders, Genetic counselling	**12**
III	**Mutations:** Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example from Drosophila and Human of each), variation in chromosome number; Nondisjunction of X chromosome in Drosophila; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in	**12**

	Drosophila by attached X method. Biochemical mutation detection in Neurospora.	
\IV	**Sex Determination & Extrachromosomal Inheritance** Mechanisms of sex determination in Drosophila and in man; Dosage compensation in Drosophila & Human, Kappa particle in Paramoecium, Shell spiralling in snail. Quantitative and multifactor inheritance, Transgressive variations, Heterosis.	**12**
TOTAL		**48**

Textbooks:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2017). IX ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2019). Principles of Genetics. VIII Edition. John Wiley and Sons Inc.

Reference Books:

1. Russell, P. J. (2018). Genetics- A Molecular Approach. VIII Edition. Benjamin Cummings.
2. Glick, B.R., Pasternak, J.J. (2017). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Subject Name: Immunology

Course Code: Major **Subject Code:** ZOO142M702

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objectives:

To help students develop skills necessary for critical analysis of essential elements of the immune system related to health and disease and molecular as well as cellular components and pathways that protect an organism from infectious agents or cancer, also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology.

Course Outcomes:

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Recall various concepts of immune system and related terminologies necessary to understand the course	BT1
CO2	Explain the various mechanisms of immune cell responses and necessary activation of various arms of immune system	BT2
CO3	Apply properly acquired knowledge to interpret the cross talk	BT3

	between various pathways of immune action.	
CO4	Analyze the roles of cytokines and other chemical messengers in the proper regulation of immune action	BT4

Course Outline:

MODULE	TOPICS/COURSE CONTENT	PERIODS
I	**Overview of the immune system:** Components of the immune system, principles of innate and adaptive immunity, antigen and immunogenicity, haptens, clonal selection theory; Evolution of immune system. Antigen recognition by immune cells: Innate Immunity- Pattern recognition in the innate immune system, TLRs and their role in innate immune response. Adaptive immunity-Antibody structure, antigen-antibody interaction, monoclonal antibodies, hybridoma technology, antigen recognition by B lymphocytes; Molecular mechanism behind BCR formation; B lymphocyte development and survival	16
II	**MHC and T cell Receptors:** Structure and function of MHC complex: antigen processing cells, antigen processing and presentation to T lymphocytes, MHC restriction. TCR structure and function: T-cell receptor gene rearrangement; T lymphocyte development and survival; Antigen recognition by T-cells, signaling through TCR and T-cell activation, co- receptors and their role in T –cell functioning; co-stimulation.	16
III	**Effector mechanisms and Regulation of immune responses**: Induced innate response to infection, Innate memory, Complement system, NK and NKT cell functions, Humoral immune response, Production of effector T- cells, cytotoxic T- cell effector mechanisms. Regulation of immune response: Leukocyte activation and migration, Cytokines, innate regulation of the immune response, T-cell mediated regulation of immune response, Immunological tolerance. Mucosal immunity.	16
IV	**Immunity in health and disease:**Allergy and hypersensitivity, Autoimmunity, Immunodeficiency diseases, Immunity and Infection, Tumour-immunology, Immunotherapy, Transplantation, Vaccines. **Techniques Related to Immunology:**Radial Immunodiffusion, RIA, ELISA, Immunoelectrophoresis, Immunofluroscence, rocket immunoelectrophoresis.	16
	TOTAL	64

Text Books:

1. Paul W.E (2013). Fundamentals of Immunology.7th Ed, Lippincott Williams & Wilkins Publishing.
2. Murphy K.P (2012). Janeway's immunobiology. 8th Ed, Garland Science

References:

1. Owen J.A, Punt J, Stranford S.A, Jones P.P. (2013). Kuby Immunology. 7th Ed, W.H.Freeman.
2. Delves P.J, Martin S.J, Burton D.R and Roitt I.M (2011). Roitt's Essential Immunology. 13th Ed, Wiley-Blackwell.
3. Coico R and Sunshine G (2015). Immunology: A Short Course. 7th Ed, Wiley-Blackwell.
4. Abbas A.K, Lichtman A.H and Pillai S (2018). Cellular and Molecular Immunology. 9th Ed, Elsevier.

Subject Name: Biostatistics and Bioinformatics

Course Code: Major **Subject Code:** ZOO142M703

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objectives:

To impart knowledge to students on the most important skill which is required to use computer programs for the daily design of experiments, data collection, and analysis of results as well as hands on practical exercises on various computer programming.

Course Outcomes:

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Understand basic concept of biostatistics and various biological databases that can be used to arrange and analyze biological data	BT2
CO2	Apply knowledge to evaluate various sequence analysis and alignment techniques of bioinformatics to construct phylogenetic tree	BT3
CO3	Analyze the role of structural bioinformatics in drug designing	BT4

Detailed syllabus

MODULE	**TOPICS/COURSECONTENT**	**PERIODS**
I	**Biostatistics-** population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, mean, median, mode, quartiles and percentiles, variance, standard deviation,	12

	Coefficient of variation.	
II	**Probability -** definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples- poisson and normal distributions. Bivariate distribution-correlation coefficient, regression equation **Test of significance**-chi-square test for independence of attributes	12
III	**Basics of bioinformatics:** Definition, Scope and Goal, Application in Computational Biology, Limitations. **Biological Database:** Types of databases, biological database: GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, Literature databases PubMed; Webtools: ExPASy server **Sequence Analysis and Sequence Alignment**: Basic concepts of sequence similarity, identity and homology, Basic concepts of sequence alignment, Uses of Sequence Alignment, Pairwise, multiple, Database Similarity search, **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, **Sequence similarity search:** BLAST and FASTA. **Molecular Phylogenetics:** Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Types of phylogenetic tree.	12
IV	**Structural bioinformatics:** proteins and its structure, Determination of protein 3-Dimensional structure, Protein structure visualization, comparision, Secondary and tertiary structure prediction, Chemiinformatics and Computer Aided Drug Designing (CADD): Introduction to cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Basics of medicinal chemistry. Drug targets, Drug solubility, Natural resources of lead compounds, Pharmacokinetics & drug metabolism	12
	TOTAL	48

Textbooks:

1. Le C. T and Eberly L. E (2016). Introductory Biostatistics. 2nd Ed, John Wiley & Sons.
2. Pagano M and Gauvreau K (2000). Principles of Biostatistics 2nd Ed, CRC Press.

References:

1. Mount D.W (2001). Bioinformatics: Sequence and Genome Analysis. 2nd Ed, Cold Spring Harbor Laboratory Press, New York, USA.
2. Krane D.E and Raymer M.L (2003). Fundamental concepts of bioinformatics. Benjamin Cummings.
3. ClaverieJ.M and Notredame C (2007). Bioinformatics for Dummies. 2nd Ed, WileyPublishing, Inc., New York, US.

Subject Name: Genetics and Genomics, Immunology, Biostatistics and Bioinformatics (Practical)

Course Code: Major **Subject Code:** ZOO142M711

L-T-P-C: 0-0-8-4

Credit Units: 4

Scheme of Evaluation: Practical

Course Objective

To provide the students basic understanding of genetics and genomics, immunology, biostatistics and bioinformatics.

Course Outcomes

CO	Course Outcome	Bloom's Taxonomy Level (BT)
CO1	Apply molecular and biotechnological tools to perform genetics and genomics experiments.	BT1
CO2	Apply lab-based tools to perform immunological experiments.	BT2
CO3	Apply knowledge of statistical software to design and analyze data.	BT3
CO4	Apply bioinformatics tool to construct phylogenetic tree.	BT4

Detailed syllabus

Modules	Course Contents	Periods
I	1. To study of karyotype of normal and aberrant metaphase plate of eukaryotes. 2. Detection of polytene chromosome in Chironomus larvae. 3. Calculation of genotype combination in dihybrid cross based on Mendelian genetics. 4. Meiotic chromosome preparation from rat/ grasshopper/ sandhopper testis.	**16**
II	5. Testing of ABO Blood group. 6. To test for Human Rh blood type. 7. Isolation of leucocytes from blood.	**16**
III	8. Analyzing biological data using statistical software to identify trends and patterns. 9. Designing and conducting statistical experiments to test hypotheses. 10. Interpreting statistical results and drawing conclusions.	**16**

IV	11. Using bioinformatics software to analyze DNA and protein sequences. 12. Construction of phylogenetic tree for DNA and Protein. 13. To study of web-based tools for sequence searches and homology screening.	**16**

Textbooks:

1. Amsath (2010). Practical Manual in Zoology.
2. Lal,S.S. (2016). Textbook of Practical Zoology,

References

1. Samal, Rout, Dasand Mohanty. (2014). Bioinformatics Practical Manual. Orissa University of Agriculture and Technology.
2. Baxevanis, A.D. (2010). Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins. Second Edition
3. PoddarT., Mukhopadhya S., Das S.K (2015) an advanced laboratory Manual of Zoology.

Subject Name: Ecology and Wildlife

Course Code: Major **Subject Code: ZOO142N701**

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objective:

This course aims to introduce undergraduate students to fundamental ecological principles and their application to wildlife conservation, with a special focus on the biodiversity and conservation challenges in Northeast India.

Course Outcomes: On completion of this course students will be able to:

CO	Course Outcome	Bloom's Taxonomy Level (BT)
CO1	Identify and summarize core ecological concepts and define key terms related to wildlife.	BT1
CO2	Identify and summarize core ecological concepts and define key terms related to wildlife.	BT2
CO3	Analyze and evaluate conservation strategies for wildlife, including those relevant to the unique ecosystems of Northeast India.	BT3
CO4	Develop case studies on ecological challenges and wildlife conservation efforts in Northeast India, proposing potential solutions and management plans.	BT4

Detailed Syllabus:

Modules	Course Contents	Periods
I	**Fundamentals of Ecology and Wildlife Introduction:** Definition and scope of ecology and wildlife biology. Levels of ecological organization (organism, population, community, ecosystem, biosphere). Key ecological concepts: habitat, niche, energy flow, food webs. Introduction to major wildlife groups and their ecological roles.	**12**
II	**Population and Community Ecology in Wildlife:** Population characteristics (density, dispersion, age structure, natality, mortality). Population growth models. Interspecific and intraspecific interactions (competition, predation, symbiosis) in wildlife communities. Understanding biodiversity and its significance for wildlife. Application of ecological principles to manage wildlife populations.	**12**
III	**Ecology of Conservation and Wildlife Management:** Threats to biodiversity and wildlife (habitat loss, fragmentation, climate change, poaching). Principles of wildlife conservation. In-situ and Ex-situ conservation approach; Wildlife management techniques: habitat restoration, translocation, captive breeding. Case studies of successful conservation initiatives for specific wildlife in Northeast India	**12**
\IV	**Applied Ecology and Wildlife Challenges in Northeast India:** Biodiversity hotspots; IUCN: CITES; WWF; Impact of human activities on wildlife and ecosystems in the region. Human- wildlife conflict (e.g., human-elephant conflict in Assam). Conservation challenges specific to endemic and endangered wildlife species of Northeast India.	**12**
TOTAL		**48**

Textbooks:

1. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of Ecology. Brooks Cole.
2. Sutherland, W. J., & Hill, D. A. (Eds.). (2010). Conservation Biology: Essential Readings. Wiley-Blackwell.

Reference Books:

3. Primack, R. B. (2010). Essentials of Conservation Biology. Sinauer Associates.
4. Das, A. (2007). The Mammals of Northeast India. WWF-India.
5. Choudhury, A. (2009). The Birds of Assam. Gibbon Books.
6. Gadgil, M., & Guha, R. (1992). This Fissured Land: An Ecological History of India. University of California Press.

Subject Name: Developmental Biology

Course Code: Major **Subject Code:** ZOO142M801

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objective:

To learn about heterogamy in eukaryotes, fertilization, biology of sex determinationand understand the process of fertilization and other assisted reproduction techniques

Course Outcomes:

CO	Course Outcome	Bloom's Taxonomy Level (BT)
CO1	Recall the basic concepts of spermatogenesis, oogenesis, fertilization and sex determination	BT1
CO2	Review the concepts of various fertilization events and identify the various techniques of In Vitro Fertilization.	BT2
CO3	Apply the knowledge of reproductive biology in understanding assisted reproductive technologies, generation of transgenic animals, contraceptive mechanisms and teratogenesis.	BT3
CO4	Analyze the various mechanisms of genetic and molecular regulation of gametogenesis and fertilization	BT4

Course Outline:

Modules	Course Contents	Periods
I	**Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development	16
II	**Oogenesis and fertilization** 1. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, 2. Collection and cryopreservation of gametes and embryos,	16

	3. Ovarian follicular growth and differentiation, Oogenesis and vitellogenesis, Ovulation and ovum transport in mammals	
III	**Early development:** Cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. **Morphogenesis and organogenesis in animals :** Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.	16
IV	1. Multiple ovulation and embryo transfer technology (MOET), In vitro oocyte maturation, Superovulation, In vitro fertilization, 2. Transgenic animals and knock-outs, Production, Applications, Embryonic stems cells. 3. Assisted reproduction technologies, Embryo sexing and cloning Screening for genetic disorders, ICSI, GIFT etc., Cloning of animals by nuclear transfer, Teratological effects of Xenobiotics, 4. Immunocontraception, Gamete specific antigens, Antibody mediated fertilization block and termination of gestation. Other contraceptive technologies, Surgical methods, Hormonal methods, Physical barriers, IUCD	16
TOTAL		64

Textbooks:

1. Gilbert S.F &Barresi M.J.F (2016). Developmental Biology. 11th Ed, Sinauer Associates.
2. Slack J.M.W (2012). Essential Developmental Biology. 3rd Ed, Wiley-Blackwell.

References:

1. Wolpert L (2002). Principles of Development. 2nd Ed, Oxford University Press.
2. Carlson B.M (2018). Human Embryology & Developmental Biology. 6th Ed, Elsevier, Inc.

Subject Name: Research Methodology

Course Code: Minor **Subject Code:** ZOO142N801

L-T-P-C: 3-1-0-4

Credit Units: 4

Scheme of Evaluation: Theory

Course Objectives: To equip students with the knowledge and skills to plan, design, execute, and interpret research studies—from selecting research problems to applying research

designs, sampling, data collection, and statistical analysis (including hypothesis testing and multivariate analysis)—and to produce clear, well-structured research reports.

Learning Outcomes:

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

Course Outcome		**Bloom's Taxonomy Level (BT)**
CO1	Recall fundamental concepts of research, including research problem identification, research design, sampling techniques, and data collection methods.	BT1
CO2	Explain the importance of research design, the role of sampling, and statistical methods in processing, analyzing, and interpreting research data	BT2
CO3	Apply appropriate data collection methods, statistical tools (e.g., Chi-square, ANOVA), and hypothesis testing techniques to solve research problems.	BT3
CO4	Analyze research findings using parametric and non-parametric tests, multivariate techniques, and report writing principles to generate meaningful insights and conclusions	BT4

Detailed syllabus

Module	**Course content**	**Teaching hours**
Module 1	Defining the Research problem- What is a research problem? Selecting the problem Research Design- Need for a research design, Features of good research design, Types Sampling Design- Census and sample design, Steps in sample design, Characteristics of a good sample design,	08
Module 2	Collection of primary data- Observation Method, Interview Method, Questionnaires Secondary data: Types, Limitations, Selection of appropriate method for data collection Processing and analysis of data. Sampling fundamentals.	08
Module 3	Role of statistics in research, Processing operations, Types of analysis, Measures of central tendency Sampling fundamentals- Need for sampling, Sampling concepts and principles	08
Module 4	Hypothesis: Procedure for Hypothesis testing. Multivariate Analysis technique: Characteristics and applications Interpretation and report writing: Why interpretation, Techniques and precautions; Significance of report writing, Different steps of report writing, Types of report, Precautions	08

	for writing research reports	

Text Books:

1. Research Methodology – Methods & Techniques 2 ed, Kothari C. R. – Vishwa Prakashan – New Delhi 1990.
2. Research Methodology: A Step-by-Step Guide for Beginners 2 ed, Kumar R. – Sage Publications – New Delhi 2011.

References:

1. The Craft of Research 3 ed, Booth W. C., Colomb G. G., Williams J. M. – University of Chicago Press – Chicago 2008.
2. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches 4 ed, Creswell J. W. – Sage Publications – Thousand Oaks 2018.