

**LEARNING OUTCOMES BASED
CURRICULUM FRAMEWORK (LOCF) FOR
UNDERGRADUATE PROGRAMMES**

(BSc Advanced Zoology and Biotechnology)

Effective from June 2024

**Department of Advanced Zoology and
Biotechnology**



**LOYOLA COLLEGE (AUTONOMOUS)
CHENNAI 600034**

PREFACE

Zoology, the scientific study of animals, is a crucial branch of biology that explores the structure, function, behavior, ecology, and evolution of animal life. Its importance extends far beyond academic curiosity, impacting multiple aspects of human life and the environment. Zoology helps in documenting and classifying the vast array of animal species on Earth, from the tiniest microorganisms to the largest mammals. Through understanding species' roles in ecosystems, zoology contributes to preserving endangered species and maintaining ecological balance.

Animals play critical roles in pollination, seed dispersal, nutrient cycling, and pest control, all of which are vital for healthy ecosystems. Zoology provides insights into zoonotic diseases and helps in developing vaccines and treatments. Research on animals like mice, fruit flies, and zebrafish provides models for studying human physiology, genetics, and diseases. Zoologists study the interactions between animals and their habitats, informing conservation strategies to protect ecosystems. Zoology helps understand how climate change affects animal populations and migrations, guiding global environmental policies. Knowledge of animal behavior and population dynamics supports sustainable practices in agriculture, forestry, and fisheries. Zoology provides evidence for the theory of evolution and reveals the interconnectedness of all life forms. Understanding animal behavior sheds light on human psychology and social structures. Zoology inspires students to pursue careers in science, technology, engineering, and mathematics by engaging with the natural world.

The **Learning Outcomes-Based Curriculum Framework (LOCF)** is an educational approach that prioritizes clear, measurable learning outcomes for students at every stage of their education. This framework is increasingly adopted worldwide to improve the relevance, quality, and efficiency of education systems. LOCF emphasizes what students are expected to know, do, and value by the end of a course or program. This clarity guides both teaching and learning. It ensures that all components of the curriculum—teaching methods, assessment, and learning resources—are aligned to achieve the desired outcomes. LOCF establishes consistent learning standards, ensuring that students achieve a defined level of competency regardless of where or how they study. By defining outcomes, educators, institutions, and policymakers can measure and demonstrate the effectiveness of educational programs. LOCF integrates skills such as critical thinking, problem-solving, teamwork, and communication into the curriculum, preparing students for the demands of the modern workplace. The framework aligns educational objectives with societal, economic, and technological advancements, ensuring graduates contribute meaningfully to their communities.

Integrating **Bloom's Taxonomy** into the **Learning Outcomes-Based Curriculum Framework (LOCF)** ensures a structured, student-centered, and outcomes-focused approach to education. It supports the development of cognitive, emotional, and practical skills, preparing students for academic, professional, and personal success. By fostering critical thinking, creativity, and lifelong learning, it contributes to building a dynamic and globally competitive education system. The 2024 UG Advanced Zoology and Biotechnology curriculum has been revised to focus on the above said priorities.

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VISION AND MISSION OF LOYOLA COLLEGE

VISION

Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity.

MISSION

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepare them for the future.
- To kindle in young minds the spirit of social and environmental justice with a blend of academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human Capital.

CORE VALUES

- Cura Personalis
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

VISION AND MISSION OF THE DEPARTMENT

VISION

To offer quality science education to inculcate respect for nature and human life and to promote scientific practices based on strong ethical principles.

MISSION

To introduce modern trends in life sciences emphasizing conservation.

To develop and hone skills of students to meet the local and global needs.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) (School of Life sciences)

PEO 1	Academic Excellence and Core Competency To provide access to quality education and enhance the core competencies in Life Sciences through training using modern tools and techniques.
PEO 2	Globally Relevant Curriculum and Learning Environment To constantly innovate and upgrade the curriculum and teaching methodologies to make Life Sciences teaching and learning relevant to the global context.
PEO 3	Effective Communication, Teamwork, and Leadership skills To provide an academic environment to students that is conducive to academic excellence, creativity, leadership, and life-long learning.
PEO 4	Environmental sustainability, social responsibility, and ethics To instill responsibility and concern towards environment, biodiversity, bioethics, and sustainable development into the curriculum of Life Sciences.
PEO 5	Skill Development, Entrepreneurship, and Lifelong learning To prioritize experiential learning through specialized professional skill training for a better career with a professional attitude.
PEO 6	Scientific temperament To kindle inquisitiveness and creativity to develop innovative protocols for solving issues related to the environment and conservation through research.

PROGRAMME OUTCOMES (POs)

(School of Life Sciences)

PO1	Disciplinary knowledge Students will apply the scientific knowledge acquired in Life Sciences and become skilled professionals adhering to the values of sustainable living.
PO2	Communication Skills, Teamwork and leadership qualities Students will enhance their communication skills to develop an attitude to work as a team and hone leadership qualities.
PO3	Critical thinking, problem solving, and analytical reasoning Students will demonstrate analytical reasoning, problem-solving, scientific reasoning, and reflective thinking as professionals in all frontiers of life sciences.
PO4	Research-related skills and Scientific reasoning Students will develop and popularize scientific temper to make conceptual contributions in life sciences and promote environmental consciousness.
PO5	Skill development, entrepreneurship and lifelong learning Students will develop skills, tools and techniques to explore prospective avenues of entrepreneurship in emerging areas of life sciences and pursue lifelong learning.
PO6	Environment and ethical awareness Students will understand and contextualize environmental and ethical issues and contribute towards the betterment of the environment and sustainable growth.
PO7	Digital literacy and self-directed learning Students will engage in self-paced and self-directed lifelong learning through digital literacy for personal development and professional accomplishment.

PROGRAMME SPECIFIC OUTCOMES (PSOs)
(Department of Advanced Zoology and Biotechnology)

PSO 1	Acquire knowledge about the diversity and distribution of animals and their interaction with the environment.
PSO 2	Understand the structural, functional and molecular properties of cells and organelles.
PSO 3	Realize the complexity of evolution, embryology, genetics, animal behaviour and bioethics.
PSO 4	To play an active role in the protection of the environment and biodiversity.
PSO 5	Understand the physiological processes and principles of genetics in the animal kingdom.
PSO 6	Perform laboratory procedures in biology and apply ethical principles
PSO 7	Acquire skills and necessary training to initiate start-ups in the realm of life sciences.

UG Advanced Zoology and Biotechnology Restructured LOCF curriculum (effective from June 2024)

PART	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	SEMESTER V	Economic Zoology: Internship (4 weeks during Christmas Holidays)	SEMESTER VI	HR	CR	
I	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)					12	12
II	General English (6h/3c)	General English (6h/3c)	General English (5h/3c)	General English (5h/3c)					22	12
III MC	Invertebrata I (4h/4c)	Chordata (4h/4c)	Cell Biology and Genetics (4h/4c)	Molecular Biology (4h/4c)	Immunology (4h/4c)			Environmental Biotechnology and Toxicology (5h/5c)	86	86
	Invertebrata II (4h/4c)	Embryology (4h/4c)	Animal Physiology (4h/4c)	Molecular Biology Lab (4h/4c)	Evolution and Animal Behaviour (4h/4c)		Environmental Biotechnology and Toxicology Lab (5h/5c)			
	Invertebrata Lab (4h/4c)	Chordata and Embryology Lab (4h/4c)	Cytogenetics and Animal Physiology Lab (4h/4c)		Animal Biotechnology (4h/4c)		Ecology and Wildlife Conservation (5h/5c)			
					Bioinformatics Lab (3h/3c)		Entomology (5h/5c)			
					Medical Laboratory Technology (3h/3c)					
					Medical Laboratory Technology Lab (4h/4c)					
AR	Plant Diversity (4h/2c)	Chemistry for Biology (4h/2c)							12	08
	Plant Diversity Lab course (2h/2c)	Chemistry Practical for Biology (2h/2c)								
AO			Biochemistry (3h/2c) /Applied Microbiology (3h/2c)	Food Chemistry (3h/2c) /Plant Biotechnology and Biostatistics (3h/2c)					10	06
			Biochemistry Lab course (2h/1c) /Applied Microbiology Lab course (2h/1c)	Food Chemistry Lab Course (2h/1c) / Plant Biotechnology and Biostatistics lab course (2h/1c)						
		MOOC/SS*	MOOC/SS*	MOOC/SS*	MOOC/SS*			SS*		
ME				3 courses available. 2 courses to be offered based on students' preference (4h/4c)	3 courses available. 2 courses to be offered based on students' preference (4h/4c)				08	08
RC					Research Methodology and Project (4h/4c)				04	04
MS/IN								Economic Zoology (6h/5c) Economic Zoology Lab (4h/3c) Internship (4c)	10	12
CD (BT/AT/ NME)			2 courses available. One course to be offered based on host department's choice (3h/2c)	2 courses available. One course to be offered based on host department's choice (3h/2c)				06	04	
FC	FC (3h/1c)	FC (3h/1c)	FC (2h/1c)	FC (2h/1c)				10	04	
CCA	CC	CC(1)							01	
ORA			OR	OR (2)					02	
Hr/C	30h/23c	30h /(23+1c)	30h/24c	30h/24c	30h/30c		30h/32c	180	159	

*Additional 1 Credit (Max. 4 courses in UG)

GL-General Language; GE-General English; MC-Major Core; AR-Allied Required; AO-Allied Optional; ME-Major Elective; MS-Major Skill; BT-Basic Tamil; AT-Advanced Tamil; NME-Non Major Elective; FC-Foundation Course; IN-Internship; SS-Self Study; CD-Cross Disciplinary; RC-Research and Competency Skill; MOOC-Massive Open Online Course; CC- Co-curricular Activities; OR-Outreach

Course Code	UAZ1MC01
Course Title	Invertebrata I
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	I
Regulation	2024

Course Overview

The course provides the foundational aspects of invertebrate zoology, emphasizing the classification, structure, and function of various invertebrate groups. It provides an in-depth understanding of Protozoa, Porifera, coelenterate, Platyhelminthes, and Annelida, focusing on their biological significance, ecological roles, and economic importance. The course explores host-parasite interactions, adaptations, and reproductive strategies in these organisms. It also highlights the evolutionary relationships and taxonomic status of invertebrates. This comprehensive approach equips students with the knowledge to analyze, classify, and evaluate the diversity and functionality of lower animals in different ecosystems.

Course Objectives

1. To understand the classification, structural organization, and biological significance of major invertebrate phyla, including Protozoa, Porifera, Coelenterate, Platyhelminthes, and annelida.
2. To explore the life cycles, host-parasite interactions, and clinical implications of protozoan and helminthic parasites in humans and other hosts.
3. To analyze the economic importance and ecological roles of sponges, corals, and other invertebrates, with a focus on biodiversity and adaptation.
4. To examine the evolutionary relationships and reproductive strategies among invertebrate taxa, highlighting their functional morphology and systemic adaptations.
5. To apply knowledge of invertebrate biology in understanding their impact on ecosystems and human health, fostering insights into conservation and sustainable utilization.

Prerequisites	Basic knowledge of animals and taxonomy.
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SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Phylum Protozoa: Basis of animal classification, Zoological nomenclature, taxonomy & systematics – Methods and Concepts, Levels of structural organization. General characters and classification of Protozoa up to classes. Type study – <i>Paramecium</i> and <i>Plasmodium</i> - Structure, life cycle and clinical significance of human protozoan Parasites and their diseases (<i>Entamoeba</i> , <i>Trypanasoma</i> & <i>Leishmania</i>). Nutrition in protozoa – Host parasitic interactions in <i>Entamoeba</i> and <i>Plasmodium</i> -Locomotion in protozoa.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

II	Phylum Porifera: General characters and classification up to classes. Structure, life cycle and biological significance of Ascon & Sycon - Canal system in sponges -Economic importance - Reproduction in sponges.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Phylum Coelenterata: General characters and classification up to classes – Type study - Structure, life cycle and biological significance of <i>Obelia</i> and <i>Aurelia</i> - Corals and coral reefs - Mesenteries in Anthozoa - Economic importance of corals and coral reefs - Polymorphism in Hydrozoa	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Platyhelminthes: General characters and classification of up to classes. Type study – <i>Fasciola hepatica</i> . Nematelminthes: <i>Taenia solium</i> – Parasitic adaptations. Host-parasitic interactions of Helminth parasites. Nematode Parasites and diseases - <i>Wuchereria bancrofti</i> , <i>Enterobius vermicularis</i> , <i>Ancylostome duodenale</i> . Aschelminthes: General characters and classification of up to classes - Type study - <i>Ascaris lumbricoides</i> . Nematode parasites of man	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Annelida: General characters and classification up to Classes. Detailed study – <i>Hirudinaria granulosa</i> . Nephridium and coelomoducts - Modes of life in Annelids. Connective links and evolutionary relationships among Taxa – up to Annelida.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan, (2016). A Manual of Zoology, Volume (I) Part (I), S. Viswanathan Printers and Publishers.
2. Jordan E.L. and Verma P.S (1995). Invertebrate Zoology, S. Chand & Co.
3. Kotpal R.L. (2019). Modern Text Book of Zoology, Invertebrates. Rastogi Publications.

Suggested Readings

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
6. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
7. Hyman L.H (1955). The invertebrates, Mc Graw Hill Book Co.
8. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.
9. Parker, J. and Haswell (1978). A text book of Zoology Vol. I - Williams and Williams.

10. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition.

Web Resources

Educational Platforms

1. The Invertebrate Zoology Course - University of California
<https://www.eeb.ucsc.edu/courses/>
2. Invertebrate Zoology – University of Toronto
<https://www.zo.utoronto.ca/>
3. National Geographic - Invertebrates
<https://www.nationalgeographic.com/animals/invertebrates/>
4. BBC Earth – Invertebrate Information
<https://www.bbcearth.com/>
5. Khan Academy – Biology (Invertebrate Overview)
<https://www.khanacademy.org/science/biology>

Research Databases and Journals

1. World Register of Marine Species (WoRMS)
<https://www.marinespecies.org>
2. The Invertebrate Taxonomy Database
<https://www.invertebrate.org>
3. Invertebrate Biology – Wiley Online Library
<https://onlinelibrary.wiley.com/journal/19321640>
4. Journal of Invertebrate Pathology
<https://www.journals.elsevier.com/journal-of-invertebrate-pathology>
5. BMC Invertebrate Biology
<https://bmcinvertebiol.biomedcentral.com/>

Specialized Resources

1. Invertebrate Zoology – The University of Kansas
<https://www.invertebratezoology.org>
2. Marine Invertebrate Animal Phylogeny – Tree of Life Web Project
<http://tolweb.org/tree/phylogeny.html>
3. The Smithsonian National Museum of Natural History – Invertebrates
<https://naturalhistory.si.edu/education/teaching-resources/invertebrates>
4. The British Arachnological Society (Arachnids)
<https://www.britishspiders.org.uk>
5. Invertebrate Conservation and Research Group (ICRG)
<https://www.invertebrateconservation.org>

Communities and Forums

1. ResearchGate – Invertebrate Biology
<https://www.researchgate.net>
2. Invertebrate Zoology Facebook Group
<https://www.facebook.com/groups/invertebrate.zoology>
3. Reddit – Invertebrates Subreddit
<https://www.reddit.com/r/Invertebrates/>

4. The Invertebrate Community of the UK (British Wildlife)
<https://www.britishwildlife.org/invertebrates>
5. BugGuide.net (Insects and Other Invertebrates)
<https://bugguide.net>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and recognize the distinguishing characteristics, structural organization, and biological significance of the invertebrate phyla Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, and Annelida and acquire foundational knowledge that enables them to classify and describe the evolutionary relationships, life processes, and ecological roles of these diverse groups of organisms.	K1, K2
CO2	Apply their understanding of biological concepts and analyze the structural, functional, and ecological differences among these invertebrate phyla. Through deeper exploration, students will develop the skills to compare the evolutionary advancements and interpret the significance of adaptations that allow these organisms to thrive in diverse environments.	K3, K4
CO3	Evaluate the evolutionary significance and functional complexities of these invertebrate phyla and create new insights or hypotheses regarding their biological roles, adaptations, and contributions to ecosystems. The course will empower students to engage in critical thinking, where they will synthesize knowledge across biological disciplines to formulate novel interpretations of the ecological and evolutionary trends within these phyla.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	1	3	3
CO2	3	2	3	3	1	3	3
CO3	3	2	3	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ1MC02
Course Title	Invertebrata II
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	I
Regulation	2024
Course Overview This course provides an in-depth overview of the invertebrate phyla Sipuncula, Echiuroidea, Pogonophora, Vestimentifera, Arthropoda, Bryozoa, Phoronida, Brachiopoda, Chaetognatha, Mollusca, and Echinodermata focusing on the morphology, classification, ecology, and evolutionary relationships. The students will explore the unique characteristics and adaptations of these groups, examining their roles in ecosystems. Emphasis will be placed on understanding their evolutionary significance, developmental biology, and how they contribute to the biodiversity and functioning of life.	
Course Objectives 1. To understand the anatomical features and classification of the invertebrate phyla Sipuncula, Echiuroidea, Pogonophora, Vestimentifera, Arthropoda, Bryozoa, Phoronida, Brachiopoda, Chaetognatha, Mollusca, and Echinodermata. 2. To analyze the ecological roles and functional adaptations of these groups, highlighting their environmental interactions and contributions to biodiversity. 3. To explore evolutionary relationships and developmental biology among the studied phyla, including the key innovations that have shaped their evolutionary history. 4. To develop skills in taxonomic identification and appreciate the importance of these invertebrates in marine research, conservation efforts, and ecological assessments.	
Prerequisites	Basic knowledge of animals and taxonomy.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Phylum: Sipunculina: General characters. Phylum: Bryozoa: General characteristics. Phylum: Phoronida: General characteristics. Phylum: Brachiopoda: General characteristics. Phylum: Chaetognatha: General organization of <i>Sagitta</i> .	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	General characters and classification of Phylum Mollusca up to Classes. Detailed study: <i>Pila globosa</i> . Foot and torsion in Mollusca, Economic importance of Molluscs – Cephalopoda as the most advanced invertebrate.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	General characters and classification of Phylum Echinodermata up to Classes. Detailed study: <i>Asterias</i> . Water	10	CO1 CO2	K1,K2,K3, K4,K5,K6

	vascular system in Echinodermata – Larval forms of Echinoderms.		CO3	
IV	Phylum: Mollusca: Classification up to Class. Type Study- Class: Gastropoda (<i>Pila globosa</i>). Classes: Monoplacophora (<i>Neopilina</i>), Amphineura (Chiton), Solenogastres and Scaphopoda (Dentalium)- General organization, Class: Pelecypoda (<i>Lamellidens marginalis</i>). Class: Cephalopoda (<i>Sepia</i>)- General organization.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Phylum: Echinodermata: Classification up to Class. Class: Crinoidea (Antedon)- General organization, Type study- Class: Asteroidea (Starfish). Class: Ophiuroidea- General characteristics, Class: Echinoidea (<i>Salmacis bicolor</i>)- General characters. Class: Holothuroidea- General characteristics.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan, (2019). Manual of Zoology (Volume I) (Part- 2) Invertebrata. Ananda Book Depot.
2. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I. (1989). Modern text book of Zoology, Rastogi Publications.
3. Srivastava, M. D. L and Srivastava, U. S, (1969). A text book of Invertebrate Zoology, Central Book Depot.
4. Verma, A (2005). Invertebrates: Protozoa to Echinodermata. Narosa Publishing House.

Suggested Readings

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
6. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
7. Hyman L.H (1955). The invertebrates, Mc Graw Hill Book Co.
8. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.
9. Parker, J. and Haswell (1978). A text book of Zoology Vol. I - Williams and Williams.
10. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition.

Web Resources

Educational Platforms

6. The Invertebrate Zoology Course - University of California
<https://www.eeb.ucsc.edu/courses/>
7. Invertebrate Zoology – University of Toronto
<https://www.zo.utoronto.ca/>
8. National Geographic - Invertebrates
<https://www.nationalgeographic.com/animals/invertebrates/>
9. BBC Earth – Invertebrate Information
<https://www.bbcearth.com/>
10. Khan Academy – Biology (Invertebrate Overview)
<https://www.khanacademy.org/science/biology>

Research Databases and Journals

6. World Register of Marine Species (WoRMS)
<https://www.marinespecies.org>
7. The Invertebrate Taxonomy Database
<https://www.invertebrate.org>
8. Invertebrate Biology – Wiley Online Library
<https://onlinelibrary.wiley.com/journal/19321640>
9. Journal of Invertebrate Pathology
<https://www.journals.elsevier.com/journal-of-invertebrate-pathology>
10. BMC Invertebrate Biology
<https://bmcinvertebiol.biomedcentral.com/>

Specialized Resources

6. Invertebrate Zoology – The University of Kansas
<https://www.invertebratezoology.org>
7. Marine Invertebrate Animal Phylogeny – Tree of Life Web Project
<http://tolweb.org/tree/phylogeny.html>
8. The Smithsonian National Museum of Natural History – Invertebrates
<https://naturalhistory.si.edu/education/teaching-resources/invertebrates>
9. The British Arachnological Society (Arachnids)
<https://www.britishspiders.org.uk>
10. Invertebrate Conservation and Research Group (ICRG)
<https://www.invertebrateconservation.org>

Communities and Forums

6. ResearchGate – Invertebrate Biology
<https://www.researchgate.net>
7. Invertebrate Zoology Facebook Group
<https://www.facebook.com/groups/invertebrate.zoology>
8. Reddit – Invertebrates Subreddit
<https://www.reddit.com/r/Invertebrates/>
9. The Invertebrate Community of the UK (British Wildlife)
<https://www.britishwildlife.org/invertebrates>

10. BugGuide.net (Insects and Other Invertebrates)

<https://bugguide.net>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and recall the fundamental anatomical structures, taxonomic classifications, and key characteristics of the invertebrate phyla Sipuncula, Echiuroidea, Pogonophora, Vestimentifera, Arthropoda, Bryozoa, Phoronida, Brachiopoda, Chaetognatha, Mollusca, and Echinodermata. They will be able to identify these groups based on their distinctive features and describe their ecological roles and evolutionary relationships. Additionally, students will distinguish between the various phyla, deepening their understanding of the biodiversity and invertebrate biology.	K1, K2
CO2	Apply their knowledge of these invertebrate phyla, to classify and categorize these organisms based on morphological, ecological, and evolutionary traits. They will analyze the functional adaptations and ecological roles of these groups and differentiate the key evolutionary developments that have shaped their diversity. Additionally, students will be able to interpret phylogenetic relationships among these invertebrate groups, integrating their knowledge into broader discussions on biodiversity and ecosystem functioning.	K3, K4
CO3	Evaluate the ecological significance and evolutionary importance of these invertebrates. They will synthesize their knowledge to create comprehensive assessments of the roles these organisms play in marine ecosystems, considering factors such as environmental impact, biodiversity, and conservation. Furthermore, students will design and propose research projects or conservation strategies aimed at addressing current challenges facing these invertebrate groups, demonstrating their ability to integrate theoretical concepts with practical applications. They will also be capable of formulating hypotheses regarding evolutionary trends and adaptations within these phyla, contributing to a deeper understanding of invertebrate biology and ecology.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	1	3	3
CO2	3	2	3	3	1	3	3
CO3	3	2	3	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ1MC03
Course Title	Invertebrata Lab
Credits	04
Hours/Week	04
Category	Major Core (MC) – Lab
Semester	I
Regulation	2024
Course Overview This course provides a hands-on exploration of invertebrate anatomy. Students will dissect various organisms like cockroaches, leeches, earthworms, snails, and prawns to understand their internal and external structures. They will also learn to prepare and mount specific anatomical parts for detailed observation. Additionally, the course will involve studying the mouthparts of insects and observing invertebrate specimens in a museum.	
Course Objectives 1. To dissect various invertebrates (cockroach, leech, earthworm, pila, and prawn) to understand their internal and external anatomy and identify and analyze the major organ systems in these organisms. 2. To prepare and mount specific anatomical parts (earthworm setae, pila radula, muscle ganglia, insect mouthparts) for microscopic examination and use microscopes to observe the detailed structure of these specimens. 3. To compare and contrast the anatomical features of different invertebrate groups and understand the evolutionary relationships between different invertebrate taxa. 4. To observe diverse invertebrate specimens in a museum and learn to identify different invertebrate groups based on their morphological characteristics.	
Prerequisites	Basic knowledge on invertebrate animals

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Major Dissection: Cockroach: Circulatory system, Nervous system, Reproductive system. Leech : Nervous System, Reproductive system. Earthworm: Nervous System, Reproductive system. <i>Pila globosa</i> : Nervous system. Prawn: Nervous system.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Minor Dissection: Cockroach: Digestive system. Earthworm: Viscera, Lateral hearts, <i>Pila globosa</i> : Digestive system (Including radula). Freshwater Mussel: Digestive system. Prawn- Appendages (Cephalic, Thoracic and Abdomen).	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Mounting: Earthworm: Body setae; Pineal setae. <i>Pila globosa</i> : Radula. Freshwater muscle: Pedal ganglia. Cockroach: Salivary apparatus & Mouth parts. Honey Bee,	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	House fly and Mosquito mouth parts.			
IV	Museum Specimen Study: Protozoa : <i>Amoeba</i> , <i>Euglena</i> , <i>Paramecium</i> , <i>Paramecium</i> conjugation, <i>Entamoeba</i> .. Porifera: Sycon, Spicules, Gemmule. Coelenterata: <i>Obelia</i> colony, <i>Physalia</i> , Sea anemone, Aurelia, Fungia, Meandrina, Tubipora. Platyhelminthes: <i>Fasciola</i> , Redia and Cercaria larva of <i>Fasciola</i> , Tapeworm, Scolex of Tapeworm. Nematelminthes: <i>Ascaris</i> : male and female, <i>Enterobius vermicularis</i> , <i>Wuchereria bancrofti</i> , <i>Ancylostoma duodenale</i> .	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Museum Specimen Study: Annelida : <i>Hirudinaria</i> , Nereis, Heteronereis, Parapodium of Nereis, Arthropoda: Millipede, Centipede, <i>Penaeus</i> , Nauplius and Zoea larva of <i>Penaeus</i> , <i>Peripatus</i> , Scorpion, <i>Limulus</i> . Mollusca : Fresh water mussel, Pearl oyster, <i>Chiton</i> , <i>Dentalium</i> , Sepia, Glochidium larva. Echinodermata: Starfish, Bipinnaria larva of Starfish, Pedicellaria, Sea cucumber, Sea urchin, Economically Important Insects: Honey bee, <i>Bombyx mori</i> , Termites, Silver fish, <i>Oryctes rhinoceros</i> , <i>Leucinodes orbonalis</i> , <i>Papilio demoleus</i> , <i>Sitophilus oryzae</i>	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan, (2016). A Manual of Zoology, Volume (I) Part (I), S. Viswanathan Printers and Publishers.
2. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan, (2019). Manual of Zoology (Volume I) (Part- 2) Invertebrata. Ananda Book Depot.
3. Ganguly, Sinha and Adhikari (2011). Biology of Animals: Volume I, New Central Book Agency.
4. Lal, S. S (2016) . Practical Zoology Invertebrate, Rastogi Publications.
5. Sinha, Chatterjee and Chattopadhyay (2014). Advanced Practical Zoology, Books & Allied Ltd.
6. Verma, P. S (2010). A Manual of Practical Zoology: Invertebrates, S Chand.

Suggested Readings

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
6. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University

Press.

7. Hyman L.H (1955). The invertebrates, Mc Graw Hill Book Co.
8. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.
9. Parker, J. and Haswell (1978). A text book of Zoology Vol. I - Williams and Williams.
10. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition.

Web Resources

Online Lab Courses and Educational Resources

1. Invertebrate Zoology – University of California, Santa Cruz
<https://www.eeb.ucsc.edu/courses/>
2. Invertebrate Zoology – University of Toronto (Lab Guides)
<https://www.zo.utoronto.ca/>
3. Virtual Invertebrate Lab – University of Arizona
<https://www.cals.arizona.edu/> (Search for invertebrate lab resources)
4. Invertebrate Zoology Lab Manual – University of Hawaii
<https://www.hawaii.edu> (Search for invertebrate courses)
5. Invertebrate Diversity and Lab Resources – University of Wisconsin
<https://www.zoology.wisc.edu/>

Interactive Resources & Virtual Labs

1. Invertebrate Virtual Lab – American Museum of Natural History
<https://www.amnh.org> (Search for invertebrate virtual labs)
2. Virtual Labs – Biology Project, University of Arizona
<http://www.biology.arizona.edu/>
3. BioMan Biology - Virtual Invertebrate Lab
<https://biomanbio.com>
4. Biology Corner – Invertebrate Lab Exercises
<https://www.biologycorner.com> (Search for invertebrate labs)
5. ExploreLearning Gizmos – Invertebrate Zoology Virtual Lab
<https://www.explorellearning.com>

Invertebrate Lab Tools & Resources

1. The Invertebrate Zoology Database – University of Kansas
<https://www.invertebratezoology.org>
2. Invertebrate Anatomy and Identification Resources – The Natural History Museum
<https://www.nhm.ac.uk> (Search for invertebrate lab resources)
3. The Invertebrate Collection – Smithsonian Institution
<https://naturalhistory.si.edu/> (Search for collections)
4. World Register of Marine Species (WoRMS)
<https://www.marinespecies.org>
5. The Tree of Life Web Project – Invertebrate Taxonomy and Phylogeny
<http://tolweb.org/tree/phylogeny.html>

Research Journals and Databases

1. Journal of Invertebrate Biology – Wiley Online Library
<https://onlinelibrary.wiley.com/journal/19321640>
2. BMC Invertebrate Biology
<https://bmcinvertebiol.biomedcentral.com/>
3. The Invertebrate Zoology Database – The University of Chicago
<https://www.uchicago.edu> (Search for invertebrate lab resources)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the external and internal anatomical features of various invertebrate organisms, including cockroaches, leeches, earthworms, snails, and prawns. Understand the functional significance of different anatomical structures and systems in invertebrates. Know the basic principles of microscopy and its applications in biological studies. Comprehend the diversity of invertebrate life forms and their ecological roles. Dissect various invertebrate organisms to identify and analyze their anatomical structures. Prepare and mount biological specimens (earthworm setae, pila radula, muscle ganglia, insect mouthparts) for detailed examination. Use microscopes to observe the detailed structure of invertebrate tissues and organs. Compare and contrast the anatomical features of different invertebrate groups. Identify invertebrate specimens in a museum collection based on their morphological characteristics. Use laboratory equipment and techniques to conduct dissections and microscopic observations. Interpret microscopic observations and experimental results to draw conclusions.	K1, K2
CO2	Analyze the evolutionary relationships between different invertebrate groups based on comparative anatomy. Compare and contrast the anatomical features of different invertebrate organisms to identify adaptations to specific environments. Interpret microscopic observations to understand the underlying cellular and tissue organization of invertebrate structures. Analyze the functional significance of different anatomical structures in relation to the lifestyle and behavior of invertebrates. Design and conduct independent laboratory experiments to investigate specific questions related to invertebrate biology. Integrate knowledge from different fields of biology (e.g., anatomy, physiology, ecology) to understand complex biological phenomena. Develop innovative approaches to studying invertebrate diversity and ecology. Communicate scientific findings effectively through written reports, oral presentations, and visual aids. Collaborate with peers to solve problems and conduct research projects.	K3, K4

CO3	Evaluate the limitations of traditional dissection techniques and propose innovative approaches. Critically assess the impact of human activities on invertebrate populations and ecosystems. Compare and contrast different methods for studying invertebrate diversity and ecology. Evaluate the ethical implications of research involving animals. Develop original research projects to investigate specific aspects of invertebrate biology. Design and conduct experiments to test hypotheses about invertebrate behavior and physiology. Create innovative tools and techniques for studying invertebrates. Contribute to the advancement of knowledge in invertebrate zoology through original research. Communicate scientific findings effectively to diverse audiences, including scientists, policymakers, and the public.	K5, K6
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ2MC01
Course Title	Chordata
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	II
Regulation	2024
Course Overview This course offers a comprehensive exploration of the vertebrate phyla Protochordates, Agnatha, Amphibia, Reptiles, Aves, and Mammals. Students will study the evolutionary history, anatomical features, ecological roles, and behavioral adaptations of these groups, examining how they have adapted to various environments over time. The students will gain a deeper understanding of the diversity, evolutionary relationships among the classes, and the implications on biodiversity.	
Course Objectives 1. To understand the evolutionary history and classification of Protochordates, Agnatha, Amphibia, Reptiles, Aves, and Mammals, including their unique anatomical features and adaptations. 2. To analyze the ecological roles and behavioral adaptations of these vertebrate groups within their respective environments, highlighting their interactions with other organisms. 3. To explore the physiological processes and developmental biology of each group, focusing on how these processes influence their survival and reproduction. 4. To evaluate the conservation status and challenges faced by these vertebrates, fostering an appreciation for biodiversity and the importance of protecting their habitats.	
Prerequisites	Basic knowledge on vertebrates.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Protochordates: General Characters and Classification of Phylum Chordata. Origin of Chordata. Type Study- Sub-Phylum: Cephalochordata (<i>Amphioxus lanceolatus</i>); Sub-Phylum: Urochordata (<i>Ascidia Sp.</i>); Sub-Phylum: Hemichordata (<i>Balanoglossus</i>). Affinities of Protochordates.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Agnatha: Type Study-Class: Cyclostomata (<i>Petromyzon</i>); Super Class: Pisces (<i>Scoliodon sorrakowah</i>). Origin of Fishes; Affinities of Dipnoi - Types of Scales and Fins - Accessory Respiratory Organs - Air Bladder - Parental Care - Migration - Economic Importance.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Amphibia: General Characters and Classification - Origin of Amphibia - Type Study - <i>Rana hexadactyla</i> - Adaptive Features	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	of Anura; Urodela and Apoda - Neoteny in Urodela - Parental Care in Amphibia. Effects of Terrestrialization			
IV	Reptiles: General Characters and Classification- Type Study- <i>Calotes versicolor</i> . Origin of Reptiles; Extinct Reptiles. Snakes of India. Poison Apparatus and Biting Mechanism of venomous Snakes- Skull in Reptiles as basis of classification	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Aves and Mammals : Aves: General Characters and Classification- Type Study- <i>Columba livia</i> - Origin of Birds; Flight Adaptations; Migration; Flightless birds. Mammalia: General Characters and Classification- Type Study- <i>Oryctolagus cuniculus</i> - Adaptive Radiation in Mammals- Egg Laying Mammals; Marsupials; Flying Mammals; Aquatic Mammals; Dentition in Mammals.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2019). Manual of Zoology (Volume II) (Part- 1) Chordata. S. Viswanathan (Printers & Publishers) Pvt. Ltd. 2. Ayyar, E.K. and T.N. Ananthakrishnan (1992). Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd. 3. Jordan, E.K. and P.S. Verma (1995). Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd. 4. Nigam, H.C (1983). Zoology of Chordates, Vishal Publications. 5. Jordan E.L, Verma P.S (2008). Chordate Zoology, S. Chand & Company Ltd. 6. Kotpal. R.L. A (2009). Modern text book of Zoology Vertebrates, Rastogi publications. 7. Ganguly, Sinha,. Bharati Goswami and Adhikari (2004). Biology of animals Vol.II - New central book Agency (p) Ltd.				
Suggested Readings 1. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill. 2. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press. 3. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill. 4. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press. 5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc. 6. Hickman, C.P. Jr., F.M.Hickman and L.S. Roberts (1984). Integrated Principles of Zoology, Times Merror/Mosby College Publication. 7. Newman, H.H. (1981). The Phylum Chordata, Satish Book Enterprise, Agra. 8. Parker and Haswell (1964). Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S. Publishers and Distributors.				

Web Resources

Educational Resources

1. Chordates Overview - Khan Academy
<https://www.khanacademy.org/science/biology>
(Search for chordates under the biology section)
2. Chordates - National Geographic
<https://www.nationalgeographic.com/animals/chordates/>
3. Chordate Biology - University of California, Berkeley
<https://ucmp.berkeley.edu/chordata/chordata.html>
4. BBC Bitesize – Chordates and Vertebrates
<https://www.bbc.co.uk/bitesize/>
(Search for chordates in the biology section)
5. Animal Diversity Web – Chordates
<https://animaldiversity.org/accounts/Chordata/>

Research Databases

1. Tree of Life Web Project – Chordates
<http://tolweb.org/Chordata>
2. Integrated Taxonomic Information System (ITIS)
<https://www.itis.gov/>
(Search for Chordata taxonomy)
3. Encyclopedia of Life (EOL) – Chordates
<https://eol.org/pages/204>
4. Global Biodiversity Information Facility (GBIF) – Chordates Data
<https://www.gbif.org/>
(Search for Chordata-related data)
5. FishBase (For Aquatic Chordates)
<https://www.fishbase.org>

Specialized Resources

1. The Vertebrate Anatomy Ontology
<https://www.ontobee.org/ontology/uberon>
2. Smithsonian National Museum of Natural History – Vertebrate Zoology
<https://naturalhistory.si.edu/research/vertebrate-zoology>
3. Chordate Evolution Resources – University of Chicago
<https://www.uchicago.edu>
(Search for chordate evolution studies)
4. Paleontology Portal – Fossil Chordates
<http://www.paleoportal.org/>
5. AmphibiaWeb (Chordate Amphibians)
<https://amphibiaweb.org/>

Interactive Learning and Communities

1. ResearchGate – Chordate Studies
<https://www.researchgate.net>
(Join discussions and access research papers on chordates)

2. Chordates Subreddit https://www.reddit.com/r/Chordates/
3. Biology Stack Exchange https://biology.stackexchange.com/ (Ask and answer questions related to chordates)
4. Arkive (Chordate Species) https://www.wildscreen.org/arkive/
5. iNaturalist – Observations of Chordates https://www.inaturalist.org/ (Explore global observations of chordate species)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the key anatomical and physiological features of Protochordates, Agnatha, Amphibia, Reptiles, Aves, and Mammals. They will recognize the fundamental classifications within these vertebrate groups and recount their evolutionary history, including significant adaptations that have enabled their survival in diverse environments. Additionally, students will be able to list the ecological roles these organisms play in their respective ecosystems, enhancing their understanding of vertebrate biodiversity and the interconnectedness of life forms.	K1, K2
CO2	Analyze the evolutionary relationships among Protochordates, Agnatha, Amphibia, Reptiles, Aves, and Mammals, highlighting the key morphological and physiological traits that distinguish each group. They will apply their understanding of ecological roles to evaluate the impact of these vertebrates on their environments and assess the significance of their adaptations for survival and reproduction. Additionally, students will be able to interpret physiological processes in these organisms, such as respiration, reproduction, and locomotion, and compare and contrast the life cycles and developmental strategies of different classes, deepening their appreciation for vertebrate diversity and evolutionary biology.	K3, K4
CO3	Evaluate the adaptive significance and ecological contributions of Protochordates, Agnatha, Amphibia, Reptiles, Aves, and Mammals, critically assessing how evolutionary processes have shaped their diversity and survival strategies. They will synthesize information from various sources to formulate comprehensive conservation strategies that address the threats facing these vertebrate groups, promoting biodiversity and ecosystem health. Furthermore, students will be able to design models demonstrating their ability to integrate theoretical knowledge with practical application. They will also create interdisciplinary frameworks that connect vertebrate evolution with	K5, K6

	contemporary issues such as climate change and habitat destruction, showcasing their understanding of the broader implications of vertebrate studies.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	2	3	3
CO2	3	2	3	3	2	3	3
CO3	3	2	3	3	2	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ2MC02
Course Title	Embryology
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	II
Regulation	2024
Course Overview This course will explore the fascinating world of developmental biology, covering topics such as early developmental events, morphogenesis, organogenesis, regeneration, biological immortality, and developmental issues. Students will gain insights into the intricate processes that shape the development of organisms from a single cell to a complex multicellular organism.	
Course Objectives 1. To understand the fundamental principles of early developmental events, including fertilization, cleavage, gastrulation, and neurulation. 2. To explore the processes of morphogenesis and organogenesis, including pattern formation, cell differentiation, and tissue development. 3. To analyze the mechanisms of regeneration and biological immortality in various organisms, and their implications for developmental biology and medicine. 4. To evaluate the impact of developmental issues, such as birth defects and aging, on human health and well-being. 5. To apply knowledge of developmental biology to address current research questions and challenges in the field.	
Prerequisites	Basic knowledge on Developmental biology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Early developmental events: History of embryology; Cell differentiation, commitment and aging; Oogenesis and Spermatogenesis. Fertilization in sea urchin and mammals; Cleavage patterns and planes. Characteristic features of embryonic stem cells.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Morphogenesis: Types of cell specification; Primary and secondary organizers, morphogens, embryonic induction, morphogenetic movements; Gastrulation in sea urchin, frog, birds and mammals; Importance of the germ layers; Construction and study of fate maps; Embryo implantation and placentation.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Organogenesis: Development of the nervous system, eye, ear, cardiovascular system, and limbs in vertebrates;	10	CO1 CO2	K1,K2,K3, K4,K5,K6

	Development of foetal membranes in vertebrates; Hormonal reactivation of development in metamorphosis.		CO3	
IV	Regeneration and biological immortality: Types of regeneration, role of adult stem cells in regeneration, regeneration in hydra, salamander limb regeneration, liver regeneration in humans; Regenerative medicine using stem cells; Induced pluripotency; Longevity and immortality in animals; Similarities between pluripotent embryonic cells and cancer cells.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Developmental Issues: Multiple births – cause and risks; Conjoined twins – cause, risks and treatment options; Infertility – types and causes; Assisted reproductive techniques – examples and procedure of IVF; Congenital malformation due to genetic, environmental and unknown causes. Preimplantation genetic diagnosis.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Kotpal, R. L. (2014). A text book of embryology (developmental zoology). Rastogi Publications.
2. Rastogi, V. K. (2021). Chordate embryology. Kedar Nath Ram Nath.
3. Singh, B. R. (2013). Chordate embryology. Rastogi Publications.
4. Subramoniam, T (2003). Developmental Biology, Narosa Publishing House, New Delhi, India.
5. Veer Bala Rastogi (2018). Chordate Embryology. Kedar Nath Ram Nath.
6. Verma, P. S., & Agarwal, V. K. (2014). Chordate embryology. S. Chand Publishing.
7. Verma, P.S., Agarwal, V. K.(2010). Chordate Embryology: Developmental Biology, S. Chand & Company, New Delhi., India.

Suggested Readings

1. Balinsky, B.I (1970). Introduction to Embryology, Philadelphia & London, UK.
2. Barresi, M. J. F., Gilbert, S. F (2020). Developmental Biology, Oxford University Press, USA.
3. Berril, N.J (1971). Developmental Biology, McGraw Hill, New York, USA.
4. Carlson, Bruce, M. 2009. Human embryology and Developmental Biology, Elsevier, Philadelphia, USA
5. Carlson, Bruce, M (2009). Human embryology and Developmental Biology, Elsevier, Philadelphia, USA.
6. Gerhart, J. et al. (1997) Cells, Embryos and Evolution. Blackwell Science.
7. Gilbert S.F (2010). Developmental Biology, Sinauer Associates, Massachusetts, USA.
8. Lewis Wolpert (2023). Principles of Development, 7th edition, Oxford University Press, New Delhi, India
9. Mishra, S. 2023. Langman's Medical Embryology, 2nd edition, Wolters Kluwer India Pvt Ltd, India.
10. Russ Hodge 2010. Developmental Biology, Facts on File, Inc., New York, USA.

11. Schoenwolf, G. C., Bleyl, S. B., Brauer, P. R., Francis-West, P. H. 2021. Larsen's Human Embryology. United States: Elsevier.
12. Slack, J. M. W., Dale, L (2021). Essential Developmental Biology, Wiley, UK.
13. Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press.

Web Resources

General Embryology Resources

1. Developmental Biology Online Textbook - NCBI Bookshelf
<https://www.ncbi.nlm.nih.gov/books/NBK9983/>
(Comprehensive resource on embryology, covering both invertebrates and vertebrates)
2. Virtual Human Embryo Project
<https://www.ehd.org/virtual-human-embryo/>
(Detailed models of vertebrate embryonic development)
3. Embryo Project Encyclopedia
<https://embryo.asu.edu/>
(History and concepts of embryology with examples from both invertebrates and vertebrates)
4. Biology Online – Embryology
<https://www.biologyonline.com/>
(Basic concepts and terminology in embryology)
5. HHMI BioInteractive – Developmental Biology
<https://www.biointeractive.org/>
(Videos and interactive modules on embryological processes)

Invertebrate Embryology Resources

1. Virtual Invertebrate Development Lab – University of Arizona
<http://www.biology.arizona.edu/>
(Detailed virtual exercises focusing on invertebrate embryology)
2. The Development of Sea Urchins – Virtual Lab
<https://www.devbio.net/>
(Specialized resources on sea urchin development as a model for invertebrates)
3. The WormAtlas – Caenorhabditis elegans Development
<https://www.wormatlas.org/>
(Comprehensive guide to the embryology of C. elegans)
4. Digital Atlas of Early Marine Invertebrate Embryos
<http://www.digitallibrary.io/>
(Images and descriptions of embryonic development in marine invertebrates)
5. Virtual Lab for Amphioxus and Tunicates
<https://scripps.ucsd.edu/>
(Focuses on primitive chordate-like invertebrates)

Vertebrate Embryology Resources

1. The Virtual Human Embryo – Carnegie Stages
https://www.ehd.org/dev_article_intro.php
(Covers vertebrate embryonic development stages)

2. Mouse Embryology Resources – The Jackson Laboratory
<https://www.jax.org/>
 (Detailed embryology tools for the mouse as a vertebrate model)
3. Chick Embryo Development – The University of Maine
<https://umaine.edu/>
 (Laboratory exercises on chick embryology)
4. ZebraFish Embryo Project – ZFIN
<https://zfin.org/>
 (Database and resources on zebrafish development)
5. Embryology of Amphibians – Xenopus Resource Center
<https://www.xenbase.org/>
 (Detailed resources on frog development as a vertebrate model)

Research Databases

1. The GUDMAP Database (Genitourinary Development)
<https://www.gudmap.org/>
 (Focuses on developmental processes in vertebrates)
2. NCBI Developmental Biology Database
<https://www.ncbi.nlm.nih.gov/>
 (Search for specific embryology-related research)
3. The Human Protein Atlas – Embryonic Development Section
<https://www.proteinatlas.org/>
 (Detailed molecular data for embryonic development in vertebrates)
4. Allen Brain Atlas – Embryonic Mouse Brain
<https://portal.brain-map.org/>
 (Focus on vertebrate neural development)
5. Biodiversity Heritage Library – Historical Embryology Texts
<https://www.biodiversitylibrary.org/>
 (Access to classical embryology literature)

Interactive Learning Tools

1. PhET Interactive Simulations – Developmental Biology
<https://phet.colorado.edu/>
 (Simulations for understanding embryology concepts)
2. Labster – Virtual Embryology Labs
<https://www.labster.com/>
 (Simulated experiments for both invertebrate and vertebrate development)
3. iBiology – Embryology Lectures
<https://www.ibiology.org/>
 (Videos from experts on embryology topics)
4. Coursera – Developmental Biology Courses
<https://www.coursera.org/>
 (Courses covering both invertebrate and vertebrate embryology)
5. The Virtual Embryo – Developmental Stages Database
<https://www.sdbonline.org/sites/virtualembryo/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify the key stages of early development, such as fertilization and gastrulation. Describe the processes of morphogenesis and organogenesis, including pattern formation and cell differentiation. Explain the mechanisms of regeneration and biological immortality in different organisms. Define the terms related to developmental biology, such as apoptosis and teratogenesis. Recognize the impact of developmental issues on human health.	K1, K2
CO2	Compare and contrast different mechanisms of cell division and differentiation during early development. Analyze the role of signaling pathways in regulating morphogenesis and organogenesis. Evaluate the factors that influence regeneration and biological immortality in various organisms. Explain the causes and consequences of different developmental issues, such as birth defects and aging. Describe the ethical implications of research on developmental biology and regenerative medicine.	K3, K4
CO3	Synthesize information about the complex interactions between genetic, epigenetic, and environmental factors that influence development. Evaluate the potential applications of regenerative medicine and stem cell research in addressing developmental disorders and aging. Design and conduct experiments to investigate specific developmental processes and analyze the results. Critically analyze ethical issues related to research on developmental biology and regenerative medicine. Propose innovative strategies for addressing developmental disorders and improving human health based on advancements in developmental biology.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	2	3	2	2	3	3
CO2	1	2	3	2	2	3	3
CO3	1	2	3	2	2	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ2MC03
Course Title	Chordata and Embryology Lab
Credits	04
Hours/Week	04
Category	Major Core (MC) – Lab
Semester	II
Regulation	2024
Course Overview This course explores the comparative anatomy and organ systems of chordates, focusing on frogs and sharks, with additional studies on Chelonia and avian specimens like pigeons. Students will examine skeletal structures such as the skull, vertebral column, pectoral and pelvic girdles, and appendages. Practical components include mounting fish scales and anatomical structures like the brain, hyoid apparatus, and jaws. The course also integrates museum-based observation of chordate specimens, the study of chordate eggs, and the analysis of homology and analogy in chordate anatomy, providing a holistic understanding of vertebrate evolution and morphology.	
Course Objectives 1. To gain hands-on experience in the dissection and mounting of anatomical structures, including fish scales, the brain, hyoid apparatus, skull, lower jaw, vertebral column, and limb girdles of frogs and sharks. 2. To examine and compare anatomical features of various chordates, such as the anapsid skull of Chelonia and the synsacrum of pigeons, to explore evolutionary adaptations and structural diversity. 3. To identify and interpret homologous and analogous structures in chordates to understand evolutionary relationships and functional significance. 4. To study preserved chordate specimens in museum settings and analyze chordate eggs to integrate theoretical knowledge with observational data, fostering a deeper understanding of vertebrate development and morphology.	
Prerequisites	Basic knowledge on vertebrate animals and Embryology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Major Dissections: Frog (Demo): External features, Digestive system, Arterial system, Venous system, 5 th Cranial nerve, 9 th and 10 th cranial nerves, Male and female urinogenital system. Fish (Shark): Digestive system and Nervous system	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Mounting and Osteology: Fish: Placoid and Ctenoid scales. Frog: Hyoid apparatus and Brain (Demo). Frog: Skull and lower jaw, Vertebral column, Pectoral girdle, Pelvic girdle,	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Forelimb, Hind limb. Chelonia- Anapsid skull, Pigeon - skull and lower jaw, synsacrum.			
III	Museum specimen and slide study: Collection and preservation of Animals (Live & Dead). Hemichordata : Balanoglossus, Tornaria larva. Urochordata : Ascidian, Ascidian larva. Cephalochordata : Amphioxus, Amphioxus - T.S. through pharynx. Specimens: <i>Doliolum</i> , <i>Salpa</i> , <i>Petromyzon</i> , <i>Ammocoetus</i> larva, <i>Scoliodon sorrakowah</i> , <i>Narcine</i> , <i>Rhinobatus</i> , <i>Protopterus</i> , <i>Catla</i> , <i>Clarias</i> , <i>Anabas</i> , <i>Hippocampus</i> , <i>Tetradon</i> , <i>Cynoglossus</i> , <i>Pterois</i> , <i>Echeneis</i> , <i>Bufo melanostictus</i> , <i>Hyla</i> , <i>Rhacophorus</i> , <i>Amblystoma</i> , Axolotl larva, <i>Proteus</i> , <i>Ichthyophis</i> , <i>Hemidactylus</i> , Chamaeleon, <i>Draco</i> , Mabuaya, Varanus, Cobra, Krait, Russell's viper, <i>Echis carinatus</i> , <i>Testudo elegans</i> , Carapace, Plastron, King fisher, Parrot, Owl, Hornbill, Wood pecker, Armadillo, Bat.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Study of eggs: Types of eggs based on quantity and distribution of yolk: sea urchin, insect, frog, Chick. Comparative study of cleavage patterns in Frog and Amphioxus models. Study of development of chick embryo through incubated chick eggs up to 96 h. Extra embryonic membranes of chick through permanent slides.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Analogy and homology: Study of adaptive radiations in feet of birds and mouth parts of insects. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit). Serial homology in appendages of Palaemon. Placenta in shark and mammals (Sheep, Goat, Pig and Humans).	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Dhami, P. S., & Dhami, J. K. (1981). Chordate Zoology. R. Chand & Company. 2. Jordan, E. L., & Verma, P. S. (1998). Chordate Zoology. S. Chand & Company. 3. Kotpal, R. L. (2000). Modern Textbook of Zoology: Vertebrates. Rastogi Publications. 4. Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing. 5. Singh, G., & Bhaskar, H. (2002). Advanced Chordate Zoology. Campus Books. 6. Verma P. S, 2000. A Manual of Practical Zoology: Chordates, S. Chand Limited.				
Suggested Readings 1. Agarwal, R. K. (2014). Embryology of Vertebrates. Varanasi, India: Banaras Hindu University Press. 2. Arora, M. P. (2010). Introduction to Chordate Embryology. New Delhi, India: Himalaya Publishing House. 3. Balinsky, B. I. (2004). An Introduction to Embryology. New Delhi, India: CBS Publishers & Distributors.				

4. Das, R. C. (2011). Principles of Developmental Biology and Chordate Embryology. Kolkata, India: Academic Publishers.
5. Kotpal, R. L. (2012). Chordate Embryology. Meerut, India: Rastogi Publications.
6. Kumar, S. (2013). Textbook of Chordate Developmental Biology. New Delhi, India: Ane Books.
7. Prasad, S. N. (2002). Chordate Developmental Biology. New Delhi, India: Kalyani Publishers.
8. Rastogi, V. B. (2022). Chordate Embryology. Meerut, India: Rastogi Publications.
9. Reddy, P. R. (2006). Advances in Chordate Embryology. Chennai, India: Allied Publishers.
10. Singh, H. R. (2005). Developmental Biology and Chordate Embryology. Jalandhar, India: Vishal Publishing.
11. Verma, P. S., & Agarwal, V. K. (2010). Chordate Embryology. New Delhi, India: S. Chand Publishing.
12. Verma, S. (2008). Chordate Embryology: Concepts and Techniques. Hyderabad, India: University Science Press.

Web Resources

Chordata Lab Resources

1. **University of California Museum of Paleontology - Chordates**
<https://ucmp.berkeley.edu/chordata/chordata.html>
 (Detailed resources on chordate anatomy and evolution)
2. **Smithsonian National Museum of Natural History – Vertebrate Zoology**
<https://naturalhistory.si.edu/research/vertebrate-zoology>
 (Includes specimen data and lab resources for vertebrate chordates)
3. **Animal Diversity Web – Chordata**
<https://animaldiversity.org/accounts/Chordata/>
 (Comprehensive data on chordate taxonomy and diversity)
4. **Lab Manual for Vertebrate Zoology – University of Texas**
<https://sites.cns.utexas.edu/>
 (Search for chordate-related lab activities)
5. **Virtual Vertebrate Anatomy Lab – University of Colorado**
<https://www.colorado.edu/>
 (Offers virtual lab materials on chordate anatomy and physiology)
6. **Marine Vertebrates Lab – Scripps Institution of Oceanography**
<https://scripps.ucsd.edu/>
 (Resources for studying marine chordates)
7. **The Virtual Human Embryo**
<https://www.ehd.org/virtual-human-embryo/>
 (Interactive learning about vertebrate embryology stages)
8. **ZebraFish Embryology Lab – ZFIN**
<https://zfin.org/>
 (Resources on zebrafish embryonic development for lab use)

9. **Chick Embryo Development – University of Maine**
<https://umaine.edu/>
 (Lab exercises and resources for studying chick embryos)
10. **Xenopus Resource Center – Amphibian Embryology**
<https://www.xenbase.org/>
 (Protocols and resources for studying frog embryos)
11. **Mouse Embryology Virtual Lab – Jackson Laboratory**
<https://www.jax.org/>
 (Focuses on vertebrate development using mouse models)

Invertebrate Embryology Lab Resources

1. **Virtual Urchin Embryology Lab**
<https://virtualurchin.stanford.edu/>
 (Virtual tools for studying the development of sea urchin embryos)
2. **WormAtlas – C. elegans Development**
<https://www.wormatlas.org/>
 (Comprehensive resources on nematode embryonic development)
3. **Embryology of Drosophila – FlyBase**
<https://flybase.org/>
 (Data and resources on fruit fly embryology)
4. **Developmental Biology Online – Invertebrates**
<https://www.ncbi.nlm.nih.gov/books/NBK9983/>
 (Covers embryology in key invertebrate model organisms)
5. **Digital Atlas of Early Marine Invertebrates**
<https://mbol.ucsd.edu/>
 (Collection of embryonic images of marine invertebrates)

Shared Educational Platforms

1. **Labster Virtual Labs**
<https://www.labster.com>
 (Virtual lab simulations for both chordates and cytogenetics)
2. **HHMI BioInteractive**
<https://www.biointeractive.org/>
 (Animations and case studies for cytogenetics and chordate labs)
3. **MIT OpenCourseWare – Biology Labs**
<https://ocw.mit.edu/courses/biology/>
 (Search for chordates and cytogenetics-related courses)
4. **Coursera – Biology Lab Courses**
<https://www.coursera.org/>
 (Online courses with sections on chordates and cytogenetics)
5. **PhET Interactive Simulations**
<https://phet.colorado.edu/>
 (Simulations for genetic analysis and biological processes)

Research Tools and Databases

1. **Ensembl Genome Browser (For Cytogenetics)**
<https://www.ensembl.org>
(Explore genomic data and cytogenetics)
2. **World Register of Marine Species (For Chordates)**
<https://www.marinespecies.org>
3. **NCBI Karyotype Database (For Cytogenetics)**
<https://www.ncbi.nlm.nih.gov/projects/dbVar/Karyotype>
4. **Biodiversity Heritage Library – Chordata and Cytogenetics**
<https://www.biodiversitylibrary.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the external and internal anatomical features of various chordate organisms, including fish, amphibians, reptiles, and birds. Recognize and explain the functional significance of different anatomical structures and systems. Understand the stages of embryonic development and the factors influencing it. Know the concepts of homology and analogy and their importance in evolutionary biology. Dissect various organisms (frog, shark, pigeon, and chelonian) to identify and analyze their anatomical structures. Prepare and mount biological specimens (fish scales, hyoid apparatus, skull, vertebral column, girdles, and limbs) for detailed examination. Apply knowledge of anatomical and genetic principles to solve biological problems. Analyze the development of embryos to understand the processes of cell differentiation and organogenesis. Apply the concepts of homology and analogy to infer evolutionary relationships among organisms. Effectively communicate scientific findings through written reports and oral presentations. Develop critical thinking and problem-solving skills to analyze complex biological phenomena.	K1, K2
CO2	Analyze the evolutionary relationships among different chordate groups based on comparative anatomy. Compare and contrast the anatomical features of various organisms to identify adaptations to specific environments. Critically evaluate the impact of genetic factors on phenotypic variation. Design and conduct independent laboratory experiments to investigate biological questions. Integrate knowledge from different fields of biology (e.g., anatomy, genetics, cell biology) to solve complex problems. . Compare and contrast the developmental stages of different organisms to identify similarities and differences. Analyze morphological and genetic data to infer evolutionary relationships. Develop innovative approaches to biological research and experimentation. Communicate scientific findings effectively	K3, K4

	through written reports, oral presentations, and visual aids. Collaborate with peers to solve problems and conduct research projects.	
CO3	Evaluate the limitations of experimental designs and propose improvements. Critically assess the validity of scientific claims and arguments. Compare and contrast different experimental methodologies and their effectiveness. Evaluate the ethical implications of biological research. Develop original research proposals to investigate specific biological questions. Design and conduct novel experiments to test hypotheses. Create innovative solutions to biological problems. Contribute to the advancement of scientific knowledge through original research. Communicate complex scientific ideas to diverse audiences, including non-scientists.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3MC01
Course Title	Cell Biology and Genetics
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	III
Regulation	2024
Course Overview This course will explore the fundamental principles of cellular biology, genetics, and their applications. Topics covered will include the organization of cells, their organelles and functions, Mendelian genetics, molecular genetics techniques, and the principles of human and applied genetics.	
Course Objectives 1. To understand the basic structure and function of cells, including their organelles and their roles in various cellular processes. 2. To explore the principles of Mendelian genetics, including inheritance patterns, genetic crosses, and genetic disorders. 3. To analyze the role of each organelle in metabolism and cell division and to evaluate the different patterns of inheritance. 4. To examine the principles of human genetics, including genetic variation, genetic diseases, and genetic counseling. 5. To apply genetic concepts to various fields, such as agriculture, medicine, and forensic science.	
Prerequisites	Basic knowledge of cells and functions.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Level
I	Organization Of Cells: Cell Theory; Types of Cells; Plasma Membrane- Chemical Composition, Models of Plasma Membrane, Membrane Transport; Cilia and Flagella - Ultrastructure and derivatives; Extra Cellular Organelles; Cytoskeleton.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Cell Organelles: Endoplasmic Reticulum; Ribosomes; Golgi Complex; Microbodies; Lysosomes – Polymorphism, Vacuolar system; Endomembrane system; Nucleus-ultrastructure of nuclear membrane; Mitochondria-biogenesis; Chromosomes – types – giant , polytene, lamp brush, holokinetic and B chromosomes; DNA structure and mechanism of replication; RNA- types and structure; Centriole; Cell Division; Cell Growth and cellular Aging; Cancer- characteristics and stages.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Mendelian Genetics: Laws of inheritance; Deviation from mendelian inheritance - Interaction of genes, Polygenic inheritance, Multiple alleles, Extrachromosomal inheritance; Linkage; Crossing over – types, Holliday model and Double strand break repair model; Chromosome mapping – Linkage mapping, Haploid mapping, mapping using somatic cell hybridization; Interference and coincidence.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Human And Applied Genetics: Sex determination; Sex-linked inheritance; Variations in chromosome number and structure; Gene mutation; Molecular basis of mutation; Genetic disorders of man; Gene pool; Hardy Weinberg equilibrium – affecting factors; Eugenics, Euphenics, and Euthenics; Pedigree Analysis. Inbreeding and Outbreeding.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Molecular and Bacterial Genetics: Insertion elements, transposable elements, retroelements, integrons and antibiotic resistance cassettes. Genetic recombination in bacteria – Lederberg's experiment; Horizontal gene transfer – conjugation, transduction and transformation.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ambrose, E.J. and Dorothy, M. Easty (1970). Cell Biology, Thomas Nelson & Sons Ltd.
2. Benjamin A. Pierce (2013). Genetics: A conceptual Approach, W.H Freeman.
3. David E Sadava (1993). Cell Biology - Organelle Structure and Function, Jones Bartlett Publishers.
4. Guptha G. K (2013). Genetics Classical to Modern, Rastogi publishers.
5. Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Pathfinder Publication.
6. Rastogi, S. C (2019). Cell Biology, New Age international Publishers..
7. Veer Bala Rastogi (2015). Elements of Genetics, Kedar Nath Ram Nath.
8. Verma P.S and Agarwal V.K. (2006). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Co.
9. Verma. P. S and V. K. Agarwal (2010). Genetics, S. Chand & Company.

Suggested Readings

1. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology. W.W. Norton & Company.
2. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. (2015). Molecular biology of cell, Taylor and Francis.
3. Anne Gardner (2009). Human Genetics, Scion Publishing Ltd.
4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Berton, G. P (2009). The World of the Cell. Pearson Benjamin Cummings Publishing.
5. Burke, Jack. D (1970). Cell Biology, Scientific Book Agency.

6. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co.
7. Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press.
8. Cohn, N. S (1979). Elements of Cytology, Freeman Book Co.
9. Cooper G.M. (2019) The Cell – A Molecular Approach, Oxford University Press.
10. De Robertis, E. D. P and E.M.F Robertis (2017). Cell and Molecular Biology, LWW.
11. Fletcher H and Hickey I (2015). Genetics, IV Edition. GS, Taylor and Francis.
12. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. Wiley India.
13. Geoffrey M. Cooper (2018). The cell: A Molecular Approach, Oxford University Press.
14. Klug, W. S., Cummings, M. R., Spencer, C. A (2012). Concepts of Genetics. Benjamin Cummings.
15. Lewis J Kleinsmith, Valerie M Kish (1995). Principles of Cell and Molecular Biology, Harpercollins College Div.
16. Peter J. Russel (2013). iGenetics: A Molecular Approach, Pearson.
17. Strickberger M. W (1995). Genetics, Prentice Hall India Learning.

Web Resources

Educational Resources

1. Khan Academy – Cell Biology and Genetics
<https://www.khanacademy.org/science/biology>
(Covers cell structure, function, and genetic principles)
2. MIT OpenCourseWare – Cell Biology
<https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2020/>
3. Nature Education – Scitable (Genetics and Cell Biology)
<https://www.nature.com/scitable>
(Offers detailed modules on genetics and cellular processes)
4. Biology Online – Cell Biology and Genetics Resources
<https://www.biologyonline.com/>
(Search for specific topics like mitosis, meiosis, and gene expression)
5. HHMI BioInteractive
<https://www.biointeractive.org/>
(Interactive animations and videos on cell biology and genetics)

Research Databases

1. National Center for Biotechnology Information (NCBI)
<https://www.ncbi.nlm.nih.gov>
(Includes PubMed and GenBank for genetics research)
2. Ensembl Genome Browser
<https://www.ensembl.org>
(Explore genome data for various organisms)
3. European Molecular Biology Laboratory (EMBL-EBI)
<https://www.ebi.ac.uk>

4. UCSC Genome Browser
<https://genome.ucsc.edu>
(Provides tools for exploring annotated genomes)
5. Gene Ontology Consortium
<http://geneontology.org/>
(Offers detailed data on gene functions)

Specialized Resources

1. The Cell: An Image Library
<https://www.cellimagelibrary.org>
(Database of high-resolution images of cells)
2. Human Genetics Resources – NIH
<https://www.genome.gov/>
(Comprehensive information on human genetics and genomics)
3. The Biology Project – University of Arizona
and Animal Physiology Lab <http://www.biology.arizona.edu/Cytogenetics>
(Interactive tutorials on cell biology and genetics)
4. Proteopedia
<https://www.proteopedia.org/>
(3D structures of proteins and genetic elements)
5. GeneCards – Human Gene Database
<https://www.genecards.org>
(Detailed data on human genes)

Interactive Tools and Simulations

1. PhET Interactive Simulations – Genetics
<https://phet.colorado.edu>
(Engaging simulations for understanding genetic concepts)
2. Virtual Cell Animation Collection
<http://vcell.ndsu.edu/animations/>
(Visualize cellular processes like mitosis and transport)
3. DNA Interactive – Genetics and Heredity
<http://www.dnai.org/>
(Interactive platform for exploring DNA and genetics)
4. iBiology – Cell Biology and Genetics Talks
<https://www.ibiology.org>
(Lectures and educational videos from experts)
5. Labster – Virtual Labs for Genetics and Cell Biology
<https://www.labster.com>

Communities and Forums

1. ResearchGate
<https://www.researchgate.net>
(Connect with researchers and access publications on cell biology and genetics)

2. Biology Stack Exchange https://biology.stackexchange.com (Ask and answer technical questions on genetics and cell biology)
3. Reddit – Genetics https://www.reddit.com/r/genetics/
4. GenomeWeb – Genetics News and Updates https://www.genomeweb.com
5. OpenWetWare – Genetics and Cell Biology Protocols https://openwetware.org

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify the different components of a cell and their functions. Describe the principles of Mendelian inheritance and genetic crosses. Explain the basic techniques used in molecular genetics, such as DNA extraction and PCR. Define the terms related to human genetics, such as genotype and phenotype. Recognize the applications of genetics in various fields, such as agriculture and medicine.	K1, K2
CO2	Compare and contrast different types of cells and their organelles based on their structure and function. Analyze the inheritance patterns of genetic traits using Mendelian genetics. Evaluate the effectiveness of different molecular genetics techniques in various applications. Explain the relationship between genotype and phenotype in human genetics. Describe the ethical implications of genetic technologies in different fields.	K3, K4
CO3	Synthesize information about the interconnectedness of cellular organelles and their roles in cellular functions. Evaluate the impact of genetic mutations on individual health and population genetics. Design and conduct experiments to investigate genetic phenomena and analyze the results. Critically analyze ethical issues related to genetic technologies and their applications. Propose innovative solutions to address genetic disorders or improve agricultural productivity using genetic engineering techniques.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	2	3	3	3
CO2	2	3	3	2	3	3	3
CO3	2	3	3	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3MC02
Course Title	Animal Physiology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	III
Regulation	2024
Course Overview This course provides a comprehensive examination of essential physiological processes in animals, focusing on nutrition and digestion, respiration, excretion, osmoregulation, circulation, and muscle contraction. Students will explore the structure and function of sense organs and reproductive systems, gaining insights into how these systems interact to maintain homeostasis and support survival. Through lectures and practical activities, participants will develop a foundational understanding of the biological mechanisms underlying these vital functions and their implications for health and behavior.	
Course Objectives 1. To equip students with a comprehensive understanding of the key physiological processes involved in nutrition and digestion, respiration, excretion, osmoregulation, circulation, and muscle contraction. 2. To enable students to analyze the structure and function of various organ systems, exploring how they work together to maintain homeostasis and support overall organism health. 3. To facilitate the investigation of the anatomy and function of sense organs, examining how sensory information is processed and integrated to influence behavior and survival. 4. To provide students with insights into the reproductive systems of animals, discussing various reproductive strategies, mechanisms, and the role of reproduction in population dynamics and species survival.	
Prerequisites	Basic knowledge on the structure and function of animals.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Nutrition and Digestion: Nutrition- Types, Composition of Food, Vitamins, Nutritive Requirements, balanced diet. Feeding Mechanism In Animals. Digestion- Kinds of Digestion. Physiology of digestion – absorption and assimilation in man, role of digestive enzymes and gastrointestinal hormones, neuronal and hormonal regulation of digestion. Composition of Feces, Defecation.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

II	Respiration, Excretion, and Osmoregulation: Respiration- Kinds of Respiration, Respiratory Organs, Modes of Respiration, Transport of Respiratory Gases, regulation and control of respiration, respiratory pigments, Respiratory Quotient. Excretion - Excretory organs and excretion in different animals - Classification of animals on the basis of excretory products, Excretion in Mammals- Structure and function of Kidney and Nephron, urine formation and composition, neural and hormonal regulation of urine formation, Osmoregulation- Osmoregulation in Freshwater, Marine, and Terrestrial Animals.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Circulation and Muscle Contraction: Circulation- Types of Circulation, Composition, and Functions of Blood, Blood Cells, Types of heart, Anatomy and Functioning of Mammalian Heart, cardiac cycle and circulation of blood. Common Cardiovascular Diseases. Muscle Contraction- Types and Properties of Muscles, Mechanism of Muscle Contraction, Chemical changes during muscle contraction.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Nervous and Endocrine Systems: Nervous System- Neuron Doctrine, Types, Morphology and Physiological Functions of Neuron. resting and action potentials, synapse-synaptic transmission. Reflex Arc. Anatomy of Mammalian Brain, Central, Sympathetic and Parasympathetic Nervous Systems. Endocrine and Neuroendocrine Systems of Vertebrates. Structure, secretion and functions of pituitary, thyroid, pancreas, adrenal, gonads.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Sense organs and reproduction: Sense Organs- Classification of Sense Organs in Animals, Types of Receptors. Structure and Function of Human Eye and Ear. Reproduction- Patterns of Reproduction in Invertebrates and Vertebrates, Anatomy of Reproductive Organs of Human, Hormonal Regulation of Reproduction, Infertility.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Arora, M. P. (2014). Animal physiology for B.Sc. and M.Sc. Himalaya Publishing House. 2. Chaturvedi, H. C. (2010). A textbook of comparative physiology of vertebrates. Himalaya Publishing House. 3. Nagabhushanam, R. (2008). Textbook of animal physiology. Oxford University Press. 4. Rastogi, S. C. (2019). Essentials of animal physiology. New Age International Publishers. 5. Reddy, P. B. (2016). Text book of animal physiology. Ratna Prasad Multidisciplinary Research & Educational Society. 6. Sarada Subrahmanyam, Madhavan Kutty, K and Singh H.D (2018). Text Book of Human Physiology, S. Chand & Co.				

7. Singh, H. R., & Kumar, N. (2017). Animal physiology and biochemistry. Vishal Publishing Co.
8. Verma, P. S., Tyagi, B. S., & Agarwal, V. K. (2014). Animal physiology. S. Chand Publishing.

Suggested Readings

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I (2002). The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E J W. (1967). Invertebrate structure and function, Nelson, London.
3. Boradale, L.A. and Potts, E.A (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd..
5. Hill, W.R., Wyse, G.A and Anderson, M. (2016). Animal Physiology. Oxford University Press.
6. Hoar, W.S (1983). General and Comparative Physiology. Prentice Hall of India.
7. Marshall, A.J and Williams, W.D (1995). Text book of Zoology-Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.
8. Prosser C.L (1985). Comparative Animal Physiology, Satish Book Enterprise.
9. Randall, D. et al. (2002) Eckert Animal Physiology (5th edition) Freeman.
10. Singh, H.R and Kumar, N (2017). Animal physiology and biochemistry, Vishal publishing company.
11. Sreekumar, S (2010). Basic physiology, PHI learning private ltd.
12. Tortora G.J. and Derrickson B (2016). Principles of Anatomy and Physiology, Johnsons, Inc.
13. Withers, P.C. et al. (1992) Comparative Animal Physiology, Brooks Cole.

Web Resources

Educational Resources

1. Khan Academy – Human and Animal Physiology
<https://www.khanacademy.org/science/biology>
(Covers various aspects of animal physiology, such as the circulatory, nervous, and digestive systems)
2. MIT OpenCourseWare – Physiology
<https://ocw.mit.edu/courses/biology/>
(Free courses on general and comparative physiology)
3. Biology Online – Animal Physiology
<https://www.biologyonline.com/>
(Detailed articles and definitions related to animal physiology)
4. Colorado State University – Animal Physiology Tutorials
<https://www.cvmb.colostate.edu/bms/>
(Focuses on veterinary and animal physiology)
5. Encyclopedia Britannica – Animal Physiology
<https://www.britannica.com/science/animal-physiology>

Research Databases

1. PubMed (Animal Physiology Research)
<https://pubmed.ncbi.nlm.nih.gov/>
(Search for research papers and articles on animal physiology)
2. National Center for Biotechnology Information (NCBI)
<https://www.ncbi.nlm.nih.gov/>
(Database for genetic and physiological studies)
3. The Physiological Society – Resources and Journals
<https://www.physoc.org/>
(Journals and resources on the latest in physiology research)
4. Journal of Experimental Biology
<https://journals.biologists.com/jeb>
(Focuses on comparative physiology and experimental studies)
5. American Physiological Society
<https://www.physiology.org/>
(Access to journals, resources, and tools for physiology research)

Specialized Resources

1. Animal Physiology Lab Manual – University of Illinois
<https://vetmed.illinois.edu/>
(Search for lab protocols in animal physiology)
2. Comparative Animal Physiology – University of Calgary
<https://ucalgary.ca/>
(Resources on how different animals adapt to their environments)
3. Virtual Frog Dissection Kit – Animal Systems
<https://www.frogguts.com/>
(Interactive tools to learn about vertebrate physiology)
4. The Fish Physiology Database
<https://fishphysiology.org/>
(Focus on the physiological processes of aquatic animals)
5. The Mammalian Physiology Resource
<https://www.mammalianbiology.org/>
(Explores physiological systems in mammals)

Interactive Learning Tools

1. PhET Interactive Simulations – Physiology
<https://phet.colorado.edu/>
(Simulations for understanding animal physiological processes)
2. Labster – Virtual Labs for Physiology
<https://www.labster.com/>
(Interactive labs for cardiovascular, respiratory, and neural physiology)
3. Animal Physiology Animations – BioInteractive
<https://www.biointeractive.org/>
(Visual explanations of complex physiological processes)

4. iBiology – Physiology Lectures
<https://www.ibiology.org/>
(Expert-led talks on cutting-edge physiology topics)
5. Anatomy & Physiology OpenStax Textbook
<https://openstax.org/details/books/anatomy-and-physiology>
(Free textbook covering animal and human physiology)

Communities and Forums

1. ResearchGate – Animal Physiology Discussions
<https://www.researchgate.net/>
(Forums for discussing research and sharing findings)
2. Biology Stack Exchange – Physiology
<https://biology.stackexchange.com/>
(Q&A platform for animal physiology-related questions)
3. Reddit – Physiology
<https://www.reddit.com/r/biology/>
(Community discussions on biology and physiology)
4. The Physiological Society Community
<https://www.physoc.org/community/>
(Network for professionals and students in physiology)
5. Zooniverse – Physiology Citizen Science Projects
<https://www.zooniverse.org/>
(Collaborative projects related to animal biology and physiology)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the fundamental physiological processes involved in nutrition and digestion, respiration, excretion, osmoregulation, circulation, and muscle contraction. They will recall the anatomical structures associated with each system and explain their functions and interrelationships in maintaining homeostasis within organisms. Additionally, students will recognize the key features of sense organs and summarize their roles in sensory perception and behavior, as well as describe the reproductive systems and strategies employed by various animal species to ensure survival and continuity of their populations.	K1, K2
CO2	Analyze and compare the physiological processes involved in nutrition and digestion, respiration, excretion, osmoregulation, circulation, and muscle contraction across different animal species. They will demonstrate the ability to assess the interconnections between these systems and how they contribute to homeostasis and overall organism function. Students will also evaluate the adaptations of sense organs, discussing their roles in sensory perception and	K3, K4

	their impact on behavior. Furthermore, they will formulate hypotheses regarding reproductive strategies and their evolutionary significance, using comparative analysis to understand the diverse reproductive mechanisms employed by various organisms.	
CO3	Synthesize information about the interconnectedness of various physiological systems and their roles in maintaining overall health. Evaluate the impact of lifestyle factors, nutrition, and environmental conditions on physiological processes. Create and implement strategies for improving nutritional intake, respiratory function, and overall physiological well-being. Design experiments to investigate specific physiological processes and analyze the results. Critically evaluate scientific literature related to nutrition, physiology, and related fields. Propose innovative solutions to address physiological challenges or disorders.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	2	2	3	3	3
CO2	1	3	2	2	3	3	3
CO3	1	3	2	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3MC03
Course Title	Cytogenetics and Animal Physiology Lab
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	III
Regulation	2024
Course Overview This laboratory course provides hands-on experience in studying cellular and physiological processes. Students will learn to use microscopes to observe cell structures and cell division, analyze metabolic products, and investigate enzyme activity. Additionally, the course will cover histological techniques to study the structure of endocrine glands and muscles. Through these practical experiences, students will gain a deeper understanding of fundamental biological processes.	
Course Objectives 1. To develop proficiency in using microscopes to observe and analyze cellular structures, cell division, and histological sections. 2. To understand fundamental cellular processes such as cell division, mitosis, and meiosis, and their role in inheritance. 3. To analyze physiological processes like enzyme activity, metabolic pathways, and hormonal regulation through experimental techniques. 4. To apply histological techniques to study the structure and function of endocrine glands and muscles.	
Prerequisites	Basic knowledge in Animal Physiology and Cytogenetics.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Cellular observations: Handling and use of Microscopes Cell size measurement using an ocular micrometer. Observation of cells in onion peels. Growth and division of cells in pollen – hanging drop culture. Observation of Baar body in buccal smear.	10	CO1 CO2 CO3	K1,K2,K3, K4, K5,K6
II	Cell division, chromosomes and inheritance: Study of the different stages of mitosis in onion root tip. Study of the different stages of meiosis in grasshopper testis. Observation of polytene chromosomes in salivary glands of Chironomus larva. Verification of the Mendelian ratios by Chi Square test (using coloured beads). Study of human karyotypes (with the help of photographs) – normal male and female karyotypes and study of karyotypes of different syndromes. Pedigree problems.	10	CO1 CO2 CO3	K1,K2,K3, K4, K5,K6

III	Analysis of metabolic products: Quantitative estimation of proteins by Bradford's method. Quantitative estimation of carbohydrates by DNSA method. Quantitative estimation of total lipids by Phosphovanillin method. Separation and identification of amino acids by paper chromatography. Estimation of urea and uric acid. Estimation ammonia as an excretory product in fishes.	10	CO1 CO2 CO3	K1,K2,K3, K4, K5,K6
IV	Physiological processes: Estimation of oxygen consumption in fish. Estimation of salt loss and salt gain in fishes. Study of the effect of adrenaline and acetylcholine on fish chromatophores.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Enzyme activity and histological study of endocrine glands and muscles: Determination of the activity of salivary amylase under varying substrate concentration and determination of its Km and Vmax values. Determination of optimum temperature of salivary amylase. Determination of optimum pH of salivary amylase. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, striated, non-striated and cardiac muscle.	12	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Agarwal R A., Anil K Srivastava., Kaushal Kumar (1978). Animal Physiology and Biochemistry, S. Chand & Co. Ltd.
2. Bishop, ML., Fody, E.P., Schoeff, LE (2010). Clinical Chemistry: Principles, Procedure, correlations. Wolters Kluwer.
3. Burtis, C.A. and Ashwood, E.R. 2008. Text book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.
4. Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
5. Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.
6. Sharma, A. K. (1972). A Textbook of Cytogenetics. Tata McGraw-Hill Education.
7. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
8. Tortora G.J. & Derrickson B (2016). Principles of Anatomy and Physiology, John Wiley and Sons.

Suggested Readings

1. Ahmed Y. S. E. and M. J. D. Simons (2016) Molecular Cytogenetics: Protocols and Applications,
2. Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.
3. Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition,

W.B.Sanders Company, Prism Books (Pvt.) Ltd., Bangalore.

4. Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi.
5. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2012). Concepts of Genetics. Pearson Education.
6. Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Publishing Co., NY, USA.
7. Orlando J. Miller and Eeva Therman (2001) Human Chromosomes, Springer.
8. Pisano, E., C. Ozouf-Costaz, F. Foresti, and B.G. Kapoor (2007) Fish Cytogenetics Science Publishers.
9. Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra.
10. Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.
11. Robert William Hegner (2015). Practical Zoology, BiblioLife.
12. Rooney D. E and B.H. Czepulkowski (2001). Human Cytogenetics: A Practical Approach, Oxford University Press.
13. Russell, P. J. (2010). iGenetics: A Molecular Approach. Pearson Education.
14. Stefan M. White (2015) Cytogenetics: Principles and Practice, CRC Press.
15. Thomas Liehr (2021) Essential Cytogenetics, Springer Nature.
16. Wilson, J.A (1984) Principles of Animal Physiology, Macmillan Publishing.
17. Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London.

Web Resources

Animal Physiology Lab Resources

1. **Animal Physiology Virtual Labs – Amrita Vishwa Vidyapeetham**
<https://vlab.amrita.edu/index.php?sub=3&brch=43>
 (Interactive virtual labs covering animal physiological processes)
2. **Carolina Biological – Animal Physiology Lab Kits**
<https://www.carolina.com/animal-physiology/>
 (Resources and lab kits for hands-on physiology experiments)
3. **Labster – Virtual Animal Physiology Labs**
<https://www.labster.com/>
 (Virtual simulations for studying cardiovascular, respiratory, and muscular physiology)
4. **Comparative Animal Physiology – University of California**
<https://ib.berkeley.edu/>
 (Resources for designing and conducting comparative physiology experiments)
5. **Protocol Online – Physiology Lab Methods**
<https://www.protocol-online.org/>
 (Protocols for various animal physiology lab techniques)

Cytogenetics Lab Resources

1. **Human Cytogenetics Laboratory – NIH**
<https://www.genome.gov/>
 (Cytogenetics methods, karyotyping tools, and clinical data)

5. **Practical Cytogenetics Lab – University of Leicester**
<https://www2.le.ac.uk/departments/genetics/>
 (Comprehensive lab resources for cytogenetics)
6. **DNA Interactive – Cytogenetics Tools**
<http://www.dnai.org/>
 (Interactive lessons and tools for cytogenetics)
7. **The Human Cytogenetics Database**
<https://www.cytogenetics.org/>
 (Detailed repository of human cytogenetic information)
8. **Cytogenetic Laboratory Protocols – OpenWetWare**
https://openwetware.org/wiki/Cytogenetics_protocols
 (Lab manuals and protocols for cytogenetics experiments)
9. **American Society of Cytogenetics – Resources and Tutorials**
<https://www.cytogenetics.org/>
 (Workshops, research, and teaching materials)

Shared Resources

1. **HHMI BioInteractive – Developmental Biology and Physiology**
<https://www.biointeractive.org/>
 (Videos and interactive materials for both physiology and embryology)
2. **LabArchives – Physiology and Embryology Protocols**
<https://www.labarchives.com/>
 (Protocols for lab activities)
3. **MIT OpenCourseWare – Developmental and Physiological Biology Labs**
<https://ocw.mit.edu/courses/biology/>
 (Course materials on both embryology and physiology)
4. **Developmental Biology Interactive – SDB**
<https://www.sdbonline.org/sites/virtualembryo/>
 (Interactive tools for studying embryology across species)
5. **PhET Interactive Simulations – Biology**
<https://phet.colorado.edu/>
 (Simulations for learning about physiological and developmental processes)

Research Databases

1. **NCBI Developmental Biology Database**
<https://www.ncbi.nlm.nih.gov/>
 (Extensive repository for embryology and physiology research)
2. **PubMed – Animal Physiology and Embryology**
<https://pubmed.ncbi.nlm.nih.gov/>
 (Search for scholarly articles)
3. **Journal of Experimental Biology**
<https://journals.biologists.com/jeb>
 (Research articles on both physiology and embryology)

4. **Biodiversity Heritage Library**
<https://www.biodiversitylibrary.org/>
 (Historical texts and resources for lab studies)
5. **American Physiological Society – Resources**
<https://www.physiology.org/>
 (Journals and educational tools for physiology)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the major metabolic pathways and their significance. Understand the physiological processes involved in respiration, circulation, digestion, and endocrine function. Know the basic principles of enzyme kinetics and their role in biochemical reactions. Comprehend the histological structure of endocrine glands and muscles. Understand the basic principles of microscopy and its applications in biological studies. Comprehend the fundamental concepts of cell division, including mitosis and meiosis. Know the basic principles of Mendelian genetics and their applications. Use microscopes to observe and measure cell size, identify stages of mitosis and meiosis, and analyze polytene chromosomes. Conduct experiments to verify Mendelian inheritance patterns and analyze genetic data. Interpret microscopic observations and experimental results to draw conclusions. Analyze metabolic products to assess metabolic status and identify metabolic disorders. Measure enzyme activity to study the effects of various factors on enzyme function. Interpret physiological data to understand the mechanisms underlying physiological processes. Examine histological sections of endocrine glands and muscles to identify cell types and their functions. Use laboratory equipment and techniques to conduct experiments and collect data. Interpret experimental results and draw conclusions.	K1, K2
CO2	Analyze the relationship between metabolic pathways and physiological processes. Compare and contrast the structure and function of different endocrine glands. Interpret histological sections to understand the cellular organization of tissues and organs. Analyze experimental data to evaluate the impact of various factors on enzyme activity and metabolic processes. Interpret microscopic observations to understand the underlying cellular and molecular processes. Analyze experimental data to test hypotheses and draw conclusions about genetic inheritance. Design and conduct experiments to investigate specific physiological or biochemical questions. Integrate knowledge from different fields of biology to understand complex biological phenomena. Develop innovative approaches to biological research and experimentation. Communicate scientific findings effectively through	K3, K4

	written reports and oral presentations. Collaborate with peers to solve problems and conduct research projects.	
CO3	Evaluate the limitations of experimental designs and propose improvements. Critically assess the validity of scientific claims and arguments. Compare and contrast different experimental methodologies and their effectiveness. Evaluate the ethical implications of biological research. Develop original research proposals to investigate specific physiological or biochemical questions. Design and conduct novel experiments to test hypotheses. Create innovative solutions to biological problems. Contribute to the advancement of scientific knowledge through original research. Communicate complex scientific ideas to diverse audiences, including non-scientists.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4MC01
Course Title	Molecular Biology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	IV
Regulation	2024
Course Overview This course focuses on understanding the molecular mechanisms that govern the structure, function, and regulation of living organisms. It explores how genetic information is stored, expressed, and regulated at the molecular level and how these processes drive cellular functions.	
Course Objectives 1. To describe and explore the roles of biological macromolecules in the cell. 2. To examine the involvement of DNA, RNA and proteins in the expression of cellular phenotypes. 3. To help students to understand the organization and significance of genomes and genes. 4. To facilitate a deeper understanding of the tools for analyzing cellular processes at the molecular level.	
Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Genome organization: Prokaryotic and eukaryotic nuclear genome organization – chromatin structure, significance of the centromere and telomere; mitochondrial and chloroplast DNA; plasmids - structure, types, functions and replication; Gene - definition, general structure, parts of a gene; differences between prokaryotic and eukaryotic gene structure; Genetic code - codons, amino acid codon table, reading frames in the genetic code, open reading frames, codon degeneracy and universality, mitochondrial codon usage, Wobble hypothesis.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	DNA repair and transcription: DNA repair mechanisms - direct reversal of DNA damage, base excision repair, nucleotide excision repair; Eukaryotic and prokaryotic transcription mechanisms; post-transcriptional modification of mRNA and its transport into the cytoplasm; RNA-dependent RNA synthesis in RNA viruses and reverse transcription in retroviruses.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Protein synthesis: Eukaryotic and prokaryotic protein synthesis mechanisms; post-translational modification of	10	CO1 CO2	K1,K2,K3, K4,K5,K6

	proteins; inhibitors of transcription and translation in cells; coupling of transcription and translation in bacteria; definition and applications of genomics, proteomics and transcriptomics.		CO3	
IV	Gene regulation: Housekeeping genes, constitutive and regulated gene expression, induction and repression of gene products, repressors, activators, operators, enhancers; Concept of operon – lac operon and trp operon; Mechanisms of gene regulation – heterochromatin, euchromatin, histone acetylation and methylation, DNA methylation, gene silencing by RNA interference and microRNA; concept of oncogenes – retroviral oncogenes, proto-oncogenes, functions of oncogene products; tumour suppressor genes – examples and functions.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Molecular analysis: Polymerase chain reaction, Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, Southern blotting, Northern blotting, Western blotting, Fluorescent in situ hybridization, Gene expression analysis using DNA microarrays, Genome sequencing by Sanger sequencing method, Restriction digestion – types and functions of restriction endonucleases, DNA fingerprinting.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Cooper, G. M., Hausman, R. E. (2019). The cell: A molecular approach (8th ed.), Sinauer Associates/Oxford University Press.
2. Gupta, P. K. (2005). Cell and Molecular Biology. India: Rastogi Publications.
3. Kumar, P. (2018). Fundamentals and Techniques of Biophysics and Molecular Biology. Pathfinder Publication unit of PAPL.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M. P. (2021). Molecular cell biology (9th ed.), W. H. Freeman.
5. Malathi, V. (2013). Molecular biology, Pearson Education India.
6. Nelson, D. L., Cox, M. M., Lehninger, A. L. (2017). Lehninger principles of biochemistry (7th ed.), W. H. Freeman.
7. Ramawat, K.G., Goyal, S. (2010). Molecular Biology and Biotechnology (For Undergraduate Courses). S Chand & Company Limited.
8. Rastogi, V. B. (2013). Principles of molecular biology (2nd ed.), Pragati Prakashan.
9. Turner, P. C. (1997). Instant Notes in Molecular Biology. Singapore: BIOS Scientific Publishers.
10. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R. (2014). Molecular biology of the gene (7th ed.), Cold Spring Harbor Laboratory Press.

Suggested Readings

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2015). Molecular biology of the cell (6th ed.), Garland Science.
2. De Robertis, E. D. P., De Robertis, E. M. F. (2017). Essentials of cell and molecular Biology (16th ed.), Wolters Kluwer.

3. Karp, G., Iwasa, J., Marshall, W. (2020). Karp's cell and molecular biology: Concepts and experiments (9th ed.), Wiley.
4. Lewin, B. (2017). Genes XII, Jones & Bartlett Learning.
5. Miller, H. B., Witherow, D. S., Carson, S. (2011). Molecular Biology Techniques: A Classroom Laboratory Manual. Netherlands: Academic Press.
6. Paul, A. (2015). Textbook of cell and molecular biology (4th ed.), Books & Allied.
7. Sastry, K. S., Ghosh, S. (1997). Textbook of molecular Biology, Vikas Publishing House.
8. Turner, P., McLennan, A., Bates, A. (2005). Instant Notes in Molecular Biology. Taylor & Francis.

Web Resources

1. Kimball's Biology Pages
<https://www.biology-pages.info/>
2. Khan Academy
<https://www.khanacademy.org/science/biology>
3. Unlocking Life's Code
<https://www.unlockinglifescode.org/>
4. MIT OpenCourseWare
<https://ocw.mit.edu/courses/7-01sc-fundamentals-of-biology-fall-2011/pages/molecular-biology/>
5. iBiology
<https://www.ibiology.org/>

Research Databases

1. PubMed (Animal Physiology Research)
<https://pubmed.ncbi.nlm.nih.gov/>
(Search for research papers and articles on molecular biology)
2. National Center for Biotechnology Information (NCBI)
<https://www.ncbi.nlm.nih.gov/>
(Database for molecular biology)
3. KEGG (Kyoto Encyclopedia of Genes and Genomes)
<https://www.genome.jp/kegg/>
4. The Nucleic Acids Research Molecular Biology Database Collection
<http://www.oxfordjournals.org/nar/database/c/>

Interactive Learning Tools

1. PhET Interactive Simulations – Physiology
<https://phet.colorado.edu/> (Simulations for understanding animal physiological processes)
2. Labster – Virtual Labs for Physiology
<https://www.labster.com/> (Interactive labs for cardiovascular, respiratory, and neural physiology)
3. BioInteractive
<https://www.biointeractive.org/>
(Visual explanations of complex molecular processes)
4. iBiology – Physiology Lectures
<https://www.ibiology.org/>

(Expert-led talks on cutting-edge topics)

Communities and Forums

1. ResearchGate – Animal Physiology Discussions

<https://www.researchgate.net/>

(Forums for discussing research and sharing findings)

2. Biology Stack Exchange

<https://biology.stackexchange.com>

(Ask and answer technical questions on molecular biology)

3. Reddit – Molecular biology

<https://www.reddit.com/r/molecularbiology/?rdt=40537>

4. Bioonline forum

<https://forum.biologyonline.com/topic/molecular-biology-d98>

5. Science forum

https://www.scienceforums.net/forum/14-biochemistry-and-molecular-biology/#google_vignette

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recall the fundamental principles of molecular biology such as DNA replication, transcription, and translation. Describe the central dogma of molecular biology and its significance in cellular processes and genetic diversity. Infer the role of nucleic acids and proteins in the study of genetics, environment and biodiversity. Examine the process of gene expression and its regulation in prokaryotic and eukaryotic systems. Recognize the molecular basis of biodiversity, evolution, embryology, physiology and animal behaviour.	K1, K2
CO2	Illustrate the flow of genetic information from DNA to RNA to protein. Employ molecular biology concepts and techniques to study genetic, physiological and evolutionary aspects of organisms. Apply molecular biology techniques like PCR, microarray, and gel electrophoresis to analyze nucleic acids and proteins. Experiment with gene expression and regulation in prokaryotic and eukaryotic systems. Evaluate the ethical implications of molecular biology in medicine, society and research.	K3, K4
CO3	Critique contemporary molecular biology research to assess the validity and significance of findings. Evaluate the efficiency of molecular techniques RNA interference, or next-generation sequencing in addressing biological and environmental problems. Justify the ethical choice of experimental approaches for studying specific molecular biology questions. Design innovative strategies for gene biodiversity, environmental or therapeutic interventions using molecular biology tools. Invent new applications of	K5, K6

	molecular biology techniques in fields like agriculture, medicine, or environmental science.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4MC02
Course Title	Molecular Biology Lab
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	IV
Regulation	2024
Course Overview This course offers students hands-on training in molecular biology techniques, including the isolation, quantitative and qualitative analysis of nucleic acids. The basic procedures of molecular analysis provide an insight into the theoretical aspects of molecular biology. It will provide learning experience in experimental design, data analysis, and the interpretation of results within the context of molecular biology principles.	
Course Objectives 1. To train students in the isolation of nucleic acids and perform their quantitative and qualitative analysis using standard molecular biology techniques. 2. To equip students with practical knowledge of nucleic acid separation, enzymatic digestion, and ligation processes for genetic studies. 3. To devise the steps in handling and storing nucleic acids and propose the methods for molecular analysis. 4. To enable students to study DNA damage and genomic variation through experimental approaches, emphasizing their applications in genetic and biomedical research.	
Prerequisites	

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Isolation of DNA: Isolation of DNA from plants. Isolation of DNA from fish blood (phenol/ chloroform method). Isolation of DNA from spleen (SSC method).	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Isolation of RNA and protein: Isolation of RNA from yeast cells. Isolation of RNA from mammalian tissue. Isolation of casein from milk.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Quantitative and qualitative analysis of nucleic acids: Quantitation of DNA by diphenylamine method. Quantitation of RNA by orcinol method. Determination of the purity of DNA and RNA. Quantification of DNA and RNA by spectrophotometry.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Electrophoretic separation of nucleic acids: Agarose gel electrophoresis of DNA. Agarose gel electrophoresis of RNA. Elution of DNA from the gel after electrophoresis. Demonstration of SDS-PAGE.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

V	DNA damage and genomic variation: Effect of UV radiation/mutagens on bacterial growth. DNA fingerprinting. Visit to a biotechnology lab and observation of techniques.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Agarwal, S., & Khan, S. (2018). Advanced lab practices in biochemistry and molecular biology. I.K. International Publishing House Pvt. Ltd. 2. Bansal M.P (2013). Molecular Biology and Biotechnology: Basic experimental protocols, The Energy and Resources Institute (TERI). 3. Baunthiyal, M., Ravi, I., & Saxena, J. (2019). Comprehensive laboratory manual of life sciences. Scientific Publishers. 4. Carson, S., Miller, H. B., Srougi, M. C., & Witherow, D. S. (2019). Molecular biology techniques: A classroom laboratory manual. Elsevier Science. 5. Chaitanya K.V (2013). Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd. 6. Masoodi, K. Z., Lone, S. M., & Rasool, R. S. (2020). Advanced methods in molecular biology and biotechnology: A practical lab manual. Elsevier Science. 7. Masters, J. R. W. (2023). Animal cell culture: A practical approach. Oxford University Press. 8. Michael Perlin, William Beckerson, Adarsh Gopinath (2017). Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA. 9. Saxena J., Baunthiyal M., Ravi I (2015). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India. 10. Surya Nandan Meena, Milind Naik (2019). Advances in Biological Science Research: A Practical Approach, Academic Press.				
Suggested Readings 1. Andreas Hofmann, Samuel Clokie (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK. 2. Dutta, S. D., & Dutta, A. (2023). Experimental biotechnology: Practical manual series 06. NIPA. 3. Gupta, N., & Gupta, V. (2021). Experimental protocols in biotechnology. Springer. 4. Hasiya, Y. (2021). Translational biotechnology: A journey from laboratory to clinics. Elsevier Science. 5. Ian Freshney R (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA. 6. Leonard Davis, Mark Dibner, James Battey (2012). Basic Methods in Molecular Biology, Elsevier Science Publishing Co. 7. Robert F. Schleif, Pieter C. Wensink (2012). Practical Methods in Molecular Biology, Springer. 8. Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, (2018). Labster Virtual Lab Experiments: Basic Genetics, Springer. 9. Seidman, L. A., Moore, C. J., & Mowery, J. (2021). Basic laboratory methods for biotechnology: Textbook and laboratory reference. CRC Press.				

10. Singh, B. R., & Kumar, R. (2022). Practical techniques in molecular biotechnology. Cambridge University Press.

Web Resources

1. **National Animal Resource Facility for Biomedical Research (NARFBR), India**
Provides resources for laboratory animal care, training programs, and ethical research practices.
<https://narfbr.org>
2. **Laboratory Animal Resources Center (LARC) - University of Texas at San Antonio**
Dedicated to providing research animal resources and ensuring compliance with animal welfare standards.
<https://research.utsa.edu/larc/>
3. **National Institute of Food and Agriculture (NIFA) - Animal Biotechnology Programs**
Offers funding and guidelines for animal biotechnology research, including genetic and biomedical applications.
<https://www.nifa.usda.gov>
4. **University of Missouri - National Swine Resource and Research Center (NSRRC)**
Focuses on genetically modified swine for biomedical research and advanced genetic technologies.
<https://nsrrc.missouri.edu>
5. **Biotechnology Risk Assessment Research Grants (BRAG) Program - USDA** Supports research on the environmental and societal impact of biotechnology, including animal biotech.
<https://nifa.usda.gov/program/biotechnology-risk-assessment-research-grants-program>
6. **Animal Biotechnology Lab - Texas A&M University** Offers resources and research insights into transgenic and cloned animal production for agricultural and medical purposes.
<https://vetmed.tamu.edu/animal-biotechnology>
7. **Jackson Laboratory** Provides genetically engineered mice models for biomedical research, including transgenic and CRISPR-edited lines.
<https://www.jax.org>
8. **Charles River Laboratories - Animal Models & Services** Offers laboratory animal models and support for preclinical studies and biotechnology research.
<https://www.criver.com>
9. **Addgene - Plasmid Repository for Animal Biotechnology** Provides plasmids, protocols, and resources for genetic engineering research, including work in animal biotechnology.
<https://www.addgene.org>
10. **Comparative Genomics Laboratory - University of Illinois** Focuses on studying animal genomes for applications in medicine, agriculture, and conservation.
<https://vetmed.illinois.edu>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recall fundamental principles and protocols for isolating nucleic acids and recognize the importance of accuracy in quantitative and qualitative analysis. They will identify key steps in nucleic acid separation, enzymatic digestion, and ligation processes, and describe their roles in molecular biology experiments. Additionally, students will understand the basic techniques for cell culture, including maintaining sterile conditions, and explain the significance of studying DNA damage and genomic variation in understanding genetic stability and diversity.	K1, K2
CO2	Apply standard techniques for isolating nucleic acids and conducting their quantitative and qualitative analysis with precision. They will demonstrate proficiency in separating, digesting, and ligating nucleic acids for molecular cloning and other genetic studies. Students will also analyze experimental data to evaluate the quality and integrity of nucleic acids and interpret results to troubleshoot issues in molecular biology experiments. Additionally, they will apply cell culture techniques to maintain viable cells and examine the effects of DNA damage and genomic variation, connecting experimental outcomes to broader implications in genetics and molecular research.	K3, K4
CO3	Evaluate methodologies for isolating nucleic acids and assess the reliability of quantitative and qualitative analysis techniques in molecular biology experiments. They will critically analyze the efficiency of nucleic acid separation, digestion, and ligation processes, and justify their application in specific research scenarios. Students will also design experimental protocols for advanced cell culture studies and develop innovative strategies to investigate DNA damage and genomic variation. Furthermore, they will formulate comprehensive interpretations of experimental data to make informed decisions in genetic and genomic research, contributing to advancements in molecular biology and biotechnology.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	3	3	3	3
CO2	2	3	3	3	3	3	3
CO3	2	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5MC01
Course Title	Immunology
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2024
Course Overview This course provides a comprehensive overview of the human immune system, covering its cellular and organ components, innate and adaptive immune responses, and the role of antigens and antibodies in immunity. It delves into the mechanisms of hypersensitivity and autoimmune diseases, as well as the immune response to cancer and immunodeficiency disorders.	
Course Objectives 1. To understand the basics of immunology, functioning of the immune system, immunological techniques and immune disorders. 2. To distinguish various cell types involved in immune responses and associated functions. 3. To compare and contrast the fundamentals of immunology and organization of immune system and its functions, Immunoglobulin structure and immunological techniques. 4. To understand the role of cytokines in immunity and immune cell activation. 5. To provide an overview of the interaction between the immune system and pathogens, major histocompatibility complex, Hypersensitivity reactions and Tumor immunology.	
Prerequisites	Basics of biotechnology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Overview of the immune system: Historical perspectives, early theories and Basic Concepts of Immunity – The Cells and Organs of the immune system. Hematopoiesis -B and T lymphocytes, mononuclear cells, Granulocytic cells, Mast cells and Dendritic cells. Organs of the Immune system: Primary lymphoid organs - Thymus and bone marrow; Secondary Lymphoid organs - Lymph nodes and spleen; Mucosal associated lymphoid tissues.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Types of Immunity: Principles of Innate Immunity and Adaptive Immunity; Anatomical barriers, Physiological barriers, Endocytic and Phagocytic barriers, Inflammatory response; Acquired immunity - Antigen presenting cells, Functions of humoral and cell-mediated immune responses. Major Histocompatibility Complex (MHC): General organization and inheritance of the MHC. Structure and cellular distribution of HLA antigens. Cytokines - General	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Properties, related diseases and therapeutic uses of cytokines and their receptors.			
III	Antigen & Antibody: Immunogenicity versus Antigenicity, Factors that influence immunogenicity - Essential features of antigens, Epitopes - properties of B-cell epitopes and properties of T-cell epitopes. Immunoglobulins: Structure & function; Antigenic determinants of immunoglobulins, Different classes of Antibodies. Hybridoma technology - production of monoclonal antibodies and catalytic antibodies (abzymes).	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Hypersensitivity & Transplantation immunology: Hypersensitive reactions - classification and brief description of various types of hypersensitivities. Autoimmunity: Cause of autoimmune diseases - organ-Specific and Systemic autoimmune diseases. Transplantation immunology: Immunologic basis of graft rejection, General immunosuppressive therapy and clinical transplantation.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Immunology of Tumors: tumor antigens, immune response to tumor antigens, cancer immunotherapy and tumor-cell vaccines. Immunization: active and passive immunization. Vaccines from whole organisms, purified macromolecules and synthetic peptides -Immunization schedule. Immune response to infectious diseases - Viral, Bacterial and protozoan diseases.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Annadurai. B (2008). A Text Book of Immunology and Immunotechnology, S.Chand & Co.
2. Chakravarty, A. K. (2014). Immunology and Serology. Kolkata, India: New Central Book Agency.
3. Coleman,R.M (2014). Fundamental Immunology, 2nd Edition, Published by Mc Graw Hill.
4. Kannan. I (2007). Immunology. MJP Publishers.
5. Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J, 2018. Immunology, 8th Edition, W.H.Freeman Publishing, New York.
6. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. M. (2012). Immunology (8th ed.). Elsevier.
7. Parija, S. C. (2009). Textbook of Immunology and Immunotechnology. Springer.
8. Punt, J., Stranford, S. A., Jones, P. P., & Owen, J. A. (2019). Kuby Immunology (8th ed.). Macmillan Learning.
9. Raj Khanna (2011). Immunology, Oxford University press.
10. Rao.C.V (2011). Immunology, Narosa Publishing House.
11. Rastogi. S. C (2011). Elements of Immunology, CBS Publishers & Distributors.
12. Roitt, M, Peter J. Delves, Seamus J. Martin and Dennis R. Burton, 2017. Essential Immunology, 13th Edition, Wiley-Blackwell Publishing,USA.
13. Srivastava, R. K., & Srivastava, A. (2008). Textbook of Immunology and

Immunotechnology. CBS Publishers.

14. Vaman Rao. C (2006). Immunology, Narosa, Publishing House.

Suggested Readings

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2018). Basic Immunology: Functions and Disorders of the Immune System (6th ed.). Elsevier.
2. Abul A. Andrew, Lichtman. H, Shiv. P, 2014. Cellular and Molecular Immunology, 8th Edition, Published by W.B. Saunders.
3. Abul A. Andrew, Lichtman. H, Shiv. P (2014). Cellular and Molecular Immunology, W.B. Saunders.
4. Chapel. H, Haeney. M, Misbah. S, and Snowden. N (2006). Essentials of Clinical Immunology, Blackwell Publishing.
5. Chapel. H, Haeney. M, Misbah. S, and Snowden. N, 2006. Essentials of Clinical Immunology, 5th Edition. Blackwell Publishing.
6. Coleman,R.M., 2014. Fundamental Immunology, 2nd Edition, Published by Mc Graw Hill Education India.
7. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2019). Kuby Immunology (8th ed.). W. H. Freeman.
8. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2017). Immunobiology: The Immune System in Health and Disease (9th ed.). Garland Science.
9. Kenneth Murphy & Casey Weaver (2016). Janeway's Immunology, Garland Science publishers.
10. Kenneth Murphy & Casey Weaver, 2016. Janeway's Immunology, Garland Science publishers.
11. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). Immunology (6th ed.). W. H. Freeman.
12. Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J (2018). Immunology, W.H. Freeman Publishing.
13. Parham, P. (2014). The Immune System (4th ed.). Garland Science.
14. Raj Khanna, 2011. Immunology, Oxford University press, New Delhi.
15. Roitt, M, Peter J. Delves, Seamus J. Martin and Dennis R. Burton (2017). Essential Immunology, Wiley-Blackwell Publishing.
16. Sharma, A. K., Katyal Batra, P., & Mishra, N. K. (2022). Immunology: An Introductory Textbook. Routledge.
17. Tizard, I. R. (2013). Immunology: An Introduction (8th ed.). Cengage Learning.
18. William R. Clark (1985). The Experimental Foundations of Modern Immunology, Johns Hopkins University Press.
19. William R. Clark, 1985. The Experimental Foundations of Modern Immunology, Published by Johns Hopkins University Press, New York.

Web Resources

Educational Resources

1. **Immunology Explained by AAI**

A comprehensive guide to understanding immunology principles and their applications,

hosted by the American Association of Immunologists.

<https://immunologyexplained.aai.org>

2. NIH: Overview of the Immune System

A detailed overview of the immune system by the National Institute of Allergy and Infectious Diseases (NIAID).

<https://www.niaid.nih.gov/research/immune-system-overview>

3. iBiology Immunology Videos

Free educational videos and lectures on immunology topics, including B-cell development and immune system function.

<https://www.ibiology.org>

Research and Professional Development

1. The Journal of Immunology (AAI)

Peer-reviewed articles and cutting-edge research in immunology.

<https://www.jimmunol.org>

2. ImmunoHorizons

A platform for innovative immunological research, hosted by AAI.

<https://www.aai.org/Publications/ImmunoHorizons>

Interactive Learning Tools

1. Flow Cytometry Learning Tools (AAI)

Resources for understanding and analyzing flow cytometry data, including remote-access tools for teaching.

<https://aai.org/education/flow-cytometry>

Communities and Forums

1. American Association of Immunologists (AAI)

A professional organization offering networking, resources, and events for immunologists.

<https://www.aai.org>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms in immunology, such as antigen, antibody, cytokine, and complement. Describe the structure and function of the major organs of the immune system, including the thymus, bone marrow, spleen, and lymph nodes. Explain the cellular components of the immune system, such as lymphocytes, macrophages, and dendritic cells. Identify the different types of innate immune responses, including phagocytosis, inflammation, and complement activation. Summarize the process of antigen recognition by T and B lymphocytes. Outline the mechanisms of antibody production and their role in immunity.	K1, K2
CO2	Analyze the complex interactions between innate and adaptive immune responses. Evaluate the role of the immune system in the pathogenesis of autoimmune diseases, such as rheumatoid arthritis and systemic lupus	K3, K4

	erythematosus. Critically analyze the mechanisms of hypersensitivity reactions, including allergies and anaphylaxis. Assess the effectiveness of vaccines in preventing infectious diseases. Apply knowledge of immunology to understand the development of immunodeficiency disorders, such as HIV/AIDS.	
CO3	Create innovative strategies for designing new vaccines and immunotherapies. Design and conduct experiments to investigate the mechanisms of immune responses and immune-related diseases. Synthesize information from diverse sources to develop a comprehensive understanding of the immune system and its role in health and disease. Evaluate the ethical implications of immune therapies and propose guidelines for responsible use. Critically analyze the limitations of current immunology research and identify emerging areas of research.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3	3	3
CO2	3	2	3	3	1	3	3
CO3	3	3	3	2	3	2	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	2	2
CO2	3	3	3	2	3	3	3
CO3	3	2	3	2	3	1	3

Course Code	UAZ5MC02
Course Title	Evolution and Animal Behaviour
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2024
Course Overview This course explores the fundamental concepts surrounding the origin of life and the mechanisms of evolution, delving into the genetic basis of behavior and its influence on patterns of behavior in various organisms. Students will examine social behavior and the role of biological clocks in regulating behavior across species. Through an interdisciplinary approach, the course combines principles from biology, genetics, and ethology to understand how these factors shape life on Earth.	
Course Objectives 1. To understand the theories and evidence regarding the origin of life and the mechanisms of evolution, including natural selection and genetic drift. 2. To analyze the genetic basis of behavior and how it influences various behavioral patterns across different species. 3. To examine social behavior in organisms, including the factors that drive social interactions and their evolutionary significance. 4. To explore the role of biological clocks in regulating behavior and physiological processes, and understand their impact on adaptation and survival in changing environments.	
Prerequisites	Basic knowledge of animals / Invertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Origin of life: Ancient and medieval beliefs. Modern hypothesis of the origin of life. Chemical origin of life. Origin of protocells. Biological evolution (Biogeny). Evolution of eukaryotes (Cognogeny). Evidence of evolution- Evidence from comparative anatomy, embryology, paleontology, biogeography, taxonomy, cytology, biochemistry, genetics and physiology. Lamarckism and Neo-Lamarckism. Darwinism and Neo-Darwinism.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Mechanism of evolution: Variation, mutation, Chromosomal aberrations, Polyploidy and aneuploidy, Genetic equilibrium, Natural selection, Genetic drift, Polymorphism, Isolation and origin of species. Paleontology- Rocks and fossils, Geological Time Scale, Determination of evolutionary rates. Evolution of man.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Patterns of behavior: Stereotypes behavior- Spatial orientation, Reflexes, Instincts, Motivation, Neurophysiology of motivation. Acquired Behaviour- Non-associative learning; habituation and sensitization. Associative learning; Classical conditioning (Pavlov's experiment), Operant conditioning, Avoidance conditioning, Latent learning, Insight learning, Imprinting, Memory.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Genetic basis of behavior: Single gene effects- Mendelian crosses, Mutations, Knockout genes, Genetic mosaic fruit flies. Multiple Gene effects- Cross-fostering experiments, Twin studies, Inbred lines, polygenic effects. Evolution of behavior: Micro and macroevolutionary changes in behavior, Evolutionary Stable Strategies.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Social behavior and biological clock: Conflict, vacuum activities, aggression. Animal communication, Innate Releasing Mechanism, Pheromones. Social behaviour- Group selection, Kin selection, Altruism, Inclusive fitness, Social organization, Territoriality, Mating systems, Parental care, Animal migration. Biological clock- Biorhythms (Circadian, circa tidal, lunar, semilunar, circannual).	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Agarwal, V. K (2009). Animal Behaviour (Ethology), S. Chand & Co.
2. Kishore R. Pawar, Ashok E. Desai (2019). A text book of Organic Evolution, Nirali Prakashan,
3. Kumar, V (2002). Biological Rhythms: Narosa Publishing House.
4. Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley.
5. Pandey, B. N (2012). BSc Zoology Series: Ecology and Animal Behaviour, Tata McGraw Hill.
6. Sanjib Chattopadhyay (2009). Life : Evolution, Adaptation and Ethology, Books and Allied.
7. Sharma, N. S (2005). Continuity and Evolution of Animals, International Scientific Publishing Company.
8. Subramnian, M. A (2015). Chordate Evolution, MJP Publishers, New Delhi. 231pp.
9. Veer Bala Rastogi (2015). Evolutionary Biology. Kedar Nath Ram Nath, Meerut, 561pp.

Suggested Readings

1. Alcock, J (2005). Animal Behaviour (8th edition) Sinauer Associate Inc., USA.
2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
3. Colbert, E.H. Morales, M. and Minkoff, E.C (2011). Colbert's Evolution of The Vertebrates: A History of the Backboned Animals Through Time, Wiley, India.
4. Dunlap, J. C.; Loros, J.J. and DeCoursey, P. J (2009). Chronobiology Biological Timekeeping (1st edition) Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

5. Hall, B. K. and Hallgrímsson, B (2008). Evolution. IV Edition. Jones and Bartlett Publishers
6. Harth and Jones EW (1998). Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.
7. Lull, R.S (2010). Organic evolution, The Macmillan.
8. Manning, A. and Dawkins, M. S (2012). An Introduction to Animal Behaviour (6th edition) Cambridge, University Press, UK.
9. McFarland, D (1999). Animal Behaviour, Pitman Publishing Limited, London, UK.
10. Ridley, M (2004). Evolution. III Edition. Blackwell Publishing.
11. Russ Hodge (2010). Developmental Biology, Facts on File, Inc., New York, USA.
12. Sherman, P. W. and Alcock, J (2013). Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
13. Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
14. Stricberger, M.W (1996). Evolution. Jones& Bartlett, USA

Web Resources

1. **Cambridge University Press - Introduction to Animal Behaviour**
A comprehensive resource covering the fundamentals of animal behaviour, including its evolutionary aspects. It includes fascinating case studies and evolutionary mechanisms.
URL: <https://www.cambridge.org>
2. **Natural History Museum - Evolution and Behaviour of Mammals**
This site provides in-depth research on the evolutionary aspects of animal behaviour, focusing on mammalian species such as elephants. The role of behaviour in evolutionary processes like exaptation is also discussed.
URL: <https://www.nhm.ac.uk>
3. **Syracuse University - Evolution and Animal Behaviour Research**
Syracuse University's Evolution and Animal Behaviour group investigates how genetics, physiology, and behaviour contribute to evolutionary processes and biological diversity. Their work spans various species, and they offer resources for further study.
URL: <https://artsandsciences.syracuse.edu>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key concepts related to the origin of life and mechanisms of evolution, and describe various patterns of behavior observed in living organisms. They will also identify the genetic factors influencing behavior and understand the significance of social behavior and biological clocks in the adaptation and survival of species.	K1, K2
CO2	Apply concepts of evolution to analyze patterns of behavior in various species, and evaluate the genetic basis of behavior to understand its impact on social interactions. They will also analyze the role of biological clocks in regulating	K3, K4

	behavior and physiological processes, allowing them to interpret how these mechanisms contribute to survival and adaptation in changing environments.	
CO3	Synthesize knowledge of the origin of life and evolutionary mechanisms to formulate hypotheses about the relationship between genetics and behavior. They will design experiments to test the effects of biological clocks on behavioral patterns and create comprehensive models that integrate social behavior, evolutionary theory, and genetic influences to better understand the complexities of life.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	3	3	3	3
CO2	3	2	3	3	3	3	3
CO3	3	2	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5MC03
Course Title	Animal Biotechnology
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	V
Regulation	2024
Course Overview This course provides an in-depth exploration of advanced techniques in biotechnology, focusing on animal cell culture, gene manipulation, and hybridoma technology. Students will learn the principles and practical applications of these methods in research and industry, including cell culture for therapeutic production, genetic modifications for enhanced traits, and antibody production through hybridoma technology. The course emphasizes applied biotechnology, equipping students with skills to develop and optimize biotechnological processes for medical, agricultural, and industrial applications.	
Course Objectives 1. To infer genome organizational complexities and explain the molecular processes essential for life. 2. To enable students to grasp the fundamentals of gene manipulation and its applications, including recombinant DNA technology for genetic modification and trait enhancement. 3. To establish genetic manipulation protocols for animal cells and illustrate the steps in genetic engineering. 4. To appraise the significance of gene transfer technologies in animal husbandry and design novel medical therapies based on recombinant DNA technology.	
Prerequisites	Basic knowledge on Biology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Basic principles of animal cell culture: Cell lines - definition, types (finite, continuous/established, transformed), culture vessels for small-scale and large-scale culture of cells, types and constituents of culture media; temperature, pH, oxygen and carbondioxide requirements; initiation of primary cultures, feeding, subculturing, secondary culture; cryopreservation of cell lines; applications of animal cell culture.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Genetic engineering of animal cells: Recombinant DNA technology - definition, basic steps in gene cloning; cloning vectors – definition, general structure of a cloning vector; plasmid vectors (pBR322, pUC19), bacteriophage lambda	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	vector, cosmids; host cells used for cloning; selectable markers; methods of gene transfer into animal cells, preparation of genomic and cDNA libraries, methods for screening of libraries for the target gene; applications of recombinant DNA technology.			
III	Genetic modification of animals: Transgenesis – definition, production and applications of transgenic mice, cattle, poultry and fish; animal pharming; creation of animal clones; animal disease model for cancer; genetic manipulation of rumen fermentation; ethical and regulatory issues regarding genetically modified organisms.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Medical applications: Production of recombinant human insulin; recombinant vaccines – subunit, peptide, live recombinant vaccines, mRNA vaccines, edible vaccines; production and applications of monoclonal antibodies (hybridoma technology); gene therapy – types, gene therapy strategies.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Applied biotechnology: Human genome project - overview, applications, ethical, legal and social implications; molecular taxonomy - DNA barcoding, species identification using molecular markers; animal conservation strategies – gene banks, somatic cell banking, cloning of extinct animals from fossil DNA.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Capes-Davis, A., Freshney, R. I. (2021). Freshney's culture of animal cells: A manual of basic technique and specialized applications, Wiley.
2. Dubey R. C (2014). A text Book of Biotechnology, S. Chand & Co.
3. Glick, B. R., Patten, C. L. (2022). Molecular biotechnology: Principles and applications of recombinant DNA, Wiley.
4. Ignacimuthu, S (2008). Basic Biotechnology, Tata McGraw hill.
5. Primrose, S. B., Twyman, R. (2014). Principles of gene manipulation and genomics, John Wiley and Sons.
6. Ramadass. P (2020). Animal Biotechnology. MJP Publishers.
7. Ranga, M.M (2003). Animal Biotechnology, Agrobios.
8. Rastogi S. C (2007). Biotechnology: Principles and applications, Alpha Science publishers.
9. Ruby, R.C., 2012. A Textbook of biotechnology, S. Chand Company.
10. Sasidhara, R (2015). Animal biotechnology, MJP publishers.
11. Sathyanarayana U (2008). Biotechnology, Books and Allied.
12. Singh B. D (2015). Biotechnology: Expanding horizon, Kalyani publishers.

Suggested Readings

1. Brown, T. A. (2018). Genomes 4. CRC Press.
2. Godbey W.T (2014). An Introduction to Biotechnology, Academic press.
3. Hames B.D. and Higgins S.J (1995). Gene Probes: A Practical Approach, Oxford University Press.
4. Hames B.D. and Higgins S.J (1995). Gene Probes: A Practical Approach, Oxford University Press.
5. Michael Crichton (2014). Essentials of Biotechnology, Medtech, Maine.
6. Peters, P (2009). Biotechnology – A guide to genetic engineering, WMC brown publisher.
7. Ramawat, K.G and Shailey Goyal (2009). Comprehensive biotechnology, S. Chand Co.
8. Renneberg, R. (2023). Biotechnology for beginners. Academic Press.
9. Srivastava, A. K., & Singh, R. K. (2018). Animal biotechnology. Oxford and IBH Publishing.
10. Veer Bala Rastogi (2016). Principles of Molecular biology, Medtech, Maine.

Web Resources**Educational Resources**

1. ISAAA Knowledge Center - Animal Biotechnology
<https://www.isaaa.org/resources/animal-biotechnology>
2. UC Davis Animal Biotechnology Program
<https://animalbiotech.ucdavis.edu>
3. Learn Genetics - University of Utah
<https://learn.genetics.utah.edu>

Communities and Forums

1. ResearchGate
<https://www.researchgate.net>
2. Reddit Biotechnology Subreddit
<https://www.reddit.com/r/biotechnology>
3. Biology Online Forums
<https://www.biology-online.org/forums>

Research Databases

1. PubMed
<https://pubmed.ncbi.nlm.nih.gov>
2. GenBank (NCBI)
<https://www.ncbi.nlm.nih.gov/genbank>
3. FAO's Domestic Animal Diversity Information System (DAD-IS)
<http://www.fao.org/dad-is/en>

Specialized Resources

1. CRISPR Tools by Addgene
<https://www.addgene.org>
2. Animal and Plant Health Inspection Service (APHIS)
<https://www.aphis.usda.gov/aphis/ourfocus/biotechnology>

Interactive Learning Tools

1. Biotech Basics by Biotechnology Innovation Organization (BIO)
<https://www.bio.org>
2. FAO Biotech Interactive Tools
<http://www.fao.org/biotech/en/>
3. ISAAA Webinars and Online Tools
<https://www.isaaa.org/resources/animal-biotechnology>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and describe the fundamental concepts and methodologies involved in animal cell and tissue culture, explaining the basic requirements and protocols for successful culture environments. They will identify key enzymes used in biotechnology, recall their properties, and explain their roles in industrial and therapeutic applications. Students will also define and describe essential principles of gene manipulation, detailing the steps involved in recombinant DNA technology and genetic modification processes. Additionally, they will recognize the techniques behind hybridoma technology and summarize its significance in producing monoclonal antibodies, focusing on its applications in diagnostics, research, and therapeutics.	K1, K2
CO2	Apply foundational knowledge of animal cell and tissue culture techniques to set up, maintain, and troubleshoot cell cultures under laboratory conditions, tailoring environments to specific cell types and research goals. They will analyze the properties and functions of enzymes in various biotechnological applications, evaluating enzyme kinetics, stability, and specificity for optimal industrial or therapeutic use. Students will demonstrate practical skills in gene manipulation, constructing recombinant DNA molecules, and utilizing gene-editing techniques to modify genetic material for desired outcomes. Additionally, they will compare and interpret methods in hybridoma technology for monoclonal antibody production, assessing its impact and advantages in biotechnological research, diagnostics, and therapy development.	K3, K4
CO3	Evaluate and critique advanced cell and tissue culture methodologies, assessing the efficacy, ethical considerations, and scalability of various culture systems for medical and industrial applications. They will design and optimize enzyme-based processes, making informed decisions on enzyme selection, modification, and stabilization to enhance productivity in biotechnological and therapeutic applications. Students will also formulate and justify strategies for gene manipulation, integrating contemporary genetic	K5, K6

	engineering and CRISPR technologies to address complex challenges in biotechnology. Finally, they will create innovative applications of hybridoma technology, proposing antibody production solutions tailored to specific research, diagnostic, or therapeutic needs.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	2	2	3	3	3
CO2	1	3	2	2	3	3	3
CO3	1	3	2	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5MC04
Course Title	Bioinformatics Lab
Credits	03
Hours/Week	03
Category	Major Core (MC) – Lab
Semester	V
Regulation	2024
Course Overview This lab course provides hands-on experience with major biological databases and computational tools for gene and protein sequence analysis, protein structure evaluation, and drug discovery. It also introduces specialized tools for zoological research, enabling students to explore and analyze biological and molecular data for advanced research applications.	
Course Objectives 1. To train students to navigate and retrieve information from major biological databases for genes, proteins, and related molecular data. 2. To equip students with the skills to utilize computational tools for analyzing gene and protein sequences to gain insights into their functions and evolutionary relationships. 3. To introduce students to tools for analyzing protein structures and properties, and databases used in drug discovery to identify potential therapeutic targets. 4. To familiarize students with specialized tools and databases for zoological studies, enabling them to analyze and interpret data relevant to animal biology and taxonomy.	
Prerequisites	Basic knowledge of biotechnology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Major biological databases: Exploration of the NCBI database and its tools. Exploration of the resources in the ExPASy database. Exploration of the resources of the PDB database. Literature retrieval from PubMed and PubMed Central databases. Retrieval of information about a genetic disorder from the OMIM database.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Tools for gene and protein sequence analysis: Retrieval of gene and protein sequences in FASTA format from NCBI database. Sequence similarity search using Nucleotide BLAST. Sequence similarity search using Protein BLAST. Alignment of DNA sequences using Clustal Omega. Alignment of protein sequences using Clustal Omega. Gene Prediction using GENSCAN.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Tools for analyzing protein structure and properties: Analysis of proteins using Compute pI/MW. Determination of protein properties using ProtParam. Downloading protein	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	structures from PDB. Visualizing protein structures at PDB using the NGL Viewer. Viewing protein 3D structures with iCn3D. Homology modelling with SwissMODEL.			
IV	Drug discovery databases and tools: Retrieval of drug/ligand information and 3D structure from the PubChem database. Drug discovery with SwissSimilarity. Drug discovery with SwissTarget Prediction. Inference of drug metabolism with SwissADME. Identification and analysis of disease genes from the KEGG database. Molecular docking with SwissDOCK.	09	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Tools for zoological research and information: Cellosaurus VenomZone. OBIS-SEAMAP. BOLD systems. Databases on Animal Genetic resources (ICAR initiative).	09	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Higgins, D., & Taylor, W. (2023). Bioinformatics: Sequence, structure and databanks. Oxford University Press.
2. Ismail, H. D. (2022). Bioinformatics: A practical guide to NCBI databases and sequence alignments. CRC Press.
3. Rana, S., Singh, V., Kashyap, P., & Sharma, B. (2020). Bioinformatics practical manual. Manojvm Publishing House.
4. Singh, D. B., & Pathak, R. K. (2021). Bioinformatics: Methods and applications. Elsevier Science.
5. Sofi, M. Y., Shafi, A., & Masoodi, K. Z. (2021). Bioinformatics for everyone. Elsevier Science.

Suggested Readings

1. Fdez-Riverola, F., Castellanos-Garzón, J. A., & Rocha, M. (2019). Practical applications of computational biology and bioinformatics, Springer.
2. Ojha, H., Sharma, N., Raghav, P., & Goyal, R. K. (2021). Chemoinformatics and bioinformatics in the pharmaceutical sciences. Elsevier Science.
3. Winkler, R. (2020). Processing metabolomics and proteomics data with open software: A practical guide. Royal Society of Chemistry.
4. Ye, S. Q. (2019). Bioinformatics: A practical approach. Taylor & Francis Ltd.
5. Yee Low, L. W., & Tammi, M. T. (2023). Practical bioinformatics for beginners: From raw sequence analysis to machine learning applications. World Scientific Company.

Web Resources**Educational Resources**

1. **NCBI (National Center for Biotechnology Information):** A vast repository of biological information, including databases, tools, and educational resources.
<https://www.ncbi.nlm.nih.gov/>
2. **ExPASy (Expert Protein Analysis System):** A comprehensive web portal for proteomics and bioinformatics.
<https://www.expasy.org/>

3. **Rosalind:** An interactive platform for learning bioinformatics through problem-solving.
<https://rosalind.info/>
4. **Bioinformatics.org:** A non-profit organization dedicated to promoting bioinformatics education and research.
<https://www.bioinformatics.org/>

Communities and Forums

1. **Biostars:** A question-and-answer forum for bioinformatics.
<https://www.biostars.org/>
2. **Reddit:** A popular social media platform with subreddits dedicated to bioinformatics, such as r/bioinformatics.
<https://www.reddit.com/>
3. **ResearchGate:** A social networking site for scientists and researchers.
<https://www.researchgate.net/>

Research Databases

1. **PubMed:** A biomedical literature database.
<https://pubmed.ncbi.nlm.nih.gov/>
2. **UniProtKB:** A comprehensive resource for protein sequence and functional information.
<https://www.uniprot.org/>
3. **GenBank:** A primary repository for sequence data.
<https://www.ncbi.nlm.nih.gov/genbank/>
4. **EMBL-EBI (European Bioinformatics Institute):** A leading institute for bioinformatics research and services.
<https://www.ebi.ac.uk/>

Specialized Resources

1. **Galaxy Project:** A platform for accessible, reproducible, and transparent computational biomedical research.
<https://galaxyproject.org/>
2. **Bioconductor:** A collection of open-source software tools for bioinformatics.
<https://www.bioconductor.org/>
3. **Open Bioinformatics Foundation (OBF):** A non-profit organization promoting open-source bioinformatics tools.
<https://startbioinfo.org/cgi-bin/browse.pl>

Interactive Learning Tools

1. **Khan Academy:** Offers free online courses in biology and genetics.
<https://www.khanacademy.org/>
2. **Coursera:** Offers online courses in bioinformatics and related fields.
<https://www.coursera.org/>
3. **edX:** Offers online courses in bioinformatics and related fields.
<https://www.edx.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify major biological databases (NCBI, UniProtKB, PDB, ubChem, etc.) and their specific roles in biological research. Recognize common file formats used in bioinformatics (FASTA, GenBank, PDB, etc.) and their significance in data analysis. Distinguish between different types of sequence analysis tools (BLAST, Clustal Omega, etc.) and their applications in gene and protein sequence analysis. Understand the basic principles of protein structure prediction and analysis tools (I-TASSER, PyMOL, etc.). Appreciate the importance of drug discovery databases (DrugBank, ChEMBL, etc.) in the pharmaceutical industry. Know the significance of various zoological databases (ZooBank, GBIF, etc.) in taxonomic research and biodiversity studies. Utilize major biological databases to retrieve relevant biological information. Employ sequence analysis tools to align, compare, and analyze gene and protein sequences. Apply protein structure prediction and analysis tools to visualize and interpret protein structures. Use drug discovery databases to identify potential drug targets and design novel drug molecules. Leverage zoological databases to explore taxonomic information, species distribution, and conservation status. Interpret the results obtained from bioinformatics analyses and draw meaningful conclusions. Solve biological problems using a combination of bioinformatics tools and techniques.	K1, K2
CO2	Explain the underlying principles and algorithms of various bioinformatics tools. Interpret the results generated by bioinformatics analyses and draw meaningful biological insights. Summarize the key findings from literature and experimental data using bioinformatics tools. Compare and contrast different bioinformatics tools and their suitability for specific research questions. Justify the choice of bioinformatics tools and techniques for a given research problem. Analyze large-scale biological datasets using bioinformatics tools to identify patterns and trends. Evaluate the quality and reliability of bioinformatics data and results. Critically assess the limitations and potential biases of bioinformatics tools and techniques. Design and implement bioinformatics workflows to address complex biological questions. Troubleshoot common issues encountered in bioinformatics analyses and propose solutions. Integrate information from multiple sources (databases, literature, and experimental data) to form a coherent understanding of biological systems.	K3, K4
CO3	Create novel bioinformatics pipelines to address specific research questions. Develop new bioinformatics tools and algorithms to improve the efficiency and accuracy of data analysis. Propose innovative solutions to biological problems using bioinformatics approaches. Integrate knowledge from	K5, K6

	multiple disciplines (biology, chemistry, computer science) to solve complex biological problems. Design and conduct independent research projects using bioinformatics techniques. Critique the limitations and potential biases of existing bioinformatics tools and databases. Evaluate the impact of bioinformatics on scientific research and society. Assess the ethical implications of using bioinformatics for research and applications. Justify the significance of bioinformatics in addressing global challenges such as climate change, disease, and food security. Defend the use of bioinformatics as a powerful tool for scientific discovery.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5MC05
Course Title	Medical Laboratory Technology
Credits	03
Hours/Week	03
Category	Major Core (MC) - Theory
Semester	V
Regulation	2024
Course Overview This course provides a comprehensive overview provides comprehensive training in diagnostic laboratory techniques, equipping students with the skills to analyse body fluids, tissues, and other medical specimens. The course covers key areas like clinical biochemistry, microbiology, haematology, and immunology, emphasizing practical and theoretical knowledge. Students gain proficiency in operating advanced laboratory equipment, adhering to safety protocols, and interpreting diagnostic results. Designed to meet the needs of modern healthcare, the program prepares graduates for rewarding careers in hospitals, diagnostic labs, and research facilities.	
Course Objectives 1. To equip students with the knowledge and skills to perform accurate diagnostic tests and analyze medical samples effectively. 2. To train students in the use of advanced laboratory equipment, maintenance of lab safety protocols, and quality control procedures. 3. To provide a strong foundation in subjects like clinical biochemistry, microbiology, hematology, and immunology to support accurate disease diagnosis. 4. To foster a commitment to ethical practices, confidentiality, and professionalism in medical laboratory settings. 5. To enable students to pursue careers in diagnostic laboratories, hospitals, and research institutions or further studies in specialized fields.	
Prerequisites	Basic understanding of biology, biochemistry, laboratory safety, common lab techniques, and ethical considerations.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Laboratory Safety Human Health and Hygiene : Laboratory safety –toxic chemicals and biohazards waste- biosafety level- good laboratory practice – hygiene and health issue -physiology effect of alcohol, tobacco, smoking & junk food & its treatment – Biomedical waste management. Malaria, Dengue, Chikungunya-symptoms, causes, diagnosis, treatment, prevention. First Aid treatment- Sterilization procedures.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

II	Hematology: Composition of blood and their function- Types of blood collection. Blood grouping- Types of Anemia, causes- blood coagulation mechanism-Factors- Bleeding time- Clotting time- Determination of hemoglobin- Erythrocyte Sedimentations Rate- Packed Cell Volume- Total count of Red blood cell count & White blood cell count- Differential count WBC- blood grouping and typing- hemostasis- bleeding disorder of man - Hemolytic disease of newborn, Platelet count, Reticulocytes count, Absolute Eosinophil count. Hemoglobin estimation by cyanmethemoglobin method.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Bio Instrumentation Techniques: Sphygmomanometer- Stethoscope-Thermometer-Ultrasound Machine- X-ray Machine-Electrocardiogram (ECG or EKG)-Computer tomography (CT scan)- Magnetic Resonance imaging (MRI) – Flowcytometry – Treadmill Test – PET. ELIS, Mammogram- Dialysis-Hemo and Peritoneal dialysis techniques-Endoscope- Pulse Oximeter.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Medical Physiology: Blood Parasites- <i>Entamoeba histolytica</i> , <i>Plasmodium Spp</i> , <i>Leishmania</i> - <i>Trypanosome-Babesia spp</i> - <i>Leptospira spp</i> . <i>Wuchereria bancrofti</i> . Cardiovascular system- regulation of heart rate, cardiac shock. Heart sounds, Electroencephalography (EEG). Echocardiogram (ECHO), urine and stool analysis- Blood Glucose- Body fluid analysis.	09	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Diagnostic Pathology: Autopsy and Biopsy, Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome-sectioning, staining –staining methods- vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.	09	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Biswapati Dasgupta (2000). Parasitology, Books and Allied (P) Ltd.
2. Chakraborty, P. (2017). A Textbook of Microbiology for Medical Laboratory Technicians. Kolkata: New Central Book Agency.
3. Dey, N. C. (2016). Dey & Dey's Textbook of Pathology and Microbiology for Medical Laboratory Technology. S. N. Ghosh & Co.
4. Godkar, P. B., & Godkar, D. P. (2021). Textbook of Medical Laboratory Technology: Volumes 1 & 2 (3rd updated edition). Mumbai: Bhalani Medical Book House.
5. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Mukherjee, K. L. (2010). Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests.

Tata McGraw Hill.

6. Kanai, L. (2014). Kanai's Manual of Clinical Laboratory Science. Chennai: CBS Publishers & Distributors.
7. Mukherjee, K. L. (2010). Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests. Tata McGraw Hill.
8. Pattabiraman, T. N. (2019). Biochemistry and Medical Laboratory Technology: An Introductory Textbook. New Delhi: I.K. International Publishing House.
9. Rajan, S (2012). Manual for Medical Laboratory Technology, Anjanaa Book house.
10. Sant, M. (2018). Textbook of Medical Laboratory Technology (2nd edition). New Delhi: Jaypee Brothers Medical Publishers.
11. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.
12. Venkatesan. P and V. Surendranath (2007). Human Pathogens, Sreeswathi Enterprise.

Suggested Readings

1. Das, D. (2017). Handbook of Medical Laboratory Technology. CBS Publishers & Distributors.
2. Godkar, P. B., & Godkar, D. P. (2024). Textbook of Medical Laboratory Technology (4th ed., Volumes 1 and 2). Bhalani Publishing House.
Sood, R. (2006). Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers.
3. Kanai, L. (2013). Clinical Laboratory Medicine: A Textbook of Laboratory Procedures and Diagnosis. CBS Publishers & Distributors.
4. Maheshwari, N., & Tiwari, P. (2018). Essentials of Medical Laboratory Technology. Paras Medical Publisher.
5. Manoharan, A, and Sethuraman, 2003. Essential of Clinical Hematology, Jaypee brothers, New Delhi.
6. Ochei, J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.
7. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia. Published by Tata McGraw-Hill Education Pvt. Ltd.,

Web Resources

1. **American Society for Clinical Pathology (ASCP) - Education & Certification**
Offers a wide range of educational programs for laboratory professionals, including certification, webinars, and training courses.
<https://www.ascp.org/content/education>
2. **American Medical Technologists (AMT)**
Provides continuing education, certification programs, and a community for professionals in the laboratory field.
<https://www.americanmedtech.org/>
3. **OneLab by CDC - Online Laboratory Training**
The CDC's OneLab initiative offers free training resources, webinars, and eLearning courses for lab professionals, with an emphasis on public health and diagnostic testing.
<https://reach.cdc.gov>

4. ClinicalLab - Online Laboratory Training This site provides access to various online training programs and resources specifically tailored for medical laboratory technicians and technologists. https://www.clinicallab.com
5. National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) A comprehensive resource for accreditation and certification of laboratory education programs, supporting academic and professional growth. https://www.nacls.org
6. LabCE - Online Continuing Education for Laboratory Professionals Provides online courses and webinars in various laboratory disciplines to help professionals maintain their certifications. https://www.labce.com

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms in microbiology and hematology, such as bacteria, virus, fungus, erythrocyte, leukocyte, and platelet. Describe the basic structure and function of bacteria, viruses, and fungi. Explain the mechanisms of bacterial growth, reproduction, and metabolism. Identify the different types of white blood cells and their roles in the immune system. Summarize the principles of blood clotting and hemostasis. Outline the basic concepts of pharmacology, including drug action, metabolism, and excretion. Describe the principles of histopathology and its role in disease diagnosis.	K1, K2
CO2	Analyze the pathogenesis of infectious diseases caused by bacteria, viruses, and fungi. Evaluate the diagnostic methods used to identify and diagnose infectious diseases. Critically analyze the mechanisms of action of antimicrobial drugs and their potential side effects. Assess the role of the immune system in combating infectious diseases. Apply knowledge of hematology to diagnose and manage blood disorders. Interpret histological sections to identify tissue abnormalities and diagnose diseases.	K3, K4
CO3	Create innovative strategies for the development of new antimicrobial drugs and vaccines. Design and conduct experiments to investigate the mechanisms of drug resistance and host-pathogen interactions. Synthesize information from multiple sources to develop a comprehensive understanding of infectious diseases and their impact on public health. Evaluate the ethical implications of antibiotic use and antimicrobial resistance. Critically analyze the limitations of current diagnostic and therapeutic approaches and propose new solutions.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	2	3	3	3
CO2	2	3	3	2	3	3	3
CO3	1	3	3	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5MC06
Course Title	Medical Laboratory Technology Lab
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	V
Regulation	2024
Course Overview This course offers a practical introduction to clinical laboratory techniques. Students will learn fundamental laboratory skills, analyze blood samples, conduct biochemical tests, and gain hands-on experience through a field visit to a healthcare facility.	
Course Objectives 1. To acquire basic laboratory skills, including pipetting, weighing, and solution preparation and learn to use laboratory equipment like microscopes, centrifuges, and spectrophotometers. 2. To study the components of blood and their functions and perform hematological tests, including complete blood count (CBC) and blood smear analysis. 3. To analyze blood and urine samples to assess organ function and detect diseases and perform biochemical tests, such as renal function tests, liver function tests, and lipid profile. 4. To gain practical experience in a healthcare setting and observe clinical laboratory procedures and interact with healthcare professionals.	
Prerequisites	Basic understanding of medical procedures in biochemistry, laboratory safety, common lab techniques, and ethical considerations.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Basics of Laboratory Techniques: Sterilization procedures, Microscope handling, collection of blood-needle injecting techniques, Blood Pressure-Pulse rate-haemocytometer and cell counter.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Haematology: Clotting time, Bleeding time, Haemoglobin estimation, Erythrocyte Sedimentation Rate, Packed cell volume, platelet count. Estimation of Blood glucose level, Bilirubin estimation. Determination of erythrocyte Indices (Wintrob's Constant) - Determination of Osmotic Fragility of Red blood cells- Detection of Malaria parasite-Determination Plasma haemoglobin.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Haemogram: Differential count, Total Red Blood cell count, Total White blood cell count, Eosinophil count,	10	CO1 CO2	K1,K2,K3, K4,K5,K6

	Reticulocyte count- Qualitative test for ABO blood grouping with antisera - sample collection, isolation, identification. Report preparation.		CO3	
IV	Clinical Biochemistry: Types of urine samples Methods of collection, preservatives- Physical Examination - Chemical Examination-Sugar, Protein, Ketone bodies, Bile pigments, Bile salts- Microscopic Examination of urine - hCG test in Urine. Protein, Carbohydrate and Lipid. Histopathology – tissue embedded slide preparation and examination.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Field Visit: Field visit to different hospitals- report submission- clinical laboratory visit & Demonstration of Medical Instrument.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Chatterjea M. N& Rana Shinde,(2012),Text book of Medical Biochemistry, Jaypee Publications .
2. Godkar, P.B. and D.B. Godkar (2006). Medical Laboratory Technology, Bhalani.
3. Lehninger (2013),Principles of Biochemistry,6th edition, W H Freeman.
4. Mukerjee, K.L. and S. Ghosh, 2010. Medical Laboratory Technology, McGraw Hill.
5. Singh & Sahni,(2008). Introductory Practical Biochemistry, Alpha science.

Suggested Readings

1. Cheesbrough, M (2006). Medical Laboratory Manual for Tropical Countries. Cambridge University Press .
2. Ochei, J. and A. Kolhatkar (2000). Medical Laboratory Science, Theory and Practice, McGraw Hill.
3. Sood, R (2006). Medical Laboratory methods and Interpretation, Jaypee.
4. Vasudevan, D M (2011),Text book of Medical Biochemistry,Jaypee Publishers.

Web Resources**Educational Resources**

1. **American Society for Clinical Pathology (ASCP) - Education & Certification**
Offers online courses and resources for clinical lab professionals, including certification training in clinical laboratory science.
<https://www.ascp.org/content/education>
2. **National Accrediting Agency for Clinical Laboratory Sciences (NAACLS)**
Provides accredited clinical laboratory education programs and resources for laboratory technologists and technicians.
<https://www.nacls.org>

Communities and Forums

1. **American Medical Technologists (AMT)**

An online community for clinical lab professionals, offering forums, peer support, and professional development resources.

<https://community.americanmedtech.org>

2. **Clinical Laboratory Education Community**

An online forum and resource hub for clinical laboratory educators and professionals to share knowledge, resources, and teaching techniques.

<https://www.labce.com>

Research Databases

1. **PubMed (National Library of Medicine) - Clinical Laboratory Science**

Provides access to scientific research articles related to clinical laboratory science, including diagnostic testing, laboratory methods, and clinical practices.

<https://pubmed.ncbi.nlm.nih.gov>

Specialized Resources

1. **ClinicalLab - Online Learning Resources for Clinical Laboratory Professionals**

Offers specialized courses, eBooks, and webinars focused on clinical laboratory science, including clinical chemistry, microbiology, hematology, and more.

<https://www.clinicallab.com>

Interactive Learning Tools

1. **LabCE Interactive Clinical Laboratory Learning Modules**

Provides interactive online modules for various clinical laboratory topics such as blood banking, urinalysis, clinical chemistry, and hematology.

<https://www.labce.com>

Communities and Forums

1. **American Association for Clinical Chemistry (AACC) - Clinical Laboratory Forum**

A professional community for clinical lab scientists to connect, share best practices, and discuss current research and trends in clinical laboratory science.

<https://www.aacc.org>

2. **Clinical Laboratory Education Network (CLEN)**

A community for educators, students, and clinical lab professionals to discuss teaching methods, curriculum development, and clinical laboratory practices.

<https://clinical-lab-education-network.com>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO 1	Identify and describe the basic laboratory equipment and their functions. Understand the principles of laboratory safety and hygiene. Know the components of blood and their physiological roles. Comprehend the significance of hematological and biochemical parameters in disease diagnosis. Perform basic laboratory techniques, such as pipetting, weighing, and solution preparation. Use laboratory equipment effectively, including microscopes, centrifuges, and spectrophotometers. Collect and process blood samples for hematological and biochemical analysis. Perform hematological tests, including complete blood count (CBC) and blood smear analysis. Analyze blood and urine samples to assess organ function and detect diseases. Interpret laboratory results and generate accurate reports. Apply knowledge of laboratory techniques and clinical biochemistry to real-world scenarios.	K1, K2
CO 2	Analyze laboratory results to identify abnormalities and potential health issues. Compare and contrast different laboratory techniques and their applications. Interpret hematological and biochemical parameters to assess disease severity and prognosis. Evaluate the impact of laboratory errors on patient diagnosis and treatment. Design and conduct laboratory experiments to investigate specific research questions. Integrate knowledge from different fields of biology and medicine to solve clinical problems. Develop innovative laboratory techniques and protocols. Communicate scientific findings effectively through written reports and oral presentations. Collaborate with healthcare professionals to improve patient care.	K3, K4
CO 3	Evaluate the quality control measures in a clinical laboratory to ensure accurate and reliable results. Critically assess the impact of laboratory errors on patient care and treatment outcomes. Compare and contrast different diagnostic tests and their limitations. Evaluate the ethical implications of laboratory practices, particularly in relation to patient confidentiality and sample integrity. Develop new laboratory protocols and procedures to improve efficiency and accuracy. Design innovative diagnostic tests to detect diseases earlier and more accurately. Contribute to the advancement of medical laboratory science through research and development. Communicate complex scientific information to a diverse audience, including healthcare professionals and the public. Collaborate with other healthcare professionals to improve patient care and public health.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	2	2	3	3	3
CO2	2	3	2	2	3	3	3
CO3	2	3	2	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MC01
Course Title	Environmental Biotechnology and Toxicology
Credits	05
Hours/Week	05
Category	Major core (MC) – Theory
Semester	VI
Regulation	2024
Course Overview This course Provides an introduction to the principles and applications of biotechnology in environmental monitoring, waste management, and sustainability. Explores the interaction and effects of natural and man-made toxins on organisms and ecosystems, emphasizing their transport, fate, and health impacts. Includes an in-depth study of bioremediation processes, bioenergy production, and innovative approaches like nanotechnology and biosensors for environmental solutions. Examines forensic toxicology concepts, toxic agent classification, and methods for assessing and mitigating environmental pollutants. Features special lectures and research discussions on contemporary biotechnological advancements in addressing environmental challenges.	
Course Objectives 1. To understand the fundamental biotechnological principles and their applications in managing environmental challenges. 2. To explore bioremediation techniques, bioenergy production, and waste management strategies. 3. To analyze the interaction between environmental toxicants and organisms, focusing on their effects and distribution. 4. To critically evaluate the impact of toxins through laboratory and fieldwork analysis and apply findings to public health and environmental sustainability. 5. To investigate advanced biotechnological solutions for pollution control, environmental monitoring, and sustainable agricultural practices.	
Prerequisites	Basic knowledge on ecology and biotechnology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Environmental Biotechnology: Important areas of Environmental Biotechnology- Wastewater treatment- Biomass as a source of energy -Renewable and Non-renewable source of energy, sources of wastes (Industrial, agricultural, forestry, municipal source), Drinking water treatment process- Microbial basis of biodegradation, biodegradation of herbicides, pesticides, and hydrocarbons, plastics and Biodegradation in marine in environment.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Bio-Energy and Medical Biotechnology: Biogas production, process and methods of bioleaching, Bioleaching of Iron,	13	CO1 CO2	K1,K2,K3, K4,K5,K6

	Copper, Gold. Uranium, Bioreactors-types and applications of bioreactor. Biogas technology in India, Bioremediation- Insitu and Exsitu bioremediation process. Anaerobic digestion- Hydrolysis Acidolysis, Acetogenesis, Methanogenesis, Methanogens, Acidogen. Biomass Conversion Technologies. Phytoremediation, GMO, ethical issues in GMO, Gene therapy-invivo and in vivo, Nanomedicine and Biochip.		CO3	
III	Forensic Toxicology: Introduction -Definition of forensic medicine- History of forensic medicine in India- Medical ethics and etiquette-Duties of a registered medical practitioner in medico-legal cases. Personal identification, Death and its medico-legal importance, Post-mortem examination (autopsy) Sexual Offences. Acute toxicity, chronic toxicity.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Biotechnological Solutions for Environmental Problems. Biodegradation of xenobiotics, Biosensors for environmental monitoring, Biofertilizers and biopesticides in sustainable agriculture, Emerging biotechnological approaches for pollution control.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Ecotoxicology: Entry and fate of chemicals in humans and fate of pollutants in ecosystems. Classification and properties of air pollutants, control device for air pollutants-photochemical smog, health effects of air pollution; Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins and chemical toxins. Water pollution- the origin of water, toxic water pollutants and their health Effects, Soil Pollution. Heavy metal contamination of health effect-Entomotoxocology.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Allan Scragg, 2020. Environmental Biotechnology, Oxford University Press.
2. Bhattacharya. S (2011). Environmental Toxicology, Books and Allied (P) Ltd.
3. Chatterji. A. K (2022). Introduction to Environmental Biotechnology, PHI Learning Private Limited.
4. Dong, H.M. 2018. An Introduction to Environmental Toxicology, Create space
5. Gupta, P. K. (2016). Environmental Biotechnology and Toxicology. Agrobios India.
6. Indu Shekhar Thakur (2011). Environmental Biotechnology, I. K. International Publishing House.
7. Joshi, S. C., & Sharma, P. (2018). Environmental Toxicology. Scientific Publishers.
8. Kumar, P., Kumar, V., & Sachan, P. K. (2012). Textbook of Environmental Biotechnology. Woodhead Publishing India.
9. Rao, C. S. (2007). Environmental Pollution Control Engineering. New Age International Publishers.

10. Rao, C. S. (2007). Environmental Pollution Control Engineering. New Age International Publishers.
11. Sharma, P. D. (2014). Environmental Biology and Toxicology. Rastogi Publications.
12. Singh, R. S., Pandey, A., & Nigam, P. (2009). Biotechnology for Environmental Management. New Delhi, India: Asiatech Publishers.
13. Thakur, I. S. (2006). Environmental Biotechnology: Basic Concepts and Applications. I.K. International Publishing House.

Suggested Readings

1. All India Congress of Zoology. (2009). Environmental Toxicology: Proceedings of the 18th All India Congress of Zoology. APH Publishing Corporation.
2. Bansal, M., & Bhushan, S. (2016). Toxicology of Environmental Pollutants. Dehradun, India: Bishen Singh Mahendra Pal Singh.
3. Chatterjee, A. K. (2010). Introduction to Environmental Biotechnology. PHI Learning.
4. Gupta, P., Chanjta, A., & Mehta, Y. (2021). Environmental Toxicology and Ecotoxicology: Recent Advances and Future Perspectives. New Delhi: Routledge.
5. Joshi, S. C., & Sharma, P. (2018). Environmental Toxicology. Delhi: Scientific Publishers India.
6. Modak, P., & Ayyar, B. N. R. (2008). Textbook of Environmental Biotechnology. Oxford University Press.
7. Pradhan, M., & Ghosh, A. (2017). Environmental Toxicology: A Practical Approach. New Central Book Agency.
8. Prasad, M. N. V., & Shih, K. (2016). Environmental Materials and Waste: Resource Recovery and Pollution Prevention. Academic Press.
9. Purohit, S. S., & Mathur, S. (1999). Environmental Biotechnology. Agrobios India.
10. Sankar, S. K., & Raj, B. (2013). Environmental Toxicology: Principles and Applications. New Delhi: APH Publishing Corporation.
11. Sharma, B. K., & Kaur, H. (2012). Environmental Chemistry and Toxicology. Krishna Prakashan Media.
12. Sharma, P. D. (2020). Ecology and Environment (14th ed.). Rastogi Publications

Web Resources

Educational Resources

1. **Environmental Protection Agency (EPA):** Provides a wealth of information on environmental science and technology, including environmental biotechnology and toxicology.
<https://www.epa.gov/>
2. **National Institute of Environmental Health Sciences (NIEHS):** A federal agency focused on environmental health sciences, including toxicology.
<https://www.niehs.nih.gov/>
3. **Environmental Science & Technology:** A leading journal in the field of environmental science.
<https://pubs.acs.org/journal/esthag>

4. **Water Environment Federation (WEF):** A non-profit organization dedicated to water quality and environmental protection.

<https://www.wef.org/>

Communities and Forums

1. **ResearchGate:** A social networking site for scientists and researchers.
2. **Academia.edu:** Another academic social network.
3. **Reddit:** A popular online forum with subreddits dedicated to various scientific topics, including environmental science and toxicology.

<https://www.researchgate.net/>
<https://www.academia.edu/>
<https://www.reddit.com/>

Research Databases

1. **PubMed:** A biomedical literature database.
2. **Google Scholar:** A search engine for scholarly literature.
3. **Scopus:** A bibliographic database.

<https://pubmed.ncbi.nlm.nih.gov/>
<https://scholar.google.com/>
<https://www.scopus.com/>

Specialized Resources

1. **Society of Environmental Toxicology and Chemistry (SETAC):** A professional society dedicated to the advancement of environmental science.
2. **American Society for Microbiology (ASM):** A professional society for microbiologists, including those working in environmental microbiology and biotechnology.
3. **Environmental Protection Agency's Office of Research and Development (ORD):** Conducts research on environmental issues, including biotechnology and toxicology.

<https://www.setac.org/>
<https://asm.org/>
<https://www.epa.gov/research>

Interactive Learning Tools

1. **Khan Academy:** Offers free online courses in biology, chemistry, and environmental science.
2. **Coursera:** Offers online courses in environmental science and engineering.
3. **edX:** Offers online courses in environmental science and engineering.

<https://www.khanacademy.org/>
<https://www.coursera.org/>
<https://www.edx.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify the key areas and applications of environmental biotechnology, including waste management and renewable energy sources. Classify various types of bioreactors, biogas technologies, and bioremediation processes. Describe the basic concepts of forensic toxicology, including acute and chronic toxicity and their implications. Illustrate the role of biosensors and bio fertilizers in sustainable environmental solutions. Define key toxic agents, pollutants, and their impact on human health and ecosystems.	K1, K2
CO2	Apply the principles of biotechnology to environmental monitoring and waste management practices. Analyze the methods and processes involved in bioleaching and biogas production technologies. Compare acute and chronic toxicity levels in forensic and ecological contexts. Interpret the mechanisms of xenobiotic biodegradation and their implications for pollution control. Summarize the classification and fate of toxic agents in environmental and human health contexts.	K3, K4
CO3	Evaluate the effectiveness of biotechnological solutions, such as bioremediation and phytoremediation, for environmental problems. Create innovative approaches using nanotechnology and biosensors to address environmental challenges. Synthesize knowledge of toxic agents and develop strategies to mitigate their effects on health and ecosystems. Formulate solutions for sustainable waste management, renewable energy, and pollution control. Discover advanced applications of ecotoxicology for monitoring and improving environmental health.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	2
CO2	3	2	2	2	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MC02
Course Title	Environmental Biotechnology and Toxicology Lab
Credits	05
Hours/Week	05
Category	Major Core (MC) - Lab
Semester	VI
Regulation	2024
Course Overview This course provides knowledge in laboratory techniques related to environmental monitoring. A course designed to explore the connections between human health and the environment. An introduction to science that investigates the effects of pollutants and toxins on the ecology of individuals, populations and communities of organisms. A field course designed to expose students to basic research techniques and methods used in the study of ecology. Students will be introduced to methods for assessing and monitoring the environmental Health of ecosystems To acquaint the student with the characteristics used to develop an awareness of the career possibilities available to students in this area.	
Course Objectives 1. To introduce students to the biological and chemical analysis of fresh water. 2. To analyse methods for assessing and monitoring the environmental health of ecosystems. Stimulate various phenomena in biology, ecology, and environmental science. 3. To use an interdisciplinary approach to analyse environmental issues/problems; show knowledge of the interplay between the ecological, social, cultural and economic aspects of environmental problems. 4. To demonstrate an understanding of core ecological principles, and define scientific principles and concepts as related to environmental studies and sustainability. 5. To participate in field research for documentation of biodiversity.	
Prerequisites	Basic knowledge on Environmental biology, Ecology or Zoology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Lab safety protocols and Estimation of Abiotic Factors: Estimation of dissolved Oxygen, Dissolved carbon dioxide, Determination of alkalinity in water samples, Determination of salinity of water samples, Determination of bicarbonate and carbonates. Analysis of Heavy Metal Contamination in Water: Using spectrophotometric or atomic absorption methods to quantify heavy metal concentrations in water samples from different sources.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Mounting Techniques: Collection, isolation, identification and mounting of marine and freshwater plankton. Analysis of Soil Nutrient Content in Agricultural vs. Natural Ecosystems.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Adaptation and Animal Associations: Study of sandy shore fauna- Study of rocky shore fauna - Study of animal Association , Assessing biodiversity by conducting plant and insect surveys in urban parks and comparing them with natural habitats. Collection of Microarthropods : Study of different soil microarthropods - Extraction and identification of soil micro arthropods through Tullgren's funnel method and Ladell's Floating Method.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Bioaccumulation and biomagnification: Analysis of bioaccumulation and biomagnification in fish samples, To study the impact of toxicants on the environment. Expose aquatic organisms (e.g., fish, daphnia) or plants (e.g., algae) to various concentrations of a toxicant. Measure survival, growth, and reproduction. Determination of LD50 and ED50, Data analysis and interpretation	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Field Work: Visit to local area to document river/forest/grassland/hill/mountain. Visit to a local polluted site- Urban/Rural/Industrial/Agricultural. Study of common pesticides usage and its ill effects. Study of simple ecosystems-pond, river, hill slopes, etc.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
2. Klaassen, C. D., & Watkins, J. B. (2020). Casarett & Doull's Essentials of Toxicology (3rd ed.). McGraw-Hill Education.
3. Manahan, S. E. (2010). Environmental science and technology: A sustainable approach to green science and technology (2nd ed.). CRC Press.
4. Maria Csuros and Robert W. R. Ballance "Environmental Sampling and Analysis for Technicians"
5. Michael, P (1984). Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill.
6. Pawlowsky-Reusing, E., & Lorz, P. M. (Eds.). (2008). Methods in environmental analysis: Water, soil, and air. CRC Press.
7. Sinha, R. K. (Ed.). (2011). Environmental monitoring handbook. Royal Society of Chemistry.

Suggested Readings

1. Ambasht, N. K., & Verma, D. (2015). Environmental engineering laboratory manual. Springer.
2. Ambasht, N. K., & Verma, D. (Year). Environmental engineering laboratory manual. Publisher.
3. Brewer, P. H., & Berg, L. R. (Year). Environmental science lab manual. Publisher.

4. Campbell, M. K., & Whitley, D. M. (Year). Laboratory manual for environmental science. Publisher.
5. Cunningham, W. P., & Cunningham, M. A. (Year). Environmental science laboratory exercises for environmental science: A global concern. Publisher.
6. Eugenia, 2008. Environmental Biotechnology and cleavers Bioprocesses, London.
7. Ramesh, R & M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
8. Wolaver, T. G. (2007). Environmental science laboratory manual. McGraw-Hill Education.

Web Resources

Educational Resources

1. **National Institute of Environmental Health Sciences (NIEHS):** A federal agency focused on environmental health sciences, including toxicology.
<https://www.niehs.nih.gov/>
2. **Environmental Protection Agency (EPA):** Provides a wealth of information on environmental science and technology, including environmental biotechnology and toxicology.
<https://www.epa.gov/>
3. **American Society for Microbiology (ASM):** A professional society for microbiologists, including those working in environmental microbiology and biotechnology.
<https://asm.org/>

Communities and Forums

1. **ResearchGate:** A social networking site for scientists and researchers.
<https://www.researchgate.net/>
2. **Academia.edu:** Another academic social network.
<https://www.academia.edu/>
3. **Reddit:** A popular online forum with subreddits dedicated to various scientific topics, including environmental science and toxicology.
<https://www.reddit.com/>

Research Databases

1. **PubMed:** A biomedical literature database.
<https://pubmed.ncbi.nlm.nih.gov/>
2. **Google Scholar:** A search engine for scholarly literature.
<https://scholar.google.com/>
3. **Scopus:** A bibliographic database.
<https://www.scopus.com/>

Specialized Resources

1. **Society of Environmental Toxicology and Chemistry (SETAC):** A professional society dedicated to the advancement of environmental science.
<https://www.setac.org/>
2. **Environmental Protection Agency's Office of Research and Development (ORD):** Conducts research on environmental issues, including biotechnology and toxicology.
<https://www.epa.gov/research>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the various physicochemical parameters of water and their significance in aquatic ecosystems. Understand the concept of biological stress and its impact on aquatic organisms. Know the different types of plankton and their ecological roles. Comprehend the mechanisms of ecological adaptation in aquatic animals. Understand the concept of toxicity and its effects on aquatic ecosystems. Know the potential of aquatic organisms as sources of bioproducts. Measure and analyze physicochemical parameters of water samples to assess water quality. Design and conduct experiments to study the biological responses of animals to stress. Identify and quantify different types of plankton using microscopic techniques. Analyze the morphological and physiological adaptations of aquatic animals to specific environments. Assess the toxicity of pollutants on aquatic organisms using laboratory bioassays. Explore the potential of aquatic organisms for the production of biofuels, pharmaceuticals, and other valuable products. Use laboratory equipment and techniques to conduct experiments and collect data. Interpret experimental results and draw conclusions.	K1, K2
CO2	Analyze the relationship between water quality parameters and aquatic ecosystem health. Compare and contrast the responses of different organisms to stress. Interpret plankton data to assess the ecological status of water bodies. Analyze the morphological and physiological adaptations of aquatic animals to specific environmental conditions. Evaluate the impact of pollutants on aquatic ecosystems. Assess the potential of different aquatic organisms for bioproduct production. Design and conduct experiments to investigate the effects of environmental factors on aquatic organisms. Integrate knowledge from different fields of biology and ecology to solve environmental problems. Develop innovative approaches to water quality monitoring and management. Communicate scientific findings effectively through written reports and oral presentations. Collaborate with other researchers to address environmental challenges.	K3, K4
CO3	Evaluate the effectiveness of different water quality monitoring methods. Critically assess the impact of human activities on aquatic ecosystems. Compare and contrast different approaches to environmental risk assessment. Evaluate the sustainability of bioproduct production from aquatic organisms. Develop innovative methods for water quality monitoring and assessment. Design strategies for mitigating the impact of pollution on aquatic ecosystems. Create new bioproducts from aquatic organisms. Contribute to the development of sustainable aquaculture practices. Communicate complex scientific information to a diverse audience.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	3	3	3
CO2	3	2	2	3	3	3	3
CO3	3	2	2	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MC03
Course Title	Ecology and Wildlife Conservation
Credits	05
Hours/Week	05
Category	Major Core (MC) - Theory
Semester	VI
Regulation	2024
Course Overview This course will explore the fundamental principles of ecology, including energy flow, nutrient cycling, and the interactions between organisms and their environments. It will also delve into the management and conservation of wildlife resources, including wildlife census techniques and the role of conservation organizations and regulations in protecting biodiversity.	
Course Objectives 1. To understand the fundamental principles of ecology, including population dynamics, community ecology, and ecosystem structure and function. 2. To explore the concepts of energy flow and nutrient cycling in ecosystems, and their importance for ecosystem sustainability. 3. To analyze the management and conservation of wildlife resources, including population assessment, habitat management, and human-wildlife conflict mitigation. 4. To evaluate the role of conservation organizations and regulations in protecting biodiversity and addressing environmental challenges.	
Prerequisites	Basic knowledge of ecology and wildlife.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Principles of Ecology: Ecological factors, Components of an Ecosystem, Ecosystems of India. Productivity, Ecological succession. Population and community Ecology- Population ecology, Dynamics of population, Community. Keystone species and ecological indicators.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Energy and nutrient cycling: Ecological energetics. Biogeochemical cycles- Water cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle. Habitat Ecology- Freshwater ecology, Marine Estuarine Ecology, Terrestrial ecology. Pollution and its impact on ecology.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Wildlife Resources: Importance of wildlife, Importance of forests, Conservation of forests. Wildlife values. Biomes. Wildlife management- Manipulation in Population Dynamics, Habitat management. Introduction and	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	reintroduction of wildlife. Captive breeding programs. In situ and Ex situ conservation.			
IV	Wildlife census: Visual count, Sample count, Stratified Transect count, Index count. Conservation strategies- Sanctuary, National Park, Reserve forests, Protected area, Biosphere reserve, Zoos. Conservation Projects- Project Tiger, Project Lion, Project Elephant, Crocodile Breeding Project,	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Conservation Organizations and regulations: Organizations: IUCN, FAO, Greenpeace, PETA, NBA, ZSI, BSI, FSI, CIBA, CMFRI, CITES, WWF, CBSG, SSC, CAMP, PHVA, MAB, BNHS, WPSI, IBWL. Regulations: Wildlife Protection Act 1972, Indian Forests Act 1927, Biological Diversity Act 2002.	13	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Bindra, P. S. (2016). The Vanishing: India's Wildlife Crisis. Penguin India. 2. Gupta, S., & Mishra, R. (2018). Wildlife Conservation in India: Theory and Practice. Springer India. 3. Ilyas, O., & Khan, A. (Eds.). (2020). Case Studies of Wildlife Ecology and Conservation in India. Routledge. 4. Khan, A. (2011). Ecology and Conservation of Indian Wildlife. New Delhi: Academic Press. 5. Saha, G. K., & Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI Learning Pvt. Ltd. 6. Saha, T. K (2017). Ecology and Environmental Biology. Books and Allied (P) Ltd. 7. Sankaran, M., & Azeez, P. A. (2015). Ecology and Conservation of Indian Forests. Oxford University Press. 8. Singh, S. K (2009). Text Book of Wildlife Management. CBS Publishers & Distributors. 9. Vashishta. M. K (2018). Wildlife Science. Oxford Book Company.				
Suggested Readings 1. Colinviaux, P. A (1993). Ecology (2nd edition) Wiley, John and Sons, Inc. 2. Kendeigh, F C (1984). Ecology with Special Reference to Animal and Man. Prentice Hall Inc. 3. Krebs, C. J (2001). Ecology (6th edition) Benjamin Cummings. 4. Odum, E.P (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole. 5. Ricklefs, R.E (2000). Ecology (5th edition) Chiron Press. 6. Southwood, T.R.E. and Henderson, P.A (2000). Ecological Methods (3rd edition) Blackwell Sci. 7. Stiling, P. D (2012). Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.				

Web Resources

Educational Resources:

1. **FutureLearn - Ecology and Wildlife Conservation Course**
An online course exploring wildlife conservation techniques, biodiversity, and ecological management.
[Ecology and Wildlife Conservation on FutureLearn](#)
2. **Open University - Nature & Environment Free Courses**
Offers free courses that cover topics in ecology, wildlife conservation, and environmental sustainability.
[Open University - Nature & Environment](#)
3. **University of Edinburgh - MSc in Ecological and Environmental Sciences**
A specialized master's program that focuses on ecology, conservation, and sustainable environmental management.
[University of Edinburgh MSc Ecological and Environmental Sciences](#)

Communities and Forums:

4. **Wildlife Conservation Network (WCN)**
A network of conservationists, scientists, and advocates working together to save endangered species and their habitats.
[Wildlife Conservation Network](#)
5. **International Union for Conservation of Nature (IUCN)**
IUCN's community platform allows professionals to connect, share knowledge, and discuss key topics related to conservation and biodiversity.
[IUCN Community](#)
6. **Wildlife and Ecology Conservation Community (LinkedIn Group)**
A LinkedIn group where professionals, researchers, and enthusiasts discuss conservation topics, share research, and network.
[Wildlife and Ecology Conservation LinkedIn Group](#)

Research Databases:

7. **Global Biodiversity Information Facility (GBIF)**
An open-access database offering biodiversity data from around the world, supporting research on species distribution, conservation, and ecosystem health.
[GBIF](#)
8. **Environmental Protection Agency (EPA) - Environmental Data Resources**
Provides access to environmental data including wildlife, habitats, and ecosystems, which can be used for ecological and conservation research.
[EPA Environmental Data Resources](#)
9. **National Center for Biotechnology Information (NCBI) - Ecology and Wildlife Conservation Resources**
A database offering scientific research articles and studies related to ecology, conservation biology, and wildlife protection.
[NCBI Ecology Resources](#)

Specialized Resources:**10. Cornell University - Terrestrial & Wildlife Ecology and Management**

Provides research opportunities and academic resources related to terrestrial ecology and wildlife conservation, focusing on species management and environmental stewardship.

[Cornell University Wildlife Ecology](#)

11. Conservation Biology Institute

A non-profit organization dedicated to advancing conservation science and applied conservation through research and resource management.

[Conservation Biology Institute](#)

Interactive Learning Tools:**12. The Nature Conservancy - Interactive Global Map of Protected Areas**

An interactive tool for exploring protected areas across the world, helping users understand global conservation efforts and biodiversity hotspots.

[Nature Conservancy Global Map](#)

13. Global Forest Watch - Interactive Forest Monitoring Tool

Provides real-time data on forest loss and conservation efforts using interactive maps and tools to track changes in forest ecosystems.

[Global Forest Watch](#)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify the key principles of ecology, such as population dynamics and ecosystem structure. Describe the processes of energy flow and nutrient cycling in ecosystems. Explain the importance of wildlife resources and their conservation. Define the different methods used for wildlife census. Recognize the role of conservation organizations and regulations in protecting biodiversity.	K1, K2
CO2	Compare and contrast different ecological concepts, such as population growth and carrying capacity. Analyze the impact of human activities on energy flow and nutrient cycling in ecosystems. Evaluate the effectiveness of different wildlife management strategies. Explain the advantages and disadvantages of various wildlife census methods. Describe the role of conservation organizations and regulations in addressing specific environmental challenges.	K3, K4
CO3	Synthesize information about the interconnectedness of ecological processes and their impact on ecosystem health. Evaluate the effectiveness of different conservation policies and strategies in addressing environmental challenges. Design and implement wildlife conservation plans based on ecological principles and population data. Critically analyze scientific literature related to ecology, wildlife management, and conservation. Propose innovative	K5, K6

	solutions to address pressing environmental issues, such as habitat loss and climate change.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	3	3	3	3	3
CO2	3	2	3	3	2	3	3
CO3	3	1	3	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MC04
Course Title	Entomology
Credits	04
Hours/Week	04
Category	Major core (MC) – Theory
Semester	VI
Regulation	2024
Course Overview This course will explore the fascinating world of insects, covering topics such as classification, morphology, physiology, ecology, behavior, and their impact on agriculture and human health. Students will gain a comprehensive understanding of insect biology and its relevance to various fields, including agriculture, pest control, and public health.	
Course Objectives 1. To understand the principles of insect classification and morphology, including taxonomic hierarchies, body structures, and adaptations. 2. To explore the physiological processes of insects, such as respiration, digestion, excretion, and reproduction. 3. To analyze the ecological roles of insects, including their interactions with plants, other animals, and the environment. 4. To evaluate the impact of insect pests on agriculture, including their identification, biology, and control measures. 5. To examine the biology and medical importance of parasitic arthropods and vectors, such as ticks, fleas, and mosquitoes. 6. To apply knowledge of insect biology to address practical issues in agriculture, pest control, and public health.	
Prerequisites	Basic knowledge of animals / Invertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Insect classification and morphology: Insect taxonomy, Phylogenetic systematics, Insect fossils, General characters of major orders of Sub-classes Apterygota and Pterygota. General account of external morphology- head, mouth parts, thorax, abdomen, wings, legs, eggs, larvae and pupae.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Insect physiology: Digestive system, Nutrition, Metabolism, Tracheal system, Circulation, Excretion, Muscular system, Nervous system, Sonication, Sensory receptors, Endocrine system, Bioluminescence, Communication in insects, Reproductive system, Development, Growth and Metamorphosis.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Insect Ecology and Ethology: Insect diversity, Environment of insects, Dynamics of insect population, Ecology of aquatic insects, soil insects, Mycophagous insects. Insect behavior, Social life of insects, Insect Migration. Plant–insect interaction.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Pests of Agriculture: Rice (<i>Atherigona oryzae</i>). Pests of stored grains (<i>Heliothis armigera</i>). Sugarcane (<i>Odontotermes obesus</i>). Cotton (<i>Aphis gossypii</i>). Groundnut (<i>Holotrichia consanguinea</i>). Brinjal (<i>Leucinodes orbonalis</i>), Bottle gourd (<i>Dacus cucurbitae</i>), Potato (<i>Phthorimaea operculella</i>). Mango (<i>Amritodus atkinsoni</i>), Jack fruit (<i>Batocera rufomaculata</i>), Guava (<i>Inderbella quadrinotata</i>), Lemon (<i>Papilio demoleus</i>), Pomegranate (<i>Calte emarginata</i>). Polyphagous pests: <i>Schistocerca gregaria</i> , <i>Locusta migratoria</i> .	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Parasitic insects and vectors: Habitat, distribution, life history and pathogenicity of arthropod parasites and vectors- <i>Pediculus humanus capitis</i> (Head louse), <i>Cimex lectularius</i> (Bed bug), <i>Xenopsylla chepis</i> (Rat flea), <i>Lutzomyia longipalpis</i> (Sand fly), <i>Musca domestica</i> (House fly), <i>Anopheles stephensi</i> , <i>Culex quinquefasciatus</i> and <i>Aedes aegypti</i> . Acarology: <i>Ixodes scapularis</i> (Tick), <i>Sarcoptes scabiei</i> (Mite).	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Biswapati Dasgupta (2000). Parasitology, Books and Allied (P) Ltd.
2. Prem Mohan Nigam and Ashok Kumar (2001). A Text Book of Agricultural Entomology, Emkay Publications.
3. Sameer Sagar (2021). Economic Zoology, Academic Aspirations.
4. Sathe. T. V (2017). Basic Entomology: A Practical Manual, Daya Publishing House.
5. Vasantharaj David, B and Ananthakrishnan, T. N (2006). General and Applied Entomology, Tata McGraw Hill.

Suggested Readings

1. Awasthi, V. B. (2016). Introduction to General and Applied Entomology, Scientific Publishers.
2. Chatterjee, P.N (2011). General Entomology, Kalyani Publishers.
3. Gullan, P.J and P.S. Cranston (2010). Insect Ecology, Blackwell Publishing.
4. Imms, A. D. (1923). A General Textbook of Entomology. Digital Library of India
5. Pruthi, H.S (2016). A Textbook of Entomology, Kalyani Publishers.
6. Srivastava, D.N (2018). Economic Entomology, Rastogi Publications
7. Srivastava, D.N (2018). Textbook of Entomology, Rastogi Publications.
8. Srivastava, K. P., & Dhaliwal, G. S. (2010). A Textbook of Applied Entomology. Kalyani Publishers.

Web Resources**Educational Resources**

1. **The American Entomological Society:** Offers a variety of educational resources, including publications, conferences, and workshops.
<https://www.entsoc.org/>
2. **Entomology Today:** A news magazine published by the Entomological Society of America, providing the latest news and research in entomology.
<https://entomologytoday.org/>
3. **BugGuide:** A collaborative website for identifying insects and other arthropods.
<https://bugguide.net/>

Communities and Forums

1. **ResearchGate:** A social networking site for scientists and researchers.
<https://www.researchgate.net/>
2. **Academia.edu:** Another academic social network.
<https://www.academia.edu/>
3. **Reddit:** A popular online forum with subreddits dedicated to various scientific topics, including entomology.
<https://www.reddit.com/>

Research Databases

1. **PubMed:** A biomedical literature database.
<https://pubmed.ncbi.nlm.nih.gov/>
2. **Google Scholar:** A search engine for scholarly literature.
<https://scholar.google.com/>
3. **Scopus:** A bibliographic database.
<https://www.scopus.com/>

Specialized Resources

1. **Entomological Society of America:** A professional society for entomologists.
<https://www.entsoc.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify different insect orders and their key characteristics. Describe the basic morphology and anatomy of insects. Explain the physiological processes of insects, such as respiration and digestion. Define the ecological roles of insects in various ecosystems. Recognize common insect pests of agriculture and their damage. Identify parasitic arthropods and vectors, and their importance in public health.	K1, K2
CO2	Compare and contrast different insect orders based on their unique characteristics. Analyze the relationship between insect morphology and their ecological roles. Evaluate the impact of insect physiology on their behavior	K3, K4

	and survival. Explain the interactions between insects and other organisms in various ecosystems. Describe the life cycles and damage caused by common insect pests of agriculture. Evaluate the public health risks associated with parasitic arthropods and vectors.	
CO3	Synthesize information about the interconnectedness of insect biology, ecology, and behavior. Evaluate the impact of climate change and habitat loss on insect populations and biodiversity. Design and implement strategies for sustainable pest management in agricultural systems. Critically analyze scientific literature related to insect biology and its applications. Propose innovative solutions to address challenges associated with insect pests and parasitic arthropods.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ1AR01
Course Title	Animal Diversity
Credits	02
Hours/Week	04
Category	Allied Required (AR) - Theory
Semester	I
Regulation	2024
Course Overview This course offers a comprehensive exploration of the diverse phyla within the animal kingdom, focusing on the taxonomy, anatomy, physiology, and ecological significance of protozoa, porifera, and cnidaria, platyhelminthes, nemathelminthes, annelida, arthropoda, mollusca, and echinodermata. The course will also cover protochordates, as well as the vertebrate groups: fishes, amphibians, reptiles, birds, and mammals. Through this course students will develop a robust understanding of the evolutionary relationships among these groups, their roles in ecosystems, and their importance in biodiversity conservation.	
Course Objectives 1. To equip students with the knowledge to classify and differentiate between major animal phyla, including protozoa, porifera, cnidaria, platyhelminthes, nemathelminthes, annelida, arthropoda, mollusca, echinodermata, protochordates, and vertebrates. 2. To explore Anatomy and Physiology and provide students with a detailed understanding of the anatomical structures and physiological processes unique to each group, highlighting adaptations that enable survival in various environments. 3. To analyze Evolutionary Relationships and facilitate the analysis of evolutionary relationships among different animal groups, enabling students to understand phylogenetic trees and the principles of evolutionary biology. 4. To examine Ecological Roles and investigate the ecological roles and significance of various animal groups within their ecosystems, emphasizing their contributions to biodiversity, ecosystem function, and conservation efforts.	
Prerequisites	Basic knowledge on animal diversity.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Protozoa, Porifera and Cnidaria: Protozoa: <i>Entamoeba histolytica</i> - General Characters and Life Cycle. Locomotion and Reproduction in Protozoa. Porifera: Sycon- General Characters; Canal System in Sponges and Spicules. Cnidaria: <i>Obelia geniculata</i> - General Characters; Polymorphism in Hydrozoan; Corals and Coral Reef Formation.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Platyhelminthes, Nemathelminthes, Annelida and Arthropoda: Platyhelminthes: <i>Schistosoma Haematobium</i> -	10	CO1 CO2	K1,K2,K3, K4,K5,K6

	General Characters and Life Cycle. Nematelminthes- <i>Taenia solium</i> - General Characters; Parasitic Adaptations in Helminthes. Annelida: <i>Hirudinaria granulosa</i> - General Characters; Evolutionary Significance of Coelome and Coelomoducts; Metamerism. Arthropoda: <i>Penaeus indicus</i> - General Characters; Mouth Parts of Insects.		CO3	
III	Mollusca, Echinodermata and Protochordates: Mollusca: <i>Pila globosa</i> - General Characters; Pearl Formation; Torsion in Gastropods; Echinodermata: <i>Asterias rubens</i> - General Characters; Water Vascular System. Protochordates: Affinities of Hemichordata; Cephalochordata and Urochordata; Cyclostomata: Comparison of Petromyzon and Myxine.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Pisces and Amphibia: Pisces: <i>Scoliodon sorrakowah</i> - General Characters; Types of Scales and Fins. Amphibia: <i>Rana tigrina</i> - General Characters; Impact of Terrestrialization; Parental Care in Amphibia; Neoteny and Paedogenesis.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Reptilia, Aves and Mammalia: Reptilia: <i>Calotes versicolor</i> - General Characters; Skull of Reptiles. Aves: <i>Columba livia</i> – General Characters; Quill Feather; Migration and Flight Adaptation. Mammalia: <i>Oryctolagus cuniculus</i> - General Characters; Dentition in Mammals.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2016). A Manual of Zoology, (Volume I) (Part I), S. Viswanathan Printers and Publishers.
2. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2019). Manual of Zoology (Volume I) (Part- 2), Ananda Book Depot.
3. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2019). Manual of Zoology (Volume II) (Part- 1), S. Viswanathan Printers & Publishers.
4. Ganguly, Sinha,. Bharati Goswami and Adhikari (2004). Biology of animals Vol.II - New central book Agency (p) Ltd.
5. Jordan E.L, Verma P.S (2008). Chordate Zoology, S. Chand & Company Ltd.
6. Jordan, E.K. and P.S. Verma (1995). Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd.
7. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I. (1989). Modern text book of Zoology, Rastogi Publications.
8. Kotpal. R.L. A (2009). Modern text book of Zoology Vertebrates, Rastogi publications.
9. Nigam, H.C (1983). Zoology of Chordates, Vishal Publications.
10. Srivastava, M. D. L and Srivastava, U. S, (1969). A text book of Invertebrate Zoology, Central Book Depot.
11. Verma, A (2005). Invertebrates: Protozoa to Echinodermata. Narosa Publishing House.

Suggested Readings

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
6. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
7. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
8. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill.
9. Newman, H.H. (1981). The Phylum Chordata, Satish Book Enterprise, Agra.
10. Parker and Haswell (1964). Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S. Publishers and Distributors.
11. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition.
12. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

Web Resources**Educational Resources**

1. **Khan Academy:** Offers free online courses in biology, including animal diversity and evolution.
<https://www.khanacademy.org/>
2. **Coursera:** Offers online courses in zoology, animal behavior, and related fields.
<https://www.coursera.org/>
3. **edX:** Offers online courses in biology, ecology, and evolution.
<https://www.edx.org/>
4. **The Smithsonian Institution:** Provides access to a vast collection of animal specimens and educational resources.
<https://www.si.edu/>

Communities and Forums

1. **ResearchGate:** A social networking site for scientists and researchers.
<https://www.researchgate.net/>
2. **Academia.edu:** Another academic social network.
<https://www.academia.edu/>
3. **Reddit:** A popular online forum with subreddits dedicated to various scientific topics, including zoology and animal diversity.
<https://www.reddit.com/>
4. **iNaturalist:** A citizen science platform for sharing observations of nature.

<https://www.inaturalist.org/>

Research Databases

1. **PubMed:** A biomedical literature database.
<https://pubmed.ncbi.nlm.nih.gov/>
2. **Google Scholar:** A search engine for scholarly literature.
<https://scholar.google.com/>
3. **Scopus:** A bibliographic database.
<https://www.scopus.com/>

Specialized Resources

1. **The Wildlife Conservation Society (WCS):** A global conservation organization dedicated to saving wildlife and wild places.
<https://www.wcs.org/>
2. **The Smithsonian Institution's National Zoo & Conservation Biology Institute:** Conducts research and conservation efforts for various animal species.
<https://nationalzoo.si.edu/>
4. **The American Society of Mammalogists:** A professional society for mammalogists.
<https://www.mammalogy.org/>
5. **International Union for Conservation of Nature (IUCN):** A global union dedicated to conserving nature.
<https://www.iucn.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the key characteristics and classification of various animal phyla, including protozoa, porifera, cnidaria, platyhelminthes, nemathelminthes, annelida, arthropoda, mollusca, echinodermata, protochordates, and vertebrates. They will recall and explain the fundamental anatomical structures and physiological processes of these groups, demonstrating an understanding of their adaptations to different environments. Students will also recognize the ecological roles of these animals within their ecosystems and summarize the significance of biodiversity across the animal kingdom, providing a foundation for further studies in zoology and ecology.	K1, K2
CO2	Analyze and compare the structural and functional adaptations of various animal phyla, including protozoa, porifera, cnidaria, platyhelminthes, nemathelminthes, annelida, arthropoda, mollusca, echinodermata, protochordates, and vertebrates. They will demonstrate practical skills in classifying and identifying organisms from these groups, utilizing appropriate taxonomic keys and methodologies. Students will also evaluate the ecological roles of these animals in their environments, discussing their contributions to ecosystem dynamics and biodiversity. Furthermore, they will formulate	K3, K4

	hypotheses regarding evolutionary relationships among these groups.	
CO3	Critically analyze the distinguishing morphological and anatomical features of the studied taxa, correlating structural adaptations to their ecological roles and evolutionary significance. Assess and integrate knowledge of phylogenetic relationships among these groups, using comparative anatomy and embryological evidence. Design and implement systematic protocols for identifying and classifying specimens, employing microscopy and other diagnostic tools with precision. Evaluate the functional roles of these organisms in their ecosystems, addressing their contributions to biodiversity, ecological balance, and human welfare. Construct and propose hypotheses on evolutionary trends, adaptive radiations, and ecological interactions across the studied taxa based on empirical observations and data analysis.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ1AR02
Course Title	Animal Diversity Lab
Credits	02
Hours/Week	02
Category	Allied Required (AR) – Lab
Semester	I
Regulation	2024
Course Overview This lab course offers hands-on experience in the anatomical dissection of cockroach, Pila, earthworm, and shark, alongside the study of developmental stages in embryology. Students will also observe and analyze preserved museum specimens, enhancing their understanding of comparative anatomy and developmental biology.	
Course Objectives 1. To enable students to perform precise dissections of cockroach, Pila, earthworm, and shark to understand their anatomical structures and functional systems. 2. To train students to observe and analyze preserved museum specimens, recognizing key features of various organisms. 3. To introduce students to embryological studies, emphasizing the stages of development and their biological significance. 4. To foster critical observation and documentation skills to support a deeper understanding of organismal diversity and evolutionary relationships.	
Prerequisites	Basic knowledge of invertebrate and Chordata.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Major Dissection: Cockroach - Digestive system, Nervous system. <i>Pila globosa</i> - Digestive system. Prawn - Nervous system. Frog - Arterial system and venous system (Demo)	05	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Minor Dissection: Earthworm: Lateral hearts. Cockroach: Reproductive system (Male and Female).	05	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Mounting: Cockroach: Mouth parts and salivary apparatus. Earthworm: Body setae. Prawn: Appendages (Cephalic, thoracic and abdomen). Frog: Hyoid apparatus and brain.	05	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Museum specimen – Invertebrate: Representatives from each phylum based on structural organization and phylogeny. Museum specimen – Vertebrate: Representatives from each phylum based on structural organization and phylogeny.	05	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

V	Embryology: Shark yolk sack placenta, Sheep/Goat embryo, human embryo. Osteology: Pelvic girdle, Pectoral girdle, Typical vertebra, Bird skull, Synsacrum.	06	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2016). A Manual of Zoology, (Volume I) (Part I), S. Viswanathan Printers and Publishers. 2. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2019). Manual of Zoology (Volume I) (Part- 2), Ananda Book Depot. 3. Ekambaranatha Ayyar. M and T. N. Ananthakrishnan (2019). Manual of Zoology (Volume II) (Part- 1), S. Viswanathan Printers & Publishers. 4. Ganguly, Sinha,. Bharati Goswami and Adhikari (2004). Biology of animals Vol.II - New central book Agency (p) Ltd. 5. Jordan E.L, Verma P.S (2008). Chordate Zoology, S. Chand & Company Ltd. 6. Jordan, E.K. and P.S. Verma (1995). Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd. 7. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I. (1989). Modern text book of Zoology, Rastogi Publications. 8. Kotpal. R.L. A (2009). Modern text book of Zoology Vertebrates, Rastogi publications. 9. Lal, S.S. 2005. A Text Book of Practical Zoology: Invertebrate, Rastogi, Meerut. 10. Nigam, H.C (1983). Zoology of Chordates, Vishal Publications. 11. Srivastava, M. D. L and Srivastava, U. S, (1969). A text book of Invertebrate Zoology, Central Book Depot. 12. Verma, A (2005). Invertebrates: Protozoa to Echinodermata. Narosa Publishing House.				
Suggested Readings 1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a Synthesis, Blackwell Publishing. 2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson. 3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home. 4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press. 5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc. 6. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill. 7. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press. 8. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw- Hill. 9. Newman, H.H. (1981). The Phylum Chordata, Satish Book Enterprise, Agra. 10. Parker and Haswell (1964). Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S. Publishers and Distributors.				

11. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, Holt Saunders International Edition.
12. Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.
13. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

Web Resources

Virtual Dissection Websites

1. **Froguts:** This website offers a virtual frog dissection, allowing users to explore the internal anatomy of a frog.
<https://thesciencebank.org/pages/froguts>
2. **The Virtual Body:** Provides interactive human anatomy models, including detailed dissections of various organs and systems.
<https://www.visiblebody.com/>
3. **Visible Body:** Offers a suite of interactive anatomy apps, including 3D models of human and animal anatomy.
<https://www.visiblebody.com/>
4. **Zygote Body:** This website provides interactive 3D models of the human body, allowing users to explore different anatomical structures.
<https://www.zygote.com/>
5. **Anatomy Arcade:** Offers interactive games and quizzes to learn about human anatomy, including muscle and bone identification.
<https://www.anatomyarcade.com/>

Educational Platforms with Virtual Dissections

1. **Khan Academy:** While not specifically for virtual dissection, Khan Academy offers videos and articles on biology and anatomy that can be helpful for understanding animal structures.
<https://www.khanacademy.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recall the fundamental anatomical structures and physiological systems of cockroach, Pila, earthworm, and shark through dissection practices. They will recognize and identify the key features of preserved museum specimens, enhancing their understanding of organismal diversity. Students will also describe the developmental stages observed in embryological studies, understanding their biological significance. Additionally, they will outline the basic principles of comparative anatomy and classify organisms based on observed structural and developmental characteristics.	K1, K2
CO2	Apply anatomical dissection techniques to accurately examine the internal and external structures of cockroach, Pila, earthworm, and shark. They will	K3, K4

	demonstrate proficiency in identifying and analyzing key features of preserved museum specimens, linking their observations to broader taxonomic and ecological contexts. Students will also analyze developmental stages in embryological studies to understand the processes and patterns of organismal growth. Furthermore, they will compare and interpret anatomical and developmental data to draw meaningful conclusions about the evolutionary relationships and functional adaptations of various organisms.	
CO3	Evaluate the anatomical structures and physiological systems of cockroach, Pila, earthworm, and shark, assessing their functional adaptations and ecological significance. They will critique the preservation and presentation methods of museum specimens and justify their relevance to the study of comparative anatomy. Students will design advanced dissections or observational studies to investigate specific biological questions. Additionally, they will formulate hypotheses regarding evolutionary relationships and developmental processes, using insights from embryology and anatomical comparisons to create comprehensive interpretations that contribute to a deeper understanding of organismal biology and biodiversity.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3AO01
Course Title	Agricultural Entomology
Credits	02
Hours/Week	04
Category	Allied Optional (AO) – Theory
Semester	III
Regulation	2024
Course Overview This course offers a comprehensive introduction to insect taxonomy, focusing on the identification, classification, and ecological roles of insects significant to agriculture. Key topics include the study of pests affecting cash crops, vegetables, and fruits, highlighting their biology, behavior, and impact on crop yield and quality. The course also covers insect culture, exploring beneficial insects for biological control and pollination, alongside practical techniques for managing insect pests. Through this course, the students will develop essential skills in insect identification, integrated pest management, and sustainable agriculture practices.	
Course Objectives 1. To develop proficiency in insect taxonomy and equip students to accurately identify and classify insects based on morphological features and taxonomic principles. 2. To understand agricultural pest dynamics and provide in-depth knowledge of insect pests that affect cash crops, vegetables, and fruits, including their life cycles, behaviors, and ecological impacts. 3. To explore insect culture techniques and introduce students to the cultivation of beneficial insects for pollination and biological control, emphasizing sustainable practices and applications in agriculture. 4. To apply Integrated Pest Management (IPM) Strategies and train students in effective, environmentally-friendly insect control techniques, focusing on minimizing pesticide use and promoting ecosystem balance.	
Prerequisites	Basic knowledge on agriculture and pests

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Insect taxonomy: Classification; External Morphology and Internal Anatomy of Insects; Development; Growth; and Anatomy; Insect Ecology; Causes for insects assuming pest status; Collection; Mounting and Preservation of Insects; Role of Insects in Agriculture.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Pests of cash crops: Rice (<i>Atherigona oryzae</i> ; <i>Chilo suppressalis</i>); Pests of stored grains (<i>Heliothis armigera</i> ; <i>Chilo partellus</i>); Sugarcane (<i>Odontotermes obesus</i> ; <i>Triporyza</i>	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	<i>nivella</i>); Cotton (<i>Aphis gossypii</i> ; <i>Thrips tabaci</i>); Groundnut (<i>Holotrichia consanguinea</i> ; <i>Amsacta moorei</i>).			
III	Pests of vegetables and fruits: Brinjal (<i>Leucinodes orbonalis</i>); Bottle gourd (<i>Dacus cucurbitae</i>); Potato (<i>Phthorimaea operculella</i>); Mango (<i>Amritodus atkinsoni</i>); Orange (<i>Othreis materna</i>); Jack fruit (<i>Batocera rufomaculata</i>); Guava (<i>Inderbella quadrinotata</i>); Lemon (<i>Papilio demoleus</i>); Pomegranate (<i>Calte emarginata</i>); Polyphagous pests: <i>Schistocerca gregaria</i> ; <i>Locusta migratoria</i> .	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Insect culture: Apiculture- Cultivable species; bee colony; and division of labour; Apiary; enemies; and diseases of honey bees; Lac culture- Species diversity; bionomics; Lac cultivation methods; enemies of lac insects; Sericulture- Mulberry cultivation; rearing of silkworm; Eri culture; Moonga culture and Tassar culture; Diseases of silkworm.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Insect control: Natural control; artificial control; biological control; Chemical control; legal measures; Green pesticides; Integrated Pest Management (IPM); Modern approaches: Attractants; hormones; repellents; chemosterilants; antifeedants; Insecticidal formulations; insecticidal appliances; aerial spraying; Insecticidal poisoning and treatment.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Awasthi. V.B (2012). Introduction to General and Applied Entomology, Scientific publishers. 2. Biswapati Dasgupta (2000). Parasitology, Books and Allied (P) Ltd. 3. Prem Mohan Nigam and Ashok Kumar (2001). A Text Book of Agricultural Entomology. Emkay Publications. 4. Sameer Sagar (2021). Economic Zoology, Academic Aspirations. 5. Sathe. T. V (2017). Basic Entomology: A Practical Manual, Daya Publishing House. 6. Vasantharaj David, B and Ananthakrishnan, T. N (2006). General and Applied Entomology, Tata McGraw Hill. 7. Vasanthraj David. B. and Ramamurthy. V. V (2012). Elements of Economic Entomology, Namrutha publications.				
Suggested Readings 1. Awasthi, V. B. (2016). Introduction to General and Applied Entomology, Scientific Publishers. 2. Chatterjee, P. N (2011). Insect Pest Management, Kalyani Publishers. 3. Gullan, P.J and P.S. Cranston (2010). Insect Ecology, Blackwell Publishing. 4. Imms, A. D. (1923). A General Textbook of Entomology. Digital Library of India				

5. Pruthi, H. S (1969). A Textbook of Agricultural Entomology, Indian Council of Agricultural Research.
6. Pruthi, H.S (2016). A Textbook of Entomology, Kalyani Publishers.
7. Srivastava, D. N (2018). Principles of Insect Pest Management, Rastogi Publications.
8. Srivastava, D.N (2018). Textbook of Entomology, Rastogi Publications.
9. Srivastava, K. P., & Dhaliwal, G. S. (2010). A Textbook of Applied Entomology. Kalyani Publishers.

Web Resources

General Agricultural Pest Information

1. **USDA Agricultural Research Service (ARS):** Provides comprehensive information on agricultural pests, including identification, biology, and management strategies.
<https://www.ars.usda.gov/>
2. **University of California Integrated Pest Management (UC IPM):** Offers practical, science-based information on pest management for home gardeners and commercial growers.
<https://ipm.ucanr.edu/>
3. **National Pesticide Information Center (NPIC):** Provides information on pesticides, including their uses, risks, and alternatives.
<https://npic.orst.edu/>

Specific Pest Information

1. **Online Pest Identification Tools:** Several online tools can help you identify specific pests.
BugGuide: A collaborative website for identifying insects and other arthropods.
<https://bugguide.net/>

Pest Management Strategies

1. **Organic Farming Research Foundation:** Provides information on organic pest management practices.
<https://ofrf.org/>
2. **The Xerces Society:** Dedicated to invertebrate conservation, including beneficial insects.
<https://xerces.org/>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and describe the fundamental concepts and classifications in insect taxonomy, identifying key distinguishing characteristics of major insect groups. They will recall and explain the roles of significant insect pests affecting cash crops, vegetables, and fruits, discussing their life cycles, behavior, and potential impact on agricultural productivity. Additionally, students will identify the principles and methods used in insect culture, particularly for beneficial insects, and will outline various insect control strategies, including Integrated Pest Management (IPM) approaches, aimed at	K1. K2

	minimizing pest damage while promoting ecological balance and sustainable agricultural practices.	
CO2	Apply their knowledge of insect taxonomy to accurately identify and classify various insect species relevant to agriculture, distinguishing them based on morphological and behavioral traits. They will analyze the interactions between insect pests and different crop types, including cash crops, vegetables, and fruits, evaluating how life cycles and environmental factors influence pest populations and agricultural impacts. Furthermore, students will demonstrate proficiency in implementing insect culture practices to rear beneficial insect species for pollination and biological control. Finally, they will compare and select appropriate pest management strategies, integrating chemical, biological, and cultural methods to formulate sustainable solutions that align with the principles of Integrated Pest Management (IPM).	K3. K4
CO3	Evaluate and justify the use of various insect classification methods, critiquing their effectiveness and limitations for practical agricultural applications. They will formulate strategic approaches for identifying, monitoring, and managing insect pests in cash crops, vegetables, and fruits, drawing on advanced knowledge of pest behaviors, life cycles, and ecological impacts. Students will design integrated pest management (IPM) plans tailored to specific agricultural contexts, combining chemical, biological, and cultural control methods to optimize crop health and sustainability. Additionally, they will propose innovative techniques for insect culture and the sustainable use of beneficial insects, considering current research and potential future advancements in agricultural entomology.	K5. K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3AO02
Course Title	Agricultural Entomology Lab
Credits	02
Hours/Week	03
Category	Allied Optional (AO) – Lab
Semester	III
Regulation	2024
Course Overview This course provides foundational knowledge and practical skills in entomology, including insect collection, mounting, and preservation techniques. It covers pest survey and identification, life cycle studies of pest insects, insecticide formulations, and their application. Additionally, the course includes an introduction to silkworm rearing practices, highlighting their economic importance and lifecycle management.	
Course Objectives 1. To equip students with hands-on techniques for collecting, mounting, and preserving various insect species. 2. To train students to identify agricultural and household pests and understand their ecological impacts. 3. To provide insights into the life cycles of pest insects to support effective pest control strategies. 4. To introduce students to insecticide formulations, safe application methods, and the principles of silkworm rearing for sericulture.	
Prerequisites	Basic knowledge on Agriculture and Insects

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Collection, mounting and preservation of insects: Methods of collection, mounting and preservation of insects. Study of insect segmentation, various tagmata and their appendages. Preparation of permanent mounts of different body parts and their appendages. Study of the mouth parts, digestive system, male and female genitalia (Grasshopper /Cockroach).	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Survey and identification of pests: Survey and identification of economically important pests of paddy, sugarcane, cotton, groundnut and coconut. Study of the sampling techniques for estimation of insect population and damage: crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Study of the life cycles: Study of the life cycles of Hemimetabolous and Holometabolous insects (at least one	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	example each). Study of parasitic and predatory insects (at least one example each) in relation to biological control.			
IV	Study of insecticides and their formulations: Computation of EIL and ETL. Sampling, extraction and estimation of insecticide residues by various methods. Study of pesticide appliances and their maintenance.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Study of silkworm rearing: Studies on honey bee colony: Bee species and castes of bees. Field trip to Tamil Nadu Agriculture University. Field visits to FCI warehouses.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Dhaliwal GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publ., New Delhi.
2. Chapman, R. F. – The Insects: Structure and Function.
3. Awasthi. V.B (2012). Introduction to General and Applied Entomology, Scientific publishers.
4. Biswapati Dasgupta (2000). Parasitology, Books and Allied (P) Ltd.
5. Prem Mohan Nigam and Ashok Kumar (2001). A Text Book of Agricultural Entomology. Emkay Publications.
6. Sameer Sagar (2021). Economic Zoology, Academic Aspirations.
7. Sathe. T. V (2017). Basic Entomology: A Practical Manual, Daya Publishing House.
8. Vasantharaj David, B and Ananthakrishnan, T. N (2006). General and Applied Entomology, Tata McGraw Hill.
9. Vasanthraj David. B. and Ramamurthy. V. V (2012). Elements of Economic Entomology, Namrutha publications

Suggested Readings

1. Abishek Shukla, D (2009). A Hand Book of Economic Entomology, Vedams e Books, New Delhi.
2. Awasthi, V. B. (2016). Introduction to General and Applied Entomology, Scientific Publishers.
3. Chatterjee, P. N (2011). Insect Pest Management, Kalyani Publishers.
4. Gullan, P.J and P.S. Cranston (2010). Insect Ecology, Blackwell Publishing.
5. Imms, A. D. (1923). A General Textbook of Entomology. Digital Library of India
6. Ministry of Agriculture, Government of India (1995). Manual on Integrated Pest Management in Rice and Cotton.
7. Pruthi, H. S (1969). A Textbook of Agricultural Entomology, Indian Council of Agricultural Research.
8. Pruthi, H.S (2016). A Textbook of Entomology, Kalyani Publishers.
9. Srivastava, D. N (2018). Principles of Insect Pest Management, Rastogi Publications.
10. Srivastava, D.N (2018). Textbook of Entomology, Rastogi Publications.
11. Srivastava, K. P., & Dhaliwal, G. S. (2010). A Textbook of Applied Entomology. Kalyani Publishers.

Web Resources

Major Organizations

1. **Entomological Society of America (ESA):** A leading organization promoting the understanding and appreciation of insects and their impact on humans and the environment.
<https://www.entsoc.org/>
2. **American Association for the Advancement of Science (AAAS):** A multidisciplinary scientific society dedicated to advancing science and innovation.
<https://www.aaas.org/>

Agricultural Organizations

1. **United States Department of Agriculture (USDA):** The primary agency responsible for agricultural research and policy in the United States.
<https://www.usda.gov/>
2. **Food and Agriculture Organization of the United Nations (FAO):** An international organization that works to improve food security and agricultural practices worldwide.
<http://www.fao.org/>

Other Relevant Organizations

1. **National Pesticide Information Center (NPIC):** Provides information on pesticides and their impact on human health and the environment.
<https://npic.orst.edu/>
2. **The Xerces Society:** Dedicated to the conservation of invertebrates, including pollinators and beneficial insects.
<https://xerces.org/>

Research Institutes

1. **Indian Agricultural Research Institute (IARI):** A premier agricultural research institute in India, with a strong focus on entomology.
<https://www.iari.res.in/>
2. **Indian Council of Agricultural Research (ICAR):** The apex body for agricultural research and education in India. It oversees numerous research institutes and agricultural universities.
<https://icar.org.in/>

Professional Societies

1. **Entomological Society of India (ESI):** A professional society dedicated to the advancement of entomology in India.
<https://entosocindia.org/>
2. **Association for Advancement of Entomology (AAE):** A non-governmental organization promoting entomological research and education.
<https://entomon.in/index.php/Entomon/AAE>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and recognize various insect species, pests, and their distinguishing characteristics. They will describe techniques for the collection, mounting, and preservation of insects, ensuring the integrity of specimens for further study. Students will also recall key concepts related to pest identification, life cycle patterns, and ecological significance, enabling them to understand the foundational principles of pest management. Additionally, they will recognize different types of insecticides and their formulations and explain basic practices involved in silkworm rearing and its significance in sericulture.	K1, K2
CO2	Apply effective techniques for collecting, mounting, and preserving insect specimens for scientific analysis. They will demonstrate the ability to conduct surveys and accurately classify pests based on their morphological and behavioral traits. Students will analyze the life cycles of pest insects to determine critical stages for implementing control measures. They will also interpret the composition and formulations of various insecticides, evaluating their suitability for different pest management scenarios. Furthermore, students will examine the processes of silkworm rearing, identifying factors that influence productivity and quality in sericulture.	K3, K4
CO3	Evaluate and critique methods for insect collection, mounting, and preservation to ensure optimal quality and accuracy for scientific and educational purposes. They will design and develop effective pest survey protocols, incorporating advanced identification techniques to address specific agricultural or ecological challenges. Students will assess the life cycles of pest insects, identifying vulnerable stages for targeted control strategies, and justify the selection of appropriate insecticides based on their formulations, effectiveness, and environmental impact. Additionally, they will formulate innovative approaches to silkworm rearing, optimizing practices to enhance productivity and contribute to sustainable sericulture advancements.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4AO01
Course Title	Industrial Biotechnology
Credits	02
Hours/Week	03
Category	Allied optional (AO) - Theory
Semester	IV
Regulation	2024
Course Overview This course provides a comprehensive overview of biotechnology applications in various industries. It covers the production of biofuels and the design of bioreactors, the use of microorganisms for environmental remediation and biotransformation, the industrial applications of yeast, the principles of food preservation and packaging, and the production of pharmaceuticals using biotechnology.	
Course Objectives 1. To understand the principles of bioreactor design and operation, and their application in biofuel production. 2. To analyze the mechanisms of bioremediation and biotransformation, and their role in environmental cleanup. 3. To evaluate the industrial applications of yeast in food production, beverage fermentation, and biofuel production. 4. To critically assess the impact of food preservation and packaging techniques on food quality and safety.	
Prerequisites	Basic knowledge of Biotechnology and Environmental Biology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Biofuels and Bioreactors: Biofuels: Process, production methods, and pros and cons of Ethanol, Biodiesel, Biogas, Vegetable Oil, Cellulosic Ethanol, Fischer-Tropsch Diesel, Biohydrogen, Bio-oil, Algal Biofuel, Algal Biodiesel, Electrofuels, Biochar, Butanol, Methanol, Green Diesel. Bioreactors: Types of Bioreactors, Design and Components of Bioreactors, Bioprocess Control, Bioreactor Kinetics, Applications of Bioreactors.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Bioremediation and Biotransformation: Bioremediation- Types, Mechanisms, Techniques, Bioremediation of Organic Pollutants, Heavy Metals, Industrial Wastes. Biotransformation- Enzymatic Mechanisms, Microbial Biotransformation, Xenobiotics, Agrochemicals, Biocatalysis and Pollutants. Metabolic Pathways in Biotransformation, Biotransformation of Renewable Resources.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Industrial Yeast: Common industrial yeast strains, Yeast in Food and Beverage Industries, Baking, Alcoholic Beverages, Dairy Products, Pharmaceuticals and Biotechnology, Enzyme Production, Biotechnology and Bioengineering, Metabolic Engineering, Wastewater Treatment, Probiotics and Health Supplements.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Food Preservation and packaging: Bio-preservation, Edible Coatings and Films, Modified Atmosphere Packaging (MAP), Sustainable Food Packaging Solutions, Biodegradable and Compostable Packaging, Nanotechnology in Food Packaging, Microbial Production of Bioplastics, Biopolymer Production, Biodegradability and Compostability Standards, Recycling and Upcycling of Packaging Materials, Food Safety and Packaging Regulations, Life Cycle Assessment (LCA), Reduction of Carbon Footprint.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Pharmaceuticals: Biopharmaceuticals, Pharmacogenomics, Production of Recombinant Proteins, Monoclonal Antibodies, Cell Culture Techniques, Nanotechnology in Drug Delivery, Gene Delivery Systems, Recombinant Vaccines, mRNA Vaccines, Regulatory Approvals for Biopharmaceuticals, Quality Control and Assurance, Patenting Biopharmaceuticals, Ethical Considerations, Personalized Medicine.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Chellapandi. P, (2007) Laboratory Manual in Industrial Biotechnology, Pointer Publications.
2. Harisha, S. (2005). An Introduction to Practical Biotechnology. India: Laxmi Publications Pvt Limited.
3. Kulandaivel and Janarthanan. S, (2012) Practical Manual on Fermentation Technology, TechSar Pvt. Ltd.
4. Maheswari. K, (2002) Practical microbiology, S. Chand publishers..
5. Patel. A.H, (2012) Industrial Microbiology by, 2nd edition , Mac Millan.
6. Watson, K (2016). Industrial Biotechnology, CBS Publishers & Distributors.
7. Yadav. P. R and Rajiv Tyagi (2005). Industrial biotechnology, Discovery Publishing house.

Suggested Readings

1. Arnold. (2004). Manual of industrial microbiology and biotechnolog. ASM Press.
2. Casida, L.E., (2010), Industrial microbiology, New age international. Crueger, W., Crueger, A., Brock, T. D. (1989). Biotechnology : A textbook of industrial microbiology. Sinauer Associates.
3. Jacques, K. A., Lyons, T. P., Kelsall, D. R. (2003). The Alcohol Textbook: A Reference for the Beverage, Fuel and Industrial Alcohol Industries. Nottingham University Press.

4. Kent, J. A. (2012). Handbook of industrial chemistry and biotechnology. Springer US.
- Whittaker, Stanbury and J. Hall, (1997), Principles of fermentation technology, 2nd edition, Aditya books.
5. McNeil, B., Harvey, L. (2008). Practical Fermentation Technology. Germany: Wiley.
6. Thatoi, Supriya Dash, Swagat Kumar Das. (2017). Practical biotechnology principles and protocols. I.K. International Publishing House Pvt. Limited.

Web Resources

Organizations and Societies:

1. **American Society for Microbiology (ASM):** <https://asm.org/>
Offers numerous resources, including journals, books, and databases, related to industrial microbiology.
2. **Biotechnology Industry Organization (BIO):** <https://www.bio.org/>
A global trade association representing biotechnology companies, focusing on public policy and advocacy.
3. **European Federation of Biotechnology (EFB):** <http://www.efbiotechnology.org/>
Promotes biotechnology research and innovation in Europe.
4. **International Union of Pure and Applied Biochemistry and Molecular Biology (IUBMB):** <https://iubmb.org/>
Provides guidelines and standards for biochemical and molecular biology research.

Protocols and Manuals:

1. **Nature Protocols:** <https://www.nature.com/nprot/>
Publishes detailed protocols for various experimental techniques, including those relevant To industrial biotechnology.
2. **Current Protocols:** <https://currentprotocols.onlinelibrary.wiley.com/>
A comprehensive collection of laboratory protocols, including those for molecular biology, biochemistry, and cell biology.
3. **American Type Culture Collection (ATCC):** <https://www.atcc.org/>
Provides a wide range of biological materials, including microorganisms, cell lines, and DNA, along with detailed protocols for their use.

Online Courses and Educational Resources:

1. **Coursera:** <https://www.coursera.org/>
Offers online courses on industrial biotechnology, including topics like bioprocess engineering, fermentation technology, and biorefineries.
2. **edX:** <http://www.edx.org/>
Provides online courses on biotechnology and related fields, often offered by top universities.
3. **MIT OpenCourseWare:** <https://ocw.mit.edu/>
Offers free access to course materials, including lecture notes, assignments, and exams, from MIT courses related to biotechnology and engineering.

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms related to biotechnology, such as bioreactor, fermentation, bioremediation, and biotransformation. Describe the different types of bioreactors and their applications in various industries. Explain the principles of microbial fermentation and its role in biofuel production. Identify the major microorganisms used in industrial biotechnology, including bacteria, fungi, and algae. Summarize the various methods of food preservation and packaging, and their impact on food quality and safety. Outline the steps involved in the production of pharmaceuticals using recombinant DNA technology.	K1, K2
CO2	Analyze the economic and environmental impacts of biofuel production and use. Evaluate the effectiveness of different bioremediation strategies for contaminated sites. Critically analyze the factors affecting the efficiency and productivity of industrial fermentation processes. Assess the safety and efficacy of food preservation techniques and their impact on consumer health. Apply knowledge of biotechnology to develop innovative solutions for sustainable agriculture and food production.	K3, K4
CO3	Create novel bioreactor designs to improve the efficiency and productivity of fermentation processes. Design and conduct experiments to optimize bioremediation strategies for contaminated environments. Synthesize knowledge from diverse fields, such as microbiology, biochemistry, and engineering, to develop sustainable biotechnological solutions. Evaluate the ethical implications of biotechnology, including issues related to food safety, environmental impact, and intellectual property. Critically analyze the limitations of current biotechnology and propose future directions for research and development.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	2	3	3
CO2	2	3	2	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4AO02
Course Title	Industrial Biotechnology Lab
Credits	01
Hours/Week	02
Category	Allied Optional (AO) - Lab
Semester	IV
Regulation	2024
Course Overview This course provides a comprehensive overview of industrial biotechnology. Students will learn about the production of various products through fermentation processes, explore the applications of plant-based biotechnology, and delve into the industrial methods used in biotechnology.	
Course Objectives 1. To understand the principles of fermentation and its applications in industrial processes and learn to produce organic acids through fermentation techniques. 2. To explore the various industrial applications of biotechnology and understand the industrial processes involved in the production of biofuels, enzymes, and other bioproducts. 3. To learn about plant tissue culture and genetic engineering techniques and understand the applications of plant biotechnology in agriculture and industry. 4. To explore the use of biotechnology in food production and processing and understand the safety and regulatory aspects of food biotechnology.	
Prerequisites	Basic knowledge on Biology

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Production of acids by fermentation: Lactic acid fermentation using milk samples. Production and estimation of citric acid. Production and estimation of acetic acid.	06	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Industrial products: Production of alcohol from organic waste materials. Production of biogas from organic materials. Production and estimation of fructose obtained by yeast sucrose hydrolysis.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Plant products: Isolate papain from papaya and determination of its enzymatic activity. Isolation of starch from potato and calculation of its percentage yield.	04	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Food products: Preparation of cheese. Preparation of wine from grape extract.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Industrial biotechnological methods: Utilization of amylase enzyme from sweet potato for starch removal from	04	CO1 CO2	K1,K2,K3, K4,K5,K6

	cloth. Recycling of paper using cellulose enzyme. Field/ Industry/ Institute visit.		CO3	
Text Books 1. Chellapandi. P, (2007) Laboratory Manual in Industrial Biotechnology, Pointer Publications. 2. Harisha, S. (2005). An Introduction to Practical Biotechnology. India: Laxmi Publications Pvt Limited. 3. Kulandaivel and Janarthanan. S, (2012) Practical Manual on Fermentation Technology, TechSar Pvt. Ltd. 4. Maheswari. K, (2002) Practical microbiology, S. Chand publishers.. 5. Patel. A.H, (2012) Industrial Microbiology by, 2nd edition , Mac Millan.				
Suggested Readings 1. Arnold. (2004). Manual of industrial microbiology and biotechnolog. ASM Press. 2. Casida, L.E., (2010), Industrial microbiology, New age international. 3. Crueger, W., Crueger, A., Brock, T. D. (1989). Biotechnology : A textbook of industrial microbiology. Sinauer Associates. 4. Jacques, K. A., Lyons, T. P., Kelsall, D. R. (2003). The Alcohol Textbook: A Reference for the Beverage, Fuel and Industrial Alcohol Industries. Nottingham University Press. 5. Kent, J. A. (2012). Handbook of industrial chemistry and biotechnology. Springer US. - Whittaker, Stanbury and J. Hall, (1997), Principles of fermentation technology, 2nd edition, Aditya books. 6. McNeil, B., Harvey, L. (2008). Practical Fermentation Technology. Germany: Wiley. 7. Thatoi, Supriya Dash, Swagat Kumar Das. (2017). Practical biotechnology principles and protocols. I.K. International Publishing House Pvt. Limited.				
Web Resources				
Educational Platforms and Virtual Labs 1. LabXchange https://www.labxchange.org Offers virtual lab simulations and interactive exercises tailored for biotechnology education. 2. PhET Interactive Simulations https://phet.colorado.edu Provides biology and chemistry-related simulations useful for understanding molecular biology and biochemistry processes. 3. MERLOT Biology Resources https://www.merlot.org A vast library of peer-reviewed educational tools, including lab exercises and tutorials. 4. Learn. Genetics by the University of Utah https://learn.genetics.utah.edu Detailed animations, videos, and virtual experiments in genetics and molecular biology.				
Research and Data Resources 1. USDA Biotechnology https://www.usda.gov/topics/biotechnology				

Includes research articles and regulatory information for agricultural biotechnology.
2. NCBI Genomic Data https://www.ncbi.nlm.nih.gov Comprehensive database for genomics, including gene sequences and bioinformatics tools.
3. Bio-Rad Explorer Program https://www.bio-rad.com/en-us/education Offers instructional videos and lab kits for biotechnology experimentation.

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the different types of fermentation processes. Understand the biochemical principles underlying fermentation. Know the various industrial applications of biotechnology. Comprehend the techniques of plant tissue culture and genetic engineering. Understand the role of biotechnology in food production and processing. Perform fermentation experiments to produce organic acids. Analyze fermentation products using various analytical techniques. Apply biotechnological techniques to produce industrial products. Culture plant cells and tissues using aseptic techniques. Evaluate the quality and safety of food products produced using biotechnology. Use laboratory equipment and techniques to conduct experiments and collect data. Interpret experimental results and draw conclusions.	K1, K2
CO2	Analyze the factors affecting fermentation efficiency and product yield. Compare and contrast different fermentation techniques and their applications. Evaluate the economic and environmental impact of industrial biotechnology processes. Interpret data from plant tissue culture experiments to assess the success of regeneration. Analyze the safety and regulatory issues associated with genetically modified organisms (GMOs) in food production. Design and conduct fermentation experiments to optimize product yield and quality. Develop new biotechnological processes for the production of industrial products. Integrate knowledge from different fields of biotechnology to solve problems in industry and agriculture. Communicate scientific findings effectively through written reports and oral presentations. Collaborate with other researchers to advance the field of biotechnology.	K3, K4
CO3	Evaluate the ethical implications of biotechnology, particularly in relation to genetic engineering and food production. Critically assess the environmental impact of industrial biotechnology processes. Compare and contrast different regulatory frameworks for biotechnology. Evaluate the economic feasibility of biotechnological innovations. Develop innovative	K5, K6

	biotechnological solutions to address global challenges, such as food security and climate change. Design novel fermentation processes for the production of value-added products. Create new plant varieties with improved traits through genetic engineering. Contribute to the advancement of biotechnology through original research. Communicate complex scientific concepts to a diverse audience, including policymakers and the public.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	1	3	3	3	3
CO2	2	2	1	3	3	3	3
CO3	2	2	1	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4ME01
Course Title	Essentials of Forensic Biology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2024
Course Overview This course provides an introduction to the analysis of biological evidence in forensic investigations, covering forensic biology, wildlife forensics, and toxicology related to poisons, narcotics, drugs, and psychotropic substances. Students will also explore forensic anthropology, learning how biological materials and human remains are used to aid in legal investigations and support wildlife conservation efforts. Through case studies and applied learning, students will gain foundational skills for careers in forensic science.	
Course Objectives 1. To understand the role and importance of biological evidence in forensic biology and its application in criminal investigations. 2. To identify and analyze biological materials in wildlife forensics to aid in species identification and wildlife conservation law enforcement. 3. To evaluate toxicological methods for detecting and interpreting the presence of poisons, narcotics, drugs, and psychotropic substances in forensic cases. 4. To apply principles of forensic anthropology to analyze human remains, including skeletal analysis, to provide critical insights in legal and investigative contexts.	
Prerequisites	Basic knowledge of biochemistry.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Biological Evidence: Nature and importance of biological evidence; Significance of hair evidence; Transfer, persistence and recovery of hair evidence; Structure of human hair; Comparison of hair samples; Morphology and biochemistry of human hair; Comparison of human and animal hair; Types and identification of microbial organisms of forensic significance; Identification of wood, leaves, pollens and juices as botanical evidence; Diatoms and their forensic significance.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Wildlife Forensics: Fundamentals; Significance ; Protected and endangered species of animals and plants; Illegal trading in wildlife items; Identification of physical evidence; Identification of pug marks of various animals. Forensic	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Entomology- Insects of forensic importance; Collection of entomological evidence during death investigations.			
III	Poisons: Classification of poisons; Physico-chemical characteristics and mode of action; Signs and symptoms of common poisoning and their antidotes; Collection and preservation of viscera, blood and urine for various poison case; Identification of biocides and metal salts in body fluids; Metabolism and excretion of poisons.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Narcotics, Drugs and Psychotropic Substances: Definitions; Broad classification; Natural, synthetic and semi-synthetic narcotics, drugs and psychotropic substances; Designer drugs. Tolerance, addiction and withdrawal symptoms; Collection and preservation of drug evidence; Isolation techniques – thin layer chromatography, gas-liquid chromatography and high performance liquid chromatography. Presumptive and screening tests.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Forensic Anthropology: Personal Identification – Somatoscopy and Somatometry Somatoscopy – observation of hair on head, forehead, eyes, root of nose, nasal bridge, nasal tip, chin, Darwin's tubercle, ear lobes, supra-orbital ridges, physiognomic ear breadth, circumference of head. Scar marks and occupational marks. Somatometry – measurements of head, face, nose, cheek, ear, hand and foot, body weight, height. Indices - cephalic index, nasal index, cranial index, upper facial index.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Bhasin, M. K and S. Nath (2002). Role of Forensic Science in the New Millennium, University of Delhi.
2. James, S. H and J.J. Nordby (2005). Forensic Science: An Introduction to Scientific and Investigative Techniques, CRC Press.
3. Nanda, B. B and R.K. Tiwari (2001). Forensic Science in India: A Vision for the Twenty First Century, Select Publishers.

Suggested Readings

1. Eckert W. G and R.K. (1997). Wright in Introduction to Forensic Sciences, W.G. Eckert (ED.), CRC Press.
2. James S. H and J.J. Nordby, (2005). Forensic Science: An Introduction to Scientific and Investigative Techniques, CRC Press.
3. Nanda, B. B and R.K. Tiwari, (2001). Forensic Science in India: A Vision for the Twenty First Century, Select Publishers.
4. Narayan Reddy K. S (2018). The Principles and Practice of Forensic Medicine, Elsevier.
5. Parikh (2019). Textbook of Forensic Medicine and Toxicology. Bhalani Publishing House.

6. Puri, A., Mahalakshmi, N., Chauhan, T., Mishra, A., & Bhatnagar, P. (2024). Fundamentals of Forensic Biology. Springer Link.
7. Saferstein, R (2004). Criminalistics, 8th Edition, Prentice Hall.
8. Sen, P. K (2019). Forensic Medicine and Toxicology, Jaypee Brothers Medical Publishers
9. Sharma B. R (2019). Forensic Science in Criminal Investigation and Trials. Universal Law Publishing.
10. Shrivastava, P., Lorente, J. A., Srivastava, A., Badiye, A., & Kapoor, N. (2023). Textbook of Forensic Science. Springer Link.
11. Tilstone, W. J., M.L. Hastrup and C. Hald (2013). Fisher's Techniques of Crime Scene Investigation, CRC Press.

Web Resources

1. **American Academy of Forensic Sciences (AAFS) - Pathology/Biology Section**
Provides an overview of the field, career opportunities, and educational resources in forensic biology.
aafs.org
2. **Forensic Resources: Blood & Bodily Fluids**
Offers insights into forensic serology tests (presumptive and confirmatory), casework resources, and training materials.
forensicsciencesources.org
3. **National Institute of Standards and Technology (NIST) - Forensic Science**
A hub for forensic biology standards and ongoing research. NIST is a key player in ensuring scientific rigor in forensic practices.
nist.gov
4. **Environmental Science - Careers in Forensic Biology**
Comprehensive information about careers, necessary qualifications, job roles, and potential salary in forensic biology.
environmentalscience.org
5. **Federal Bureau of Investigation (FBI) - Forensic Biology**
The FBI provides educational content and outlines the role of biology in solving crimes.
fbi.gov
6. **Forensic Science International**
A peer-reviewed journal featuring the latest research in forensic biology and related disciplines. Subscription or institutional access might be required for full content.
forensic-science.com
7. **Scientific Working Group on DNA Analysis Methods (SWGDM)**
Guidelines and best practices for DNA analysis in forensic science. Essential for forensic biology professionals focused on genetic analysis.
swgdam.org
8. **Directorate of Forensic Science Services (DFSS), Ministry of Home Affairs**
The DFSS oversees forensic science laboratories in India, providing essential resources for forensic research and practices.
[Visit DFSS](#)

9. Central Forensic Science Laboratories (CFSL)

These laboratories, located in cities like Kolkata, Hyderabad, and Chandigarh, specialize in various forensic fields, including biological sciences.

[CFSL Overview](#)

10. National Forensic Sciences University (NFSU)

Based in Gujarat, NFSU offers specialized education and research opportunities in forensic sciences. It is an international-level institution dedicated to forensics.

[Visit NFSU](#)

11. Lok Nayak Jayaprakash Narayan National Institute of Criminology and Forensic Science (NICFS)

NICFS provides training, research, and resources for forensic and criminological sciences in India.

[Visit NICFS](#)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define and describe key concepts and techniques in forensic biology, wildlife forensics, toxicology, and forensic anthropology. They will also be able to identify various types of biological evidence, including substances and remains, and understand their significance in forensic investigations and wildlife conservation efforts.	K1, K2
CO2	Apply forensic biology techniques to examine biological evidence in criminal and wildlife cases. They will also be able to analyze toxicological data related to poisons, narcotics, drugs, and psychotropic substances, and interpret forensic anthropological findings from human remains to support legal and investigative processes.	K3, K4
CO3	Evaluate complex forensic evidence from biological, toxicological, and anthropological sources to draw substantiated conclusions in criminal and wildlife cases. They will create comprehensive forensic reports and propose informed strategies for analyzing biological evidence that enhance the accuracy and integrity of legal investigations and conservation efforts.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	1	3	3
CO2	3	2	2	3	1	3	3
CO3	3	2	2	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4ME02
Course Title	Fundamentals of Marine Biology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2024
Course Overview This course provides an in-depth examination of seawater's physical, chemical, and biological properties, exploring how these factors interact to shape marine ecosystems. Students will investigate community ecology within marine environments, including species interactions and biodiversity. Additionally, the course will address the impact of marine pollution on these ecosystems, emphasizing the importance of understanding and mitigating human-induced changes to ocean health. Through a combination of lectures, discussions, and case studies, students will gain a comprehensive understanding of the dynamics of marine systems and their ecological significance.	
Course Objectives 1. To understand the fundamental physical properties of seawater, including temperature, salinity, density, and their implications for marine life and ocean circulation. 2. To analyze the chemical properties of seawater, focusing on nutrient cycles, pH levels, and the role of dissolved gases in supporting marine ecosystems. 3. To explore the biological properties of the sea by examining marine organisms, their adaptations, and their roles within various marine communities and ecosystems. 4. To evaluate the effects of marine pollution on ecosystem health, biodiversity, and community structure, and develop strategies for mitigating these impacts through conservation and policy initiatives.	
Prerequisites	Basic knowledge of ecology and environment.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Physical Properties of Seawater: Topography of the Oceans; Zonation and its Significance; Temperature; Density; Viscosity; Surface Tension; Hydrostatic Pressure. Waves: Types of Waves and its Dynamics. Tides: Definition; Types; Generating Force. Wind and Ocean Circulation; Currents and its Types.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Chemical Properties of Seawater: Chlorinity and Salinity of Seawater; Dissolved Gases in Seawater: Non-Reactive Gases; Minor Reactive Gases; Elements- Major and Minor Elements. Organic Matter: Dissolved and Particulate Organic Matter-	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Sources and Types; Biogeochemical Cycle - Carbon; Nitrogen; Phosphorus; Silicate and their significance.			
III	Biological Properties of Sea: Primary and Secondary Productivity of the Coastal Environment; Phytoplankton and Zooplankton: Classification; Distribution; Inter-relationship. Measurement of Primary and Secondary Productivity.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Community Ecology: Pelagic; Benthic; Coral Reef; Estuaries; Seagrass; Mangrove; Intertidal and Deep-Sea Ecology-Animal Association and their Assemblages.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Marine Pollution: Classification; Organic wastes; BOD and COD; Origin and transport of organic pollutants to the oceans; Sewage Pollution; Thermal Pollution; Pesticide Pollution; Heavy Metal Pollution; Physical; chemical and biological effects on marine organisms; Bioaccumulation; Biomagnification and Biodepuration.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Andres; H. A.; & Jorge; E. 2017. Marine Pollution and Climate Change. Taylor & Francis.
2. Coffield; R. L (2019). Saving Our Oceans. Moonlight Mesa Associates.
Judith S. Weis (2015). Marine Pollution. Oxford University Press.
3. Naskar; K.; & Mandal; R (1999). Ecology and Biodiversity of Indian Mangroves (Vols. 1-2). Daya Publishing House.
4. Singh; P (1995). Environmental Pollution and Management. Chugh Publications.
5. Spoel. S. Vander; & Heyman; R. P. 1983. Comparative atlas of Zooplankton biological patterns in the oceans. Springer.

Suggested Readings

1. Aaradhana; S (2018). Marine; Nuclear and Thermal Pollution. Jnanada Prakashan (P&D). Clark; R. B. (1989). Marine pollution. Clarendon Press.
2. Nybakken; J. W.; & Mark; D. Bertness (2004). Marine Biology an Ecological Approach (6th ed.). Benjamin-Cummings
3. Park; P. K.; Kester; D. R.; Deudall; J. W. & Ketchum; B. H (1983). Wastes in the Ocean. (Vols.1-3). Wiley Interscience Publishers.
4. Ricardo; B (2018). Marine Pollution: Sources; Fate and Effects of Pollutants in Coastal Ecosystem. Elsevier.
5. Sumich; J. L (1999). Introduction to the biology of Marine Life (7th ed.). The Mc Graw Hill Companies Inc.

Web Resources**Marine Biology Resources in India**

1. **Centre for Marine Living Resources and Ecology (CMLRE)** - This Indian government initiative promotes marine research, focusing on the Indian Ocean's ecosystem.
<https://cmlre.gov.in>

2. **National Centre for Coastal Research (NCCR)** - A Ministry of Earth Sciences body conducting advanced studies on coastal and marine ecosystems.
<https://nccr.gov.in>
3. **Andaman and Nicobar Centre for Ocean Science and Technology (ANCOST)** - Research hub dedicated to marine biodiversity and ecosystems in India's coastal waters.
<https://ancost.org.in>
4. **IUCN India** - Offers resources and reports about marine biodiversity conservation and ecosystem health in India, with a global perspective.
<https://www.iucn.org/asia/countries/india>

Marine Biology Resources Abroad

1. **MarineBio Conservation Society** - Comprehensive insights into marine life, research methods, and conservation efforts.
<https://marinebio.org>
2. **International Union for Conservation of Nature (IUCN)** - Provides global research and conservation programs, including those targeting marine ecosystems.
<https://www.iucn.org>
3. **National Oceanic and Atmospheric Administration (NOAA)** - A U.S.-based organization offering a wealth of marine biology resources and research opportunities.
<https://www.noaa.gov>
4. **University of Queensland (Australia): Marine Science Program** - Renowned for its research in marine ecosystems, including coral reefs and coastal environments.
<https://marine.uq.edu.au>
5. **European Marine Board** - Focuses on policies and research frameworks for marine sciences in Europe.
<https://www.marineboard.eu>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define and describe the key physical, chemical, and biological properties of seawater and their roles in shaping marine environments. They will be able to identify factors that influence oceanic conditions, such as temperature, salinity, and nutrient availability, and recognize the importance of community ecology in sustaining marine biodiversity. Students will also understand the sources and impacts of marine pollution, gaining foundational insights into how pollution affects marine life, ecosystems, and the broader ecological balance of the oceans.	K1, K2
CO2	Analyze the physical properties of seawater, including temperature, salinity, density, and pressure, and their impact on marine ecosystems. Evaluate the chemical composition of seawater, focusing on major and minor elements, nutrients, and dissolved gases, and their role in marine biogeochemical cycles.	K3, K4

	Critically analyze the diversity and distribution of marine organisms, considering factors such as temperature, salinity, light, and nutrients. Assess the ecological interactions within marine communities, including competition, predation, and symbiosis, and their influence on community structure and function. Evaluate the sources, impacts, and management strategies for marine pollution, including plastic pollution, nutrient pollution, and chemical contaminants.	
CO3	Create innovative solutions to address challenges related to marine pollution, such as designing sustainable waste management strategies or developing novel technologies for ocean cleanup. Design and conduct original research projects to investigate specific aspects of marine science, such as the impact of climate change on marine ecosystems or the development of new marine biotechnology applications. Synthesize information from diverse sources to develop comprehensive understanding of complex marine systems, such as the interactions between physical, chemical, and biological processes in the ocean. Evaluate the effectiveness of marine conservation and management strategies, such as marine protected areas and sustainable fisheries practices, and propose improvements. Critically analyze current scientific literature and research findings to identify knowledge gaps and future research directions in marine science.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	3	1	3	3
CO2	3	1	2	3	1	3	3
CO3	3	1	2	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4ME03
Course Title	Fundamentals of Nanobiology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2024
Course Overview This course provides a comprehensive introduction to the emerging field of nanobiology, exploring the intersection of nanotechnology and biology. Students will delve into the fundamental concepts of nanostructures and nanomaterials, their synthesis, characterization, and applications in biological systems. The course will cover the interactions between nanomaterials and biological entities, including cells and biomolecules, and their potential impact on health and disease. Additionally, students will gain insights into the latest advancements in nanobiotechnology, particularly in the areas of medicine and healthcare, such as drug delivery, diagnostics, and tissue engineering. The course will conclude with a discussion of future trends and challenges in the field of nanobiology.	
Course Objectives 1. To understand the fundamental principles of nanotechnology and its applications in biology. 2. To analyze the properties and synthesis of nanomaterials, and their interactions with biological systems. 3. To evaluate the potential of nanobiotechnology in various medical and healthcare applications, such as drug delivery, diagnostics, and tissue engineering. 4. To critically assess the ethical implications and future directions of nanobiology research.	
Prerequisites	Basic knowledge of animals / Invertebrates

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Introduction to Nanobiology: Definition and Scope of Nanobiology; Historical Overview and Evolution of the Field; Basic Concepts of Nanotechnology; Nanoscience and its relevance to biology; Nanoscale; Nanostructures in Nature; - Biomimetics and bioinspiration; Overview of Experimental and Imaging Techniques.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Nanostructures and Nanomaterials: Types of Nanomaterials- Nanoparticles (gold, silver, quantum dots), Nanotubes, nanowires, and nanofibers, Nanopolymers and dendrimers. Synthesis of Nanomaterials- Top-down vs. bottom-up approaches; Biological methods for nanomaterial synthesis; Properties of Nanomaterials; Characterization Techniques.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Nanobiological Interactions: Protein-nanoparticle interactions; DNA and RNA as nanoscale materials; Membrane and cell interactions with nanomaterials; Nanostructured Biological Systems; Structural biology at the nanoscale: Protein folding and molecular motors; Enzyme and catalytic properties at the nanoscale; Nanotechnology in Genetic Engineering; Nanobiomechanics.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Nanobiotechnology in Medicine and Healthcare: Drug delivery systems and targeted therapies; Nanocarriers: Liposomes, micelles, dendrimers, and nanoparticles; Nanoparticle-based imaging and diagnostics; Nanotechnology in Disease Treatment; Cancer nanotechnology: Tumor targeting, photothermal therapy; Nanotechnology in cardiovascular and neurodegenerative diseases; Nanobiosensors and Diagnostics.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Future Prospects and Applications of Nanobiology: Nanotechnology in Biotechnology; Nanofabrication techniques for biochips; Synthetic biology at the nanoscale; Nanotechnology in environmental biotechnology (pollution control, bio-remediation); Emerging Applications of Nanobiology; Challenges and Future Directions; Ethical, Safety, and Regulatory Issues.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Bharat Bhushan (2010). Springer Handbook of Nanotechnology, Springer Science & Business Media.
2. Christof M. Niemeyer, Chad A. Mirkin (2006). Nanobiotechnology: Concepts, Applications and Perspectives, John Wiley & Sons.
3. Jain, Kewal. (2017). The Handbook of Nanomedicine. Humana Press.
4. Robert Kelsall, Ian W. Hamley, Mark Geoghegan (2005). Nanoscale Science and Technology, John Wiley & Sons.

Suggested Readings

1. Arben Merkoci (2009) Biosensing using Nanomaterials. Wiley Publication.
2. Cao, G (2004). Nanostructures and Nanomaterials - Synthesis, Properties and Applications, Imperial College Press.
3. Challa Kumar(2010). Semiconductor Nanomaterials, Wiley-VCH.
4. Challa S.S.R. Kumar (2006) - Nanosystem Characterization Tools in the Life Science, Wiley-VCH, Verlag.
5. Challa S.S.R. Kumar (2007) - Nanomaterials for Biosensors, Wiley-VCH, Verlag.
6. Daniel L. Feldheim, Colby. A. Foss (2002). Metal Nanoparticles: Synthesis, Characterization and Applications, Marcel Dekker, NY.
7. Didier Astruc(2008). Nanoparticles and Catalysis, Wiley-VCH.
8. Hdjipanayis, G. C., R.W. seigel (1994). Nanophase Materials- Synthesis, Properties and

Applications, Kluwer Academic Publishers.

9. Janos. H. Fendler (1998) - Nanoparticles and Nanostructured Films: Preparation, Characterization and Applications, Wiley.
10. Ralph S. Greco, Fritz B. Prinz and R. Lane Smith (2005) - Nanoscale Technology in Biological Systems, CRC Press.

Web Resources

Resources in India

1. **NanoBiology Lab, IISc Bangalore**
Focused on interdisciplinary research integrating nanotechnology and biology. The lab addresses molecular systems biology and single-molecule analysis.
[Visit the NanoBiology Lab Website](#)
2. **Institute of Nano Science and Technology (INST), Mohali**
INST offers research programs in nanobiotechnology, including drug delivery, diagnostics, and tissue engineering.
[INST Official Website](#) 【
3. **Centre for Nanotechnology, IIT Guwahati**
Conducts advanced research in nanotechnology applications in biology, including nanomedicine and biosensors.
[Centre for Nanotechnology IIT Guwahati](#)
4. **National Centre for Biological Sciences (NCBS), Bengaluru**
Collaborates on projects combining nanotechnology with biological systems for research in medicine and biotechnology.
[NCBS Official Website](#)

Resources Abroad

1. **Nanobiotechnology - Wikipedia Overview**
Provides a comprehensive introduction to nanobiotechnology concepts and applications, such as nanomedicine, biosensors, and artificial cells.
[Wikipedia on Nanobiotechnology](#)
2. **Johns Hopkins Institute for NanoBioTechnology (INBT), USA**
Specializes in nanobiology research across molecular imaging, tissue engineering, and cancer nanomedicine.
[INBT Official Website](#)
3. **NanoBioNet, Germany**
A leading network for nanobiotechnology professionals and researchers. It focuses on interdisciplinary collaboration in nanomedicine and biophysics.
[NanoBioNet Website](#)
4. **University of Twente, The Netherlands**
Offers an advanced MSc in Nanotechnology with a focus on its biological applications.
[University of Twente Nano Program](#)
5. **NanoBioLab, National University of Singapore (NUS)**
Engaged in cutting-edge research in nanotechnology applications in biology, including

biocompatible materials and drug delivery systems.

[NanoBioLab at NUS](#)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms and concepts in nanotechnology and nanobiology, such as nanoparticles, nanomaterials, and nanobiotechnology. Describe the various techniques used to synthesize, characterize, and manipulate nanomaterials. Explain the unique properties of nanomaterials and how they differ from bulk materials. Identify the potential applications of nanotechnology in various fields, including medicine, healthcare, and environmental science. Compare and contrast different types of nanomaterials, such as carbon nanotubes, quantum dots, and liposomes, and their respective properties. Summarize the principles of nanobiological interactions, including the mechanisms of cellular uptake and intracellular trafficking of nanoparticles.	K1, K2
CO2	Analyze the physical and chemical properties of nanomaterials and their impact on biological systems. Evaluate the potential risks and benefits of nanotechnology, including toxicological and environmental concerns. Critically analyze the literature on nanobiotechnology and identify emerging trends and challenges. Assess the efficacy and safety of nanotechnology-based medical devices and therapies. Apply the principles of nanotechnology to design innovative solutions for biomedical problems.	K3, K4
CO3	Create novel nanomaterials and nanodevices with tailored properties for specific biomedical applications. Design and conduct experiments to investigate the biological effects of nanomaterials and optimize their performance. Synthesize knowledge from diverse fields, such as chemistry, biology, physics, and engineering, to address complex challenges in nanobiotechnology. Evaluate the ethical, legal, and societal implications of nanotechnology and propose strategies for responsible innovation. Critically analyze the limitations of current nanotechnology and identify emerging opportunities for future research and development.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	2	2	3	3	3
CO2	1	3	2	2	3	3	3
CO3	1	3	2	2	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5ME01
Course Title	Fundamentals of Neuroscience
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2024
Course Overview This course provides a comprehensive overview of the structure and function of the human brain. It explores the anatomy of the brain and brainstem, the electrical and chemical signaling mechanisms of neurons, and the hormonal regulation of brain function. The course delves into the neural basis of cognition, emotion, and behavior, as well as the neurobiological underpinnings of neurological disorders.	
Course Objectives 1. To understand the fundamental anatomy and physiology of the brain and brainstem. 2. To analyze the neural mechanisms underlying cognitive processes, emotions, and behavior. 3. To evaluate the role of hormones in brain function and behavior. 4. To critically assess the neurobiological basis of neurological disorders and potential therapeutic interventions.	
Prerequisites	Basic knowledge of biotechnology and behavior biology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Brain Anatomy and Brainstem Regulatory Systems: Brain anatomy- Different Lobes; Cortex Brain Organisation; Structure of Cerebellum and Basal Ganglia; Evolution of brain; Brain cells and functions. Sensory systems; Sensory Receptors; Somatosensory Systems; Why and how male and female brains differ. Neural Mechanisms of Motivation, Reinforcement System Brain Aversion Systems; Plasticity of nervous system; Addiction; Circadian Rhythms; Sleep and Dreaming.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Neurophysiology: Neurons and glial cells; Resting membrane potential and Action potential; Propagation of Nerve Impulses; Degeneration and regeneration /repair of nerve fibers; Nerve growth factors; Synaptic and neuro-muscular transmission; Muscle tone, posture, Equilibrium and their regulation. Pain production, pathways and analgesics, head ach and referred pain. Vestibular apparatus & motion sickness. Integrative functions of thalamus, cerebellum, basal ganglia and Cerebral	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	cortex. Blood brain barrier, Blood CSF barrier, Split Brain, EEG.			
III	Neuroendocrinology: Structure and function of hypothalamus, pituitary, median eminence, circumventricular organs, Hypophysiotrophic hormones; Posterior Pituitary and Neurohormones; Feedback loops & neuroendocrine control of pituitary hormones; Neuron as target cells for hormone action; pineal gland and neuroendocrine regulation of biological rhythms; Regulation of circadian rhythms, Metabolic regulation of hypothalamic function; Neuroendocrine-immune interaction Neuroendocrine regulation of energy metabolism Neuroendocrine disorders.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Cognitive neuroscience: Brain and cognitive development; Aging and cognition; Cognitive functions of the motor system; Visual perception of objects; Spatial cognition; Theories of learning and memory; Models and mechanisms of short-term and long-term memory; Neuronal organization for language; Executive brain functions; Consciousness.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Neurological Diseases: Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Dystonia, Wilson Disease, Epilepsy, Autism, Multiple Sclerosis, Amyotrophic Lateral Sclerosis (ALS), Attention Deficit Hyperactivity Disorder (ADHD), Schizophrenia, Depression, Dementia, Cerebro-vascular Disease (Stroke).	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Eric R. Kandel, James Harris Schwartz, Thomas Jessell (2000). Principles of Neural Science, McGraw-Hill Companies. 2. Gazzaniga, M. S., Ivry, R. B., Mangun, G. R. (2018). Cognitive Neuroscience: The Biology of the Mind. United Kingdom: W.W. Norton.. 3. Larry Squire (2013). Fundamental Neuroscience, Academic Press.				
Suggested Readings 1. Barrett, K.E., Barman, S.M., Boitano, S., & Brooks, H.L (2019). Ganong's Review of Medical Physiology, McGraw-Hill Education. 2. Eric Kandel, James H. Schwartz, Thomas M. Jessell (2013). Principles of Neural Science, McGraw-Hill Education. 3. Jain, A. K (2018). Textbook of Medical Physiology, CBS Publishers & Distributors. 4. Mark F. Bear, Barry W. Connors, Michael A. Paradiso (2016). Neuroscience: Exploring the Brain, Lippincott Williams & Wilkins.				

Web Resources**In India**

1. **National Brain Research Centre (NBRC):** The NBRC is India's leading institute for neuroscience research and education. It offers information about ongoing research, academic programs, and collaborations.
nbrc.ac.in
2. **Institute of Neurosciences Kolkata (I-NK):** This institute provides cutting-edge treatment facilities for neurological disorders, research opportunities, and neuro-rehabilitation programs.
neurokolkata.org
3. **All India Institute of Medical Sciences (AIIMS), Delhi - Department of Neurology:** AIIMS is renowned for its research and treatment facilities in neuroscience.
aiims.edu
4. **Indian Academy of Neurosciences (IAN):** IAN supports the dissemination of neuroscience research and organizes conferences and workshops across India.
neuroscienceacademy.org.in
5. **Society for Neurochemistry, India (SNCI):** This organization promotes neurochemistry research and collaboration among scientists.
snciindia.org

International Resources

1. **Society for Neuroscience (SfN):** This global organization advances the understanding of the brain and nervous system through research and education.
sfn.org
2. **Federation of European Neuroscience Societies (FENS):** A hub for European neuroscience researchers offering educational resources, conferences, and job opportunities.
fens.org
3. **International Brain Research Organization (IBRO):** Focused on brain research and education worldwide, with grants and fellowships for neuroscientists.
ibro.org
4. **BrainFacts.org:** A public resource created by SFN, providing educational materials about the brain and nervous system.
brainfacts.org
5. **Human Brain Project (HBP):** An EU-funded initiative aimed at understanding the human brain through cutting-edge technologies.
humanbrainproject.eu

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms and concepts in neuroscience, such as neuron, synapse, neurotransmitter, and hormone. Describe the major structures of the brain	K1, K2

	and their functions. Explain the cellular and molecular mechanisms underlying neural signaling. Identify the different types of neurotransmitters and their roles in brain function. Summarize the hormonal regulation of brain function and behavior. Outline the basic principles of cognitive neuroscience and the neural basis of perception, attention, memory, and decision-making.	
CO2	Analyze the neural circuitry underlying specific behaviors and cognitive functions. Evaluate the impact of neurotransmitters and hormones on brain development, aging, and disease. Critically analyze the evidence for various theories of consciousness, memory, and emotion. Assess the effectiveness of different neuroimaging techniques in studying brain function. Apply knowledge of neuroanatomy and neurophysiology to understand the pathophysiology of neurological disorders, such as Alzheimer's disease, Parkinson's disease, and stroke.	K3, K4
CO3	Create innovative research designs to investigate specific questions in neuroscience, such as the neural basis of consciousness or the development of novel therapies for neurological disorders. Design and conduct experiments to test hypotheses about brain function and behavior, using a variety of techniques, including neuroimaging, electrophysiology, and behavioral assays. Synthesize information from multiple sources to develop a comprehensive understanding of complex neurological phenomena, such as memory consolidation, emotion regulation, and decision-making. Evaluate the ethical implications of neuroscience research and develop guidelines for responsible research practices. Critically analyze the limitations of current neuroscience knowledge and propose future directions for research.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	3	3	2	3	3	1
CO2	1	3	3	3	2	3	2
CO3	1	3	3	1	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	3
CO3	3	3	3	3	3	2	3

Course Code	UAZ5ME02
Course Title	Limnology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2024
Course Overview This course provides a comprehensive overview of freshwater ecosystems, including lakes, rivers, and wetlands. It covers the physical, chemical, and biological characteristics of these systems, with a focus on the ecology of plankton and the unique features of estuaries.	
Course Objectives 1. To understand the physical, chemical, and biological processes that shape freshwater ecosystems. 2. To analyze the ecological significance of plankton in aquatic food webs. 3. To evaluate the impact of human activities on freshwater ecosystems, including pollution, overexploitation, and climate change. 4. To critically assess the conservation and management strategies for freshwater ecosystems.	
Prerequisites	Basics of Environmental Biology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Lakes and Rivers: Lentic and lotic water bodies; Lakes- Origin and classification; Lake as an Ecosystem, Lake morphometry, Nutrient Cycles in Lakes- Nitrogen, Sulphur, and Phosphorous. Chlorophyll concentration; Eutrophication and management. Rivers- Origin and classification; Adaptation of hill-stream fishes.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Physico-chemical features of Freshwater System: Physical features- Temperature, Thermal Stratification; Light Penetration and Photosynthetically Active Radiation (PAR), Turbidity, Conductivity; Currents. Chemical features- pH, Alkalinity, Hardness, Dissolved Oxygen, Total Dissolved Solids (TDS), Redox Potential.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Estuaries: Origin and classification; Bogs- Origin and types; Animal Diversity and Adaptation; Marshes: Origin and characteristics; Vernal pools and their significance. Ecological Functions of estuaries- Filter and Buffer Zones, Carbon Sequestration and Flood Control. Conservation and Management of estuaries. Laws, Legislations, Treaties, and Conservation programs.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Plankton: Phytoplankton- Types and role in food chain; Composition; Distribution; Organic nutrients and plankton growth; Floating adaptation. Zooplankton- Composition and Distribution; Cyclomorphosis; Role in Aquaculture. Benthos- Composition and Distribution; Role in aquatic ecosystem. Plankton and climate change; Plankton and fisheries; Eutrophication and Algal Blooms.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Wetlands: Types; Ecological characteristics and Biodiversity; Animals and adaptation; Wetlands and Climate Change; Ecosystem Services; Human Impact; Wetland Conservation and Restoration; Wetlands and Agriculture; Wetlands and Sustainable Development; Laws, Legislations, Treaties, Conventions and Conservation programs.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Agarwal S. C (2016). Limnology, CBS Publishers & Distributors.
2. Arvind Kumar (2005). Fundamentals of Limnology, APH Publishing Corporation.
3. Gopal, B. (1995). Limnology in Developing Countries (Vol. 1). International Scientific Publications.
4. Jain, M. K., & Singh, R. (2018). Applied Limnology and Freshwater Fish Culture. Agro Bios (India).
5. Jhingran, V. G. (1991). Inland Fisheries of India and Adjacent Countries (Vol. 1 & 2). Hindustan Publishing Corporation.
6. Kar, D. (2024). Fundamentals of Limnology and Aquaculture Biotechnology. Daya Publishing House.
7. Mishra, S. R. (2007). Aquatic Ecology: A Study of Indian Water Bodies. APH Publishing Corporation.
8. Nath, S. (2020). Recent Advances in Fish Ecology, Limnology and Eco-Conservation (Vol. VI). Narendra Publishing House.
9. Saha, V. B. (2010). Limnology of Thermal Springs. Narendra Publishing House.
10. Sakhare, V. B. (2007). Reservoir Fisheries and Limnology. Narendra Publishing House.
11. Sharma, M. P. (2011). Wetland Ecosystems and Limnology. Scientific Publishers.
This book delves into the ecological importance of wetland systems, emphasizing their biodiversity and limnological characteristics in the Indian context.
12. Singh, H. R. (2013). Advances in Limnology. Narendra Publishing House.

13. Trivedy, R. K. (1993). Aquatic Ecosystem Conservation and Management. Indian Environmental Society.
14. Welch, P. S. (1952). Limnological Methods. Narendra Publishing House (Reprinted edition).

Suggested Readings

1. Hutchinson, G. E (1957-1975). A Treatise on Limnology, John Wiley & Sons.
2. Singh, H. R (2010). Limnology, Narendra Publishing House.
3. Welch P. S (2012) Limnological Methods, McGraw-Hill Education.

Web Resources

In India

1. **National Brain Research Centre (NBRC):** The NBRC is India's leading institute for neuroscience research and education. It offers information about ongoing research, academic programs, and collaborations.
nbrc.ac.in
2. **Institute of Neurosciences Kolkata (I-NK):** This institute provides cutting-edge treatment facilities for neurological disorders, research opportunities, and neuro-rehabilitation programs.
neurokolkata.org
3. **All India Institute of Medical Sciences (AIIMS), Delhi - Department of Neurology:** AIIMS is renowned for its research and treatment facilities in neuroscience.
aiims.edu
4. **Indian Academy of Neurosciences (IAN):** IAN supports the dissemination of neuroscience research and organizes conferences and workshops across India.
neuroscienceacademy.org.in
5. **Society for Neurochemistry, India (SNCI):** This organization promotes neurochemistry research and collaboration among scientists.
snciindia.org

International Resources

6. **Society for Neuroscience (SfN):** This global organization advances the understanding of the brain and nervous system through research and education.
sfn.org
7. **Federation of European Neuroscience Societies (FENS):** A hub for European neuroscience researchers offering educational resources, conferences, and job opportunities.
fens.org
8. **International Brain Research Organization (IBRO):** Focused on brain research and education worldwide, with grants and fellowships for neuroscientists.
ibro.org
9. **BrainFacts.org:** A public resource created by SFN, providing educational materials about the brain and nervous system.
brainfacts.org

10. **Human Brain Project (HBP):** An EU-funded initiative aimed at understanding the human brain through cutting-edge technologies.

humanbrainproject.eu

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms related to aquatic ecosystems, such as lentic, lotic, plankton, and estuary. Describe the physical and chemical characteristics of freshwater systems, including temperature, pH, dissolved oxygen, and nutrient concentrations. Explain the concept of ecological succession in aquatic ecosystems. Identify the major groups of plankton, including phytoplankton and zooplankton. Summarize the unique features of estuaries and their role in coastal ecosystems. Outline the ecological functions of wetlands and their importance in water quality and biodiversity.	K1, K2
CO2	Analyze the impact of human activities, such as pollution and climate change, on freshwater ecosystems. Evaluate the effectiveness of different water quality monitoring and management strategies. Critically analyze the role of plankton in aquatic food webs and biogeochemical cycles. Assess the ecological significance of wetlands in mitigating floods, filtering pollutants, and providing habitat for diverse organisms. Apply ecological principles to understand the dynamics of freshwater ecosystems and develop sustainable management practices.	K3, K4
CO3	Create innovative solutions to address challenges facing freshwater ecosystems, such as habitat restoration, water quality improvement, and climate change adaptation. Design and conduct research studies to investigate the ecological processes and biodiversity of aquatic ecosystems. Synthesize information from multiple sources to develop a comprehensive understanding of the complex interactions within freshwater ecosystems. Evaluate the effectiveness of conservation and management strategies for freshwater ecosystems and propose improvements. Critically analyze the limitations of current knowledge and identify emerging research questions in freshwater ecology.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	2	3	3	3	2
CO2	3	1	3	3	2	3	3
CO3	3	1	1	3	1	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ5ME03
Course Title	Ornithology
Credits	04
Hours/Week	04
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2024
Course Overview This course offers a deep dive into the fascinating world of birds. It explores their evolutionary history, classification, and incredible diversity. Students will delve into the intricate relationship between bird form and function, understanding how their unique adaptations allow them to thrive in various environments. The course also examines the diverse breeding strategies employed by birds, from complex courtship rituals to parental care. The enigmatic phenomenon of bird migration will be explored, along with the essential techniques used to monitor and survey bird populations.	
Course Objectives 1. To understand the principles of bird classification, evolution, and diversity. 2. To analyze the functional morphology of birds and their adaptations to different ecological niches. 3. To evaluate the reproductive strategies of birds, including mating systems, parental care, and nest building. 4. To critically assess the challenges faced by bird populations and the importance of conservation efforts.	
Prerequisites	Basic knowledge on Chordates and ecology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Systematics, Diversity and Origin of Birds: Fossil history - Archeopteryx – Theories of avian origin; Evolution of flight in birds; Diversification of modern birds – Adaptive radiation and speciation in birds; Major schools of avian classification; Modern classifications – Molecular systematics. Diversity and distribution of birds of India; Endemism in Indian avifauna.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Form and Function in Birds: Body plan in birds – Topography – Feathers: structure, types, colour, function, and maintenance – Feather tracts & pterylosis – Moults and plumages – Annual moult cycles and moulting strategies – Moults scores – Avian flight: forms, mechanisms, and energetics. Echolocation in birds – Taste and olfactory sense – Tactile sense in birds – Thermoregulation in birds; Cognition and intelligence in birds; Vocalization in birds.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

III	Breeding Strategies in Birds: Annual breeding cycle; Photoperiodism; Territoriality; Courtship display; Mate choice and copulatory behaviour; Bird nests: evolution, structure, and functions. Avian eggs: size, structure, shape, colour, and texture. Incubation behaviour - Role of sexes in incubation. Parental care and role of sexes. Mating systems in birds: monogamy, polygyny, and polyandry. Egg dumping and brood parasitism.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Bird Migration: Evolution of migratory behaviour in birds – Types of migration. Migratory syndrome in birds - Physiological aspects of migration – Migratory restlessness - Circadian and circannual rhythms in birds – Metabolic adaptations – Behavioural adaptations. Orientation and navigation in migratory birds - Mapping and landmarks – Major migratory flyways. Migratory ecology of birds - Habitat selection in stopover and winter quarters. Threats to migratory bird populations.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Bird Census, Population Monitoring and surveys: Bird census techniques - Their applications, assumptions, and limitations – Territory mapping – Distance sampling – Line transects – Belt transects – Point count – Call counts – Passive acoustic monitoring – Mark recapture framework – Mist-netting - Types of marking birds: rings/bands, flags, tags, dyes, and natural markers – Radio-tracking of birds & satellite telemetry – Survey techniques for rare, elusive, and sparse populations. Citizen Science initiatives in Bird Population Monitoring – Asian Midwinter Waterbirds Census – eBird.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Ali, S. (1996). The Book of Indian Birds (12th ed.). Oxford University Press.
2. Faaborg, J (2020). Book of Birds: Introduction to Ornithology. United States: Texas A&M University Press.
3. Irby J. Lovette and John W. Fitzpatrick (2016). Handbook of Bird Biology. (2016). Wiley.
4. Pittie, A. (2014). Indian Birds: A Comprehensive Guide. Bishen Singh Mahendra Pal Singh.
5. Rahmani, A. (2021). Indian Ornithology: A 40-Year Legacy. Sanctuary Nature Foundation.
6. Scott, G., Scott, G. W (2020). Essential Ornithology. Oxford University Press.

Suggested Readings

1. Ali, S. (2002). The book of Indian birds (13th ed.). Bombay Natural History Society. Publisher: Oxford University Press.
2. Ali, S., & Ripley, S. D. (1987). Handbook of the birds of India and Pakistan: Together with those of Bangladesh, Nepal, Bhutan, and Sri Lanka. Oxford University Press.

3. Ali, S., & Ripley, S. D. (1996). Compact handbook of the birds of India and Pakistan. Bombay Natural History Society.
4. Grimmett, R., Inskipp, C., & Inskipp, T. (2012). Birds of the Indian subcontinent (2nd ed.). Oxford University Press.
5. Kazmierczak, K. (2000). A field guide to the birds of the Indian subcontinent. A & C Black.
6. Krysko, M. E., Ali, S., & Bhatnagar, A. (Eds.). (2019). Ornithology in the Indian subcontinent: Perspectives and contributions. Springer.
7. Neelakantan, K. K., & Subramanian, S. (1980). The birds of Kerala. Kerala Forest Research Institute.
8. Rasmussen, P. C., & Anderton, J. C. (2012). Birds of South Asia: The Ripley guide (Vol. 1 & 2, 2nd ed.). Lynx Edicions.
9. Salim Ali Centre for Ornithology and Natural History. (2005). Avian biodiversity: Status and conservation. Salim Ali Centre for Ornithology and Natural History.
10. Vijayan, V. S. (1987). Keoladeo National Park ecology and management. Bombay Natural History Society.

Web Resources

Ornithology Resources in India:

1. **Sálim Ali Centre for Ornithology and Natural History (SACON)**
SACON, based in Coimbatore, is a premier institute for bird research and conservation in India. It conducts studies on bird ecology, behavior, and conservation, and collaborates with academic and research organizations.
<https://www.sacon.in>
2. **Indian Birds Journal**
This publication focuses on South Asian birds, covering ecology, behavior, conservation, and birdwatching. It provides articles, checklists, and other valuable insights.
<http://www.indianbirds.in>
3. **Bird Count India**
A collaborative effort to promote bird monitoring and documentation across India, it offers resources for citizen science initiatives like the Great Indian Bird Count.
<https://birdcount.in>.
4. **eBird India**
Part of the global eBird platform, this resource allows bird enthusiasts to record sightings and access data on bird distributions across India.
<https://ebird.org/india>

Ornithology Resources Abroad:

1. **Cornell Lab of Ornithology (USA)**
This world-renowned institution offers resources for bird research, education, and citizen science, including eBird and Merlin Bird ID.
<https://www.birds.cornell.edu>
2. **British Trust for Ornithology (BTO)**
A UK-based organization focused on research and surveys to support bird conservation. Their website provides scientific insights and opportunities to participate in citizen science

projects. https://www.bto.org. 3. BirdLife International A global partnership of organizations working to conserve birds and their habitats worldwide. Their database is an essential tool for global bird conservation efforts. https://www.birdlife.org. 4. Ornithological Societies of North America (OSNA) A collective of societies like the American Ornithological Society and Cooper Ornithological Society, supporting ornithological research and publications. https://www.osnabirds.org.

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms in ornithology, such as species, subspecies, phylogeny, and adaptation. Describe the major taxonomic groups of birds and their distinguishing characteristics. Explain the process of speciation and the factors that drive diversity in birds. Identify the key anatomical and physiological adaptations of birds for flight, feeding, and reproduction. Summarize the different breeding strategies employed by birds, including monogamy, polygamy, and cooperative breeding. Outline the major migration routes and the factors influencing bird migration. Describe the various methods used to conduct bird surveys and population monitoring.	K1, K2
CO2	Analyze the evolutionary relationships among different bird groups based on morphological, behavioral, and genetic data. Evaluate the impact of human activities, such as habitat loss and climate change, on bird populations. Critically analyze the role of behavior in bird ecology, including territoriality, courtship displays, and parental care. Assess the effectiveness of different bird conservation strategies, such as habitat restoration and captive breeding. Apply knowledge of bird ecology and behavior to understand and solve real-world problems, such as bird strikes and disease outbreaks.	K3, K4
CO3	Create innovative research projects to investigate specific aspects of avian biology, such as the evolution of bird song or the impact of climate change on migration patterns. Design and conduct bird surveys and monitoring programs to collect data on population trends and habitat use. Synthesize information from diverse sources to develop a comprehensive understanding of bird ecology and conservation. Evaluate the ethical implications of bird research and conservation practices, such as bird banding and wildlife rehabilitation. Critically analyze the limitations of current knowledge and propose future directions for research in avian biology.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZRC01
Course Title	Research Methodology and Project
Credits	04
Hours/Week	04
Category	Research and Competency Skill (RC) – Theory
Semester	V
Regulation	2024
Course Overview This course provides a comprehensive introduction to research methodology, guiding students through the fundamental processes of defining a research problem, designing effective research frameworks, and selecting appropriate research methods. Students will learn about sampling design and data collection techniques, as well as how to interpret results and effectively communicate findings through report writing. By the end of the course, students will have developed essential skills for conducting rigorous research and presenting their work in a clear and professional manner.	
Course Objectives 1. To gain a foundational understanding of research methodology, including key concepts, terminology, and the importance of a systematic approach to research. 2. To develop skills to identify and clearly define research problems, formulating relevant research questions that guide the research process. 3. To learn to design effective research projects by selecting appropriate research methods, sampling techniques, and data collection strategies that align with the research objectives. 4. To acquire the ability to interpret research findings accurately and communicate them effectively through well-structured reports that adhere to academic and professional standards.	
Prerequisites	Basic inclination towards research.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Introduction to Research Methodology: Meaning, Objectives, and Characteristics of research - Research methods Vs Methodology -Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research -Developing a research plan.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Defining the research problem: Selecting the problem, Necessity of defining the problem, Techniques involved in defining the problem, Importance of literature review, Survey of literature, Primary and secondary sources, Reviews, treatise, monographs patents, web as a source,	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	searching the web. Identifying gap areas from literature review. Development of working hypothesis.			
III	Research design and methods: Research design. Basic Principles- Need of research design. Features of good design. Important concepts relating to research design. Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Sampling design: Steps in sampling design - Characteristics of a good sample design - Types of sample designs - Measurement and scaling techniques - Methods of data collection -Collection of primary data - Data collection instruments. Testing of hypotheses - Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses testing - Data analysis with Statistical Packages. IPRs- Invention and Creativity: Intellectual Property-Importance and Protection of intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications- Establishment of WIPO-Application and Procedures.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Interpretation and report writing: Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure, and language of the report - Illustrations and tables - Types of report - Technical reports and thesis.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Kothari C. R (2004). Research Methodology: Methods and Techniques. New Age International Publishers.
2. Ranjit Kumar (2013). Research Methodology: A Step-by-Step Guide for Beginners, SAGE Publications India Pvt. Ltd.
3. Singh, A. K (2018). Research Methodology: Techniques and Applications, S. Chand Publishing.
4. Tripathi, D. N (2019). Research Methodology: Methods and Techniques, Vikas Publishing House Pvt. Ltd.

Suggested Readings

1. Day, R.A (1992). How to Write and Publish a Scientific Paper, Cambridge University Press.
2. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K (2002). An introduction to Research Methodology, RBSA Publishers.
3. Sinha, S.C. and Dhiman, A.K (2002). Research Methodology, Ess Ess Publications.

4. Trochim, W.M.K (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing.

Web Resources

In India

1. **Indian Statistical Institute (ISI) - Research Programs**
ISI offers comprehensive courses and resources in statistics and related research methodologies.
www.isical.ac.in
2. **IIM Bangalore - Research Programs**
The Indian Institute of Management Bangalore provides resources on business and social science research methodologies.
www.iimb.ac.in
3. **NPTEL Online Certification on Research Methodology**
This free course by IITs under the NPTEL platform focuses on the basics of research methodology.
NPTEL Research Methodology
4. **ICSSR (Indian Council of Social Science Research)**
Resources and funding opportunities for social science researchers in India.
www.icssr.org

Abroad

1. **Coursera - Understanding Research Methods (University of London)**
An excellent MOOC covering both qualitative and quantitative research methods.
Coursera - University of London
2. **MIT OpenCourseWare - Research Methodology in Science and Engineering**
Offers free online lectures and materials on research techniques for scientific studies.
MIT OpenCourseWare
3. **University of Amsterdam - Qualitative Research Methods**
This course dives deep into qualitative research approaches, ethical considerations, and writing.
Coursera - University of Amsterdam
4. **Research Gate**
A global platform for researchers to share publications, ask questions, and discuss methodologies.
www.researchgate.net
5. **European Research Council (ERC)**
Provides grants and guidelines for research methodology in various scientific domains.
erc.europa.eu

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and recall fundamental concepts of research methodology, including the significance of systematic inquiry and the research process. They will identify key components involved in defining a research problem and formulating relevant research questions that guide inquiry. Students will also describe various research designs and methods, along with their appropriate applications in different contexts. Additionally, they will be able to differentiate between sampling techniques, recognizing their importance in data collection, and explain the process of data interpretation. Finally, students will summarize the essential elements of report writing, demonstrating the ability to present research findings clearly and coherently in written format.	K1, K2
CO2	Apply the principles of research methodology to identify and articulate research problems relevant to their fields of study. They will analyze various research designs and methods, assessing their suitability for different types of research questions and contexts. Students will also evaluate different sampling designs, comparing their effectiveness in producing representative data, and will be prepared to distinguish between qualitative and quantitative approaches in data collection. Furthermore, students will examine the interpretation of research data, utilizing appropriate statistical or analytical techniques to derive meaningful insights. They will be able to construct comprehensive research reports that effectively communicate findings, utilizing appropriate structures and formats while critically reflecting on the implications of their research results. Through these activities, students will demonstrate a deep understanding of the research process and its application in real-world scenarios.	K3, K4
CO3	Evaluate and critique various research methodologies, demonstrating a comprehensive understanding of their strengths and limitations in addressing specific research problems. They will synthesize knowledge from different areas of research design, enabling them to create innovative and methodologically sound research proposals that effectively address identified gaps in the literature. Students will also be able to design robust sampling strategies that maximize the representativeness and reliability of their findings, while formulating clear and testable research hypotheses. Moreover, students will develop advanced data interpretation skills, allowing them to assess the validity of research results and draw meaningful conclusions that contribute to their fields. They will also create professional research reports that not only communicate their findings effectively but also advocate for evidence-based practices and recommendations. Through these	K5, K6

	outcomes, students will demonstrate leadership in research endeavors, equipped to advance knowledge and contribute to informed decision-making within their professional contexts.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	1	1	2	3	3	3	3
CO2	1	1	2	3	3	3	3
CO3	1	1	2	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MS01
Course Title	Economic Zoology (Theory)
Credits	05
Hours/Week	06
Category	Major Skill (MS) - Theory
Semester	VI
Regulation	2024
Course Overview This course will explore the principles and practices of various animal husbandry techniques, including apiculture (beekeeping), vermiculture (worm farming), aquaculture (fish farming), poultry farming, and cattle farming. Students will gain knowledge about the biology, management, and economic aspects of these agricultural practices.	
Course Objectives 1. To understand the biology, behavior, and management practices of bees, worms, fish, poultry, and cattle. 2. To explore the principles of sustainable agriculture and their application in apiculture, vermiculture, aquaculture, poultry farming, and cattle farming. 3. To analyze the economic and environmental benefits and challenges associated with these agricultural practices. 4. To evaluate the ethical considerations and best practices for animal welfare in these industries. 5. To apply knowledge of animal husbandry to develop sustainable and profitable farming operations.	
Prerequisites	Basic knowledge of farming.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Apiculture: Cultivable species, anatomy and physiology of honeybees. Colony structure, Hive Management and Beekeeping Practices, Honey Production and Harvesting, Bee Health and Disease Management. Sericulture: Types of silkworms, Life cycle of <i>Bombyx mori</i> , Mulberry Cultivation, Silkworm Rearing Techniques, Post-Cocoon Processing, Silk reeling and reeling devices. Lac Culture: Life cycle of <i>Kerria lacca</i> , Host plant selection and management, Lac Insect Rearing Techniques, Lac Processing and Industrial Applications.	14	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Vermiculture: Overview of composting worm species (<i>Eisenia fetida</i> , <i>Lumbricus rubellus</i>), Setting Up and Managing a Vermiculture System, Vermicomposting and	14	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Harvesting, quality assessment, Applications in Agriculture and Horticulture, Environmental and Economic Impact.			
III	Aquaculture: Pisciculture, Prawn culture, Oyster and mussel culture. Cultivable species, Selection Criteria, Types of culture- Pond Culture, Cage Culture, Recirculating Systems, Hatcheries, Integrated Aquaculture. Water Parameters, Nutrient Requirements, Feed Formulation, Feeding Practices, Alternative Feeds. Fish Diseases, Parasites, Antibiotics, Environmental Impact, Sustainable Aquaculture.	14	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Poultry Farming: Poultry Farming and Breeds - Poultry Species, Breeds, Production Systems (Broilers vs. Layers), Poultry Housing and Farm Management- Housing Design, Ventilation, Lighting, Biosecurity, Waste Management. Poultry Nutrition and Feeding- Nutrient Requirements, Feed Formulation, Feeding Systems, Supplements. Poultry Health and Disease Management- Common Diseases, Vaccination, Biosecurity, Parasites, Antibiotic Use. Sustainable and Commercial Poultry Farming- Organic Poultry Farming, Free-Range Systems, Environmental Impact.	15	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Cattle Farming: Cattle Breeds, Production Systems, Cattle Housing and Farm Management- Housing Design, Pasture Management, Grazing Systems, Biosecurity, Waste Management. Cattle Nutrition and Feeding- Nutrient Requirements, Feed Formulation, Grazing vs. Supplementation. Cattle Health and Disease Management- Common Cattle Diseases, Vaccination, Biosecurity, Parasites, Veterinary Care. Sustainable and Commercial Cattle Farming- Organic Farming, Environmental Impact, Animal Welfare, Business Planning, Meat and Dairy Production.	15	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Dandin, S.B., Jayant Jayaswal, and K. Giridhar (2003). Handbook of Sericulture Technologies. Central Silk Board, Bangalore.
2. Indian Lac Research Institute (2003). Lac: Processing and Products. Indian Lac Research Institute, Ranchi.
3. Jaiswal, M.L (2005). Lac Culture and Rural Economy. Agrobios (India).
4. Misra, R.C (1982). Lac Cultivation in India: A Manual. Indian Lac Research Institute, Ranchi.
5. Mitta, Kishan & Ramaiah, Aruna & Mishra, Geetanjali & M R, Srinivasan (2017). Beekeeping in India. Springer.
6. Sameer Sagar (2021). Economic Zoology, Academic Aspirations.
7. Shanmugham. K (1992). Fishery Biology and Aquaculture, Leo Pathipagam.
8. Singh, R., and M.L. Jaiswal (1990). Lac Culture in India. ICAR, New Delhi.

9. Ullal, S.R., and M.N. Narasimhanna (1987). Handbook of Practical Sericulture. Central Silk Board, Bangalore.

Suggested Readings

1. Biswas, K. P. (2004). Industrial Fisheries. Daya Publishing House.
2. Jawaid, A., & Sinha, S. P. (2010). A Handbook on Economic Zoology (2nd ed.). S. Chand & Company Ltd.
3. Shukla, G. S., & Upadhyay, V. B. (2005). Economic Zoology. Rastogi Publications.
4. Upadhyay, V. B. (2006). Economic Zoology. Rastogi Publications.
5. Yadav, M. (2003). Economic Zoology. Discovery Publishing House.

Web Resources

Resources in India:

1. **National Biodiversity Authority (NBA):** This organization promotes biodiversity conservation, sustainable use, and equitable sharing of its benefits in India.
<https://nbaindia.org>
2. **Indian Council of Agricultural Research (ICAR):** A key resource for studies on the economic aspects of zoology in agriculture, including animal husbandry and aquaculture.
<https://icar.org.in>
3. **Centre for Wildlife Studies (CWS):** Offers resources on biodiversity and its economic importance in India, including research publications and conservation strategies.
<https://cwsindia.org>
4. **Biodiversity of India:** A detailed database focusing on Indian flora and fauna, their economic importance, and conservation needs.
<https://biodiversityofindia.org>

Resources Abroad:

1. **IUCN (International Union for Conservation of Nature):** Provides resources on global biodiversity, including economic analyses of species conservation and ecosystem services.
<https://www.iucn.org>
2. **World Bank – Economic Case for Nature:** A global perspective on the economic value of biodiversity and policy pathways for sustainable development.
<https://www.worldbank.org/en/topic/environment>
3. **Convention on Biological Diversity (CBD):** Offers insights into the economic importance of biodiversity, including animals and ecosystems, with policy recommendations.
<https://www.cbd.int>
4. **United Nations Environment Programme (UNEP):** Hosts reports and studies on the economic valuation of ecosystems and their resources, with relevance to economic zoology.
<https://www.unep.org>
5. **FAO (Food and Agriculture Organization):** Features extensive resources on the economic aspects of aquaculture, fisheries, and animal husbandry.
<https://www.fao.org>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify the key characteristics and life cycles of bees, worms, fish, poultry, and cattle. Describe the basic techniques and equipment used in apiculture, vermiculture, aquaculture, poultry farming, and cattle farming. Explain the economic and environmental benefits of these agricultural practices. Define the terms related to animal husbandry, such as brood, hatchling, and herd. Recognize the importance of animal welfare in these industries.	K1, K2
CO2	Compare and contrast the different characteristics and behaviors of bees, worms, fish, poultry, and cattle. Analyze the advantages and disadvantages of different farming techniques in apiculture, vermiculture, aquaculture, poultry farming, and cattle farming. Evaluate the impact of various factors, such as climate and market demand, on the profitability of these agricultural practices. Explain the ethical considerations and best practices for animal welfare in each industry. Describe the role of these agricultural practices in sustainable food production and environmental conservation.	K3, K4
CO3	Synthesize information about the interconnectedness of different agricultural practices and their impact on the environment and economy. Evaluate the effectiveness of various sustainable farming techniques in apiculture, vermiculture, aquaculture, poultry farming, and cattle farming. Design and implement sustainable farming plans for these industries, considering factors such as animal welfare, environmental impact, and economic viability. Critically analyze the ethical and social implications of animal husbandry practices and propose solutions to address these challenges. Propose innovative strategies for promoting sustainable agriculture and improving food security in the context of these industries.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ6MS02
Course Title	Economic Zoology Lab
Credits	03
Hours/Week	04
Category	Major Skill (MS) - Lab
Semester	VI
Regulation	2024
Course Overview This course offers a practical introduction to sustainable agriculture practices. Students will gain hands-on experience in beekeeping, vermicomposting, fish farming, poultry farming, and dairy farming. The course will cover topics such as feed management, disease control, and product processing.	
Course Objectives 1. To understand the principles and practices of sustainable agriculture and learn to apply sustainable methods in various farming systems. 2. To acquire knowledge and skills in managing poultry and dairy livestock and learn about feeding, breeding, and disease control in livestock. 3. To gain practical experience in fish farming and vermicomposting and understand the ecological and economic benefits of these practices. 4. To learn the techniques of beekeeping, including hive management, honey extraction, and pollination and understand the ecological importance of bees and their role in agriculture.	
Prerequisites	Basic understanding of biology and ecological principles.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Apiculture: Identification of various honey bee species. Observation of bees in a hive box. Estimation of the total reducing sugars in honey. Determination of pollen in honey. Preparation of honey-based food products.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Vermiculture: Earthworm collection and identification. Preparation of vermiculture bed. Inspection of beds and watering. Determination of the composition of vermicompost. Harvesting and marketing of the vermicompost.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Aquaculture: Identification of commercially important fishes. Estimation of protein, carbohydrate and lipid in fish. Maintenance of ornamental fishes. Preparation of fish-based food products.	10	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

IV	Poultry farming: Identification of commercially important poultry breeds. Estimation of the nutritional content of different varieties of eggs – albumin protein, cholesterol.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Dairy farming: Identification of commercially important cattle breeds. Methylene blue reduction test for different milk samples to check the quality of milk. Comparison of the protein, sugar and lipid content of various milk samples. Preparation of dairy products. Visit to a sericulture farm, aquarium, vermiculture unit, and an apiary.	11	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Mathew, S., Raman, M., Kalarikkathara Parameswaran, M., & Rajan, D. P. (2019). Fish and fishery products analysis: A theoretical and practical perspective. Springer Nature.
2. Munroe, G. (2017). Manual of on-farm vermicomposting and vermiculture. Holdanca Farms Ltd.
3. NIIR Project Consultancy Services. (2007). The complete book on beekeeping and honey processing (2nd rev. ed.). NIIR Project Consultancy Services.
4. Sen, M. (2022). Food chemistry: The role of additives, preservatives and adulteration. Wiley.
5. Tanwar, S., Mudgal, V. D., & Meena, K. K. (2021). Dairy process engineering. Satish Serial Publishing House.

Suggested Readings

1. Banerjee, G. C. (1992). Poultry. Oxford and IBH Publishing Co. Pvt. Ltd.
2. Banerjee, G. C. (2006). Textbook of animal husbandry (8th ed.). Oxford and IBH Publishing Company Ltd.
3. Bardach, J. E., Ryther, J. H., & McLarney, W. O. (1972). Aquaculture: The farming and husbandry of freshwater and marine organisms. Wiley Interscience.
4. Bell, D. D., & Weaver, W. D. (2002). Commercial chicken meat and egg production. Springer.
5. Eckles, C. H., & Anthony, E. L. (2001). Dairy cattle and milk production. Tata McGraw Hill Publishing Co. Pvt. Ltd.
6. Gupta, P. K. (2008). Vermicomposting for sustainable agriculture (2nd ed.). Agrobios.
7. Talashikar, S. C. (2008). Earthworms in agriculture. Agrobios.
8. Walstra, P., Wouters, J. T. M., & Geurts, T. J. (2006). Dairy science and technology. CRC Press.

Web Resources**India:**

1. **National Bee Board (NBB)**
<https://nbb.nic.in/>
Provides support for beekeeping and development of the honeybee industry in India.
2. **Central Silk Board (CSB)**
<https://csb.gov.in/>
The CSB oversees the development of sericulture, including silkworm seed production and technology development.

3. **Indian Council of Agricultural Research (ICAR)**

<https://icar.org.in/>

ICAR conducts research and provides training in areas such as sericulture, apiculture, aquaculture, and dairy farming. The e-learning portal includes courses on apiculture and sericulture [here](#).

4. **Rajasthan State Bee Keeping and Sericulture Institute (RSBB)**

<https://www.rlbcau.ac.in>

Offers resources and education on apiculture, sericulture, and related practices.

5. **National Dairy Development Board (NDDB)**

<https://www.nddb.coop/>

NDDB plays a pivotal role in the dairy farming sector of India, supporting cooperative movements and farm management.

6. **National Institute of Fisheries Post Harvest Technology & Training (NIFPHATT)**

<http://nifphatt.gov.in/>

Works on the development of aquaculture techniques, fisheries management, and post-harvest technologies.

7. **Central Tasar Research and Training Institute**

<https://csb.gov.in/>

Focuses on research and development in non-mulberry sericulture, including tasar silk.

International:

1. **Food and Agriculture Organization (FAO) - Fisheries and Aquaculture**

<http://www.fao.org/fishery/en>

The FAO offers resources on global aquaculture and fisheries management.

2. **International Apicultural Congress (IAP)**

<https://www.apimondia.com>

A global association supporting apiculture through international congresses and research.

3. **International Sericultural Commission (ISC)**

<http://www.sericulturecouncil.org/>

A global body promoting sericulture and the silk industry worldwide.

4. **Aquaculture Stewardship Council (ASC)**

<https://www.asc-aqua.org/>

ASC promotes responsible aquaculture practices worldwide, ensuring environmental sustainability.

5. **FAO - Dairy Farming**

<https://www.fao.org/dairy-production-products/en/>

The FAO provides global information and guidelines on dairy production and sustainable practices.

6. **University of California Agriculture and Natural Resources - Poultry Resources**

<https://ucanr.edu/>

Offers resources and training on poultry farming and animal husbandry.

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Identify and describe the different types of farming systems, including apiculture, vermiculture, aquaculture, poultry, and dairy farming. Understand the basic principles of livestock husbandry and management. Know the importance of sustainable agricultural practices. Comprehend the ecological and economic significance of various farming systems. Apply practical skills in beekeeping, vermicomposting, fish farming, poultry farming, and dairy farming. Use appropriate tools and equipment for various farming tasks. Implement sustainable farming practices to minimize environmental impact. Analyze data on livestock production and productivity. Solve problems related to livestock health and disease management.	K1, K2
CO2	Analyze the impact of various factors (e.g., climate, feed, and disease) on livestock productivity. Compare and contrast different farming systems in terms of their economic and environmental sustainability. Evaluate the effectiveness of different livestock management practices. Interpret data on livestock performance and identify trends. Design and implement sustainable farming plans for specific contexts. Develop innovative solutions to challenges in livestock production. Integrate knowledge from different fields of agriculture to improve farming practices. Communicate technical information effectively to farmers and other stakeholders. Collaborate with other professionals to address issues in agriculture.	K3, K4
CO3	Evaluate the effectiveness of different farming practices and technologies. Critically assess the impact of agricultural practices on the environment and society. Compare and contrast different approaches to sustainable agriculture. Evaluate the economic feasibility of various farming systems. Develop innovative farming techniques and technologies. Design sustainable farming systems that balance economic, environmental, and social goals. Create new products and services based on agricultural resources. Contribute to the development of sustainable agriculture policies and regulations. Lead and inspire others to adopt sustainable farming practices.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	3	3	3	3
CO2	3	2	3	3	3	3	3
CO3	3	2	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3NME01
Course Title	Addiction Science
Credits	02
Hours/Week	03
Category	Non-major Elective (NME) – Theory
Semester	III
Regulation	2024
Course Overview This course provides an introduction to addiction science, examining the psychological and social factors that contribute to addiction. Students will explore different types of addiction, including substance use and behavioral addictions, and gain insight into various treatment approaches and recovery processes. Additionally, the course covers public health perspectives, policy considerations, and advocacy efforts in the field of addiction, equipping students with a comprehensive understanding of addiction's impact on individuals and society.	
Course Objectives 1. To gain foundational knowledge of addiction, including its biological, psychological, and social underpinnings. 2. To examine how various psychological and social factors influence addiction development, progression, and recovery. 3. To differentiate between substance use and behavioral addictions, and explore evidence-based treatment methods and recovery models. 4. To assess the role of public health initiatives, policies, and advocacy efforts in addressing addiction at the community and societal levels.	
Prerequisites	Basic knowledge of human anatomy and behavior.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Introduction to Addiction Science. Definitions of Addiction: Substance Use vs. Behavioral Addictions. Theories and Models of Addiction (Biological, Psychological, Sociocultural). Historical and Cultural Perspectives on Addiction. Key Terms and Concepts (Dependence, Tolerance, Withdrawal, etc.). Neurobiology of Addiction: Brain Structure and Neurotransmitters Involved in Addiction. The Reward System: Dopamine and Pleasure Pathways. Genetic and Epigenetic Factors in Addiction Vulnerability. Neuroadaptive Changes and Tolerance Development. Brain Imaging and Neuroscience Research in Addiction.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Psychological and Social Factors in Addiction: Risk and Protective Factors in Addiction Development. Psychological	08	CO1 CO2	K1,K2,K3, K4,K5,K6

	Factors (Stress, Trauma, Personality Disorders). Social Determinants of Health and Addiction (Peer Influence, Socioeconomic Status). Family Dynamics and Addiction. Addiction in Different Populations (Youth, Elderly, LGBTQ+, etc.).		CO3	
III	Types of Addiction: Substances and Behaviors: Substance Use Disorders (Alcohol, Opioids, Stimulants, Cannabis, etc.). Behavioral Addictions (Gambling, Gaming, Internet Use, etc.). Emerging Addictions (Technology, Exercise, Food, etc.). Diagnostic Criteria and Assessment of Addiction. Differences and Overlaps Between Substance and Behavioral Addictions.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Treatment Approaches and Recovery: Evidence-Based Approaches (CBT, Motivational Interviewing, Contingency Management). Pharmacological Treatments (Methadone, Buprenorphine, Naltrexone, etc.). The Role of Self-Help and Peer Support Groups (AA, NA, SMART Recovery). The Stages of Change Model and Relapse Prevention. Integrative and Holistic Approaches in Addiction Treatment.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Public Health, Policy, and Advocacy in Addiction: Public Health Approaches to Addiction and Harm Reduction. Addiction Policy: Regulations on Substance Use and Behavioral Addictions. Prevention Programs and Community-Based Interventions. Ethical Considerations in Addiction Treatment and Policy. Advocacy and Legal Aspects of Addiction (Decriminalization, Legalization).	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
Text Books 1. Chopra, R.N. and Chopra, F.C (1965). Drug Addiction with Special Reference to India, New Delhi Council of Scientific and Industrial Research. 2. Ghuman, R. S., Singh, J., & Kaur, G. (2023). Dynamics of Drug Addiction and Abuse in India. Routledge. 3. Kaur, Ravneet and Gulati, J. K (2007). Drug Abuse: Trends and issues, International Marketing Conference on Marketing & Society, IIMK. 4. Singh, Chandra Paul (2000). Alcohol and Drug Dependence Among Industrial Worker, Delhi Shipra Publications. 5. Singh, R. (2023). Dynamics of Drug Addiction and Abuse in India. Routledge. 6. Smith, C., & Hunt, J. (2021). Understanding Addiction: Know Science, No Stigma. Amazon.				

Suggested Readings

1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Arlington: APA.
2. Babor, T.F., Caulkins, J., and Edwards, G. Drug Policy and the Public Good. New York: Oxford University Press.
3. DiClemente, C.C. Addiction and Change: How Addictions Develop and Addicted People Recover. New York: Guilford Press.
4. Everitt, B.J., and Robbins, T.W. The Neurobiology of Addiction: New Vistas for New Treatments. London: Oxford University Press.
5. Galea, S., and Vlahov, D. Addiction: Public Health Perspectives and Community Interventions. London: Oxford University Press.
6. Griffiths, M.D., and Kuss, D.J. Addiction in the Family: The Influence of Environment and Social Context. London: Routledge.
7. Koob, G.F., Arends, M., and Le Moal, M. Drugs, Addiction, and the Brain. San Diego: Academic Press.
8. Marlatt, G.A., and Donovan, D.M. Relapse Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors. New York: Guilford Press.
9. Marlatt, G.A., and Witkiewitz, K. Addictive Behaviors: New Readings on Etiology, Prevention, and Treatment. Washington, D.C.: APA Press.
10. McLellan, A.T., and Hagan, T.A. Treating Addiction: A Guide for Professionals. New York: Guilford Press.
11. Miller, W.R., and Carroll, K.M. Rethinking Substance Abuse: What the Science Shows, and What We Should Do about It. New York: Guilford Press.
12. Miller, W.R., and Rollnick, S. Motivational Interviewing: Helping People Change. New York: Guilford Press.
13. Nestler, E.J., Hyman, S.E., and Malenka, R.C. Molecular Neuropharmacology: A Foundation for Clinical Neuroscience. New York: McGraw-Hill.
14. Potenza, M.N., and Weinstein, A. Behavioral Addictions: Criteria, Evidence, and Treatment. London: Academic Press.
15. Shaffer, H.J. Understanding Addiction: A Model-Based Approach. Oxford: Oxford University Press.
16. Shapiro, S.L. The Art and Science of Mindfulness: Integrating Mindfulness into Psychology and the Helping Professions. Washington, D.C.: APA.
17. Volkow, N.D., and Li, T.K. Substance Use and Addiction. New York: Oxford University Press.
18. Volkow, N.D., and Li, T.K. The Addiction Solution: Treating Our Dependence on Opioids and Other Drugs. New York: Simon and Schuster.

Web Resources

1. **National Institute on Drug Abuse (NIDA) - USA**
NIDA offers a wealth of information on the science of addiction, including research findings, treatment strategies, and prevention resources.
<https://nida.nih.gov/>
2. **Addiction Psychiatry Society of India (APSI)**

APSI is an organization focused on promoting research and education in addiction psychiatry in India. It is a hub for addiction professionals in the country.

<https://addictionpsychiatry.in/>

3. **International Society of Substance Use Professionals (ISSUP)**

ISSUP supports professionals working in the field of addiction and substance use by providing training, resources, and global networking opportunities. The Indian chapter offers specialized content related to addiction treatment in India.

<https://www.issup.net>

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and recall fundamental concepts of addiction science, including the biological, psychological, and social dimensions of addiction. They will be able to describe the various types of addiction, both substance-related and behavioral, and identify key psychological and social factors that contribute to the development and progression of addictive behaviors. Additionally, students will be able to summarize different treatment and recovery approaches, with an understanding of their goals, processes, and effectiveness. Finally, students will recall and explain the importance of public health policies, advocacy strategies, and their role in shaping addiction prevention, treatment accessibility, and community support.	K1, K2
CO2	Apply foundational concepts of addiction science to analyze the biological, psychological, and social dimensions of addiction. They will be equipped to examine and differentiate between various types of addiction, both substance-related and behavioral, assessing how each type uniquely impacts individuals and communities. Students will demonstrate an understanding of psychological and social factors by analyzing their influence on the development and persistence of addictive behaviors. Furthermore, students will be able to compare and distinguish between treatment approaches and recovery models, evaluating their effectiveness in diverse contexts. Lastly, they will interpret the impact of public health policies and analyze advocacy efforts to address addiction at the community and societal levels, supporting informed discussions about addiction prevention and intervention.	K3, K4
CO3	Evaluate complex theories and models within addiction science, critically assessing the biological, psychological, and social dimensions that contribute to addiction. They will synthesize knowledge of different types of addiction, both substance-related and behavioral, to form a comprehensive understanding of how each type impacts individuals and societies. Students will be able to judge the effectiveness of various treatment approaches and recovery models, taking into account diverse factors such as individual needs,	K5, K6

	cultural contexts, and accessibility. Additionally, they will construct informed recommendations for public health policies and design advocacy strategies that address addiction from a community and societal perspective. By the end of the course, students will be prepared to create innovative solutions and contribute to discourse and action in addiction prevention, treatment, and policy-making.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	0	3	3	1	3	3	3
CO2	0	3	3	1	3	3	3
CO3	0	3	3	1	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ3NME02
Course Title	Environmental Impact Assessment
Credits	02
Hours/Week	03
Category	Non-major Elective (NME) – Theory
Semester	III
Regulation	2024
Course Overview This course offers an introduction to environmental laws and policies in India, emphasizing pollution control, risk analysis, and the Environmental Impact Assessment (EIA) process. Students will explore EIA methodologies and techniques, with a focus on sector-specific considerations, to understand how assessments guide sustainable development and regulatory compliance in various industries. The course combines legal frameworks with practical applications, equipping students with essential skills in environmental management and policy evaluation.	
Course Objectives 1. To gain knowledge of key environmental laws, regulations, and policies that govern environmental protection and sustainable development in India. 2. To develop the ability to evaluate pollution sources, control measures, and risk analysis methods to assess environmental hazards. 3. To learn to implement the EIA process, including scoping, impact prediction, and mitigation strategies, to ensure sustainable project planning. 4. To assess the unique environmental impacts and EIA requirements for different sectors, such as infrastructure, mining, and industry, to ensure sector-appropriate environmental management.	
Prerequisites	Basic knowledge of Ecology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Environmental Laws and Policies in India: The Water (Prevention and control of pollution) Act, 1974; The Air Act (Prevention and control of pollution), 1981; The Water (Prevention and control of pollution) Cess Act, 1977; The Environment (Protection) Act, 1986; The Public Liability Insurance Act, 1991; Indian Policy Statement for abatement of Pollution, 1992; Hazardous Wastes (Management and Handling) Rules, 1989; Manufacture, Storage and Import of Hazardous Chemical Rules, 1989; The Forest (Conservation) Act, 1980; The Wildlife Protection Act, 1972. The National Environment Tribunal Act, 1995; The National Environment Appellate Authority Act, 1997; Biological Diversity Act,	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	2002.			
II	Pollution and Risk Analysis: Environmental impacts of mining industry; nuclear power plant, textile industry; pulp and paper industry; petroleum refining; pesticide manufacturing industry; fertilizer industry. Risk Analysis: Definition of risk, environmental risk analysis-risk assessment and risk management. Basic steps in risk assessment - Hazard identification. Dose-response assessment, Exposure assessment, Risk characterization, Risk assessment in EIA. Strategic Environmental Assessment (SEA). Case studies of EIA – Hydroelectric dam and river valley projects; thermal power plants and petroleum exploration.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	EIA Process and Methodology: Screening, scoping, and scoping report. Terms of Reference (ToR). Baseline data collection. Impact prediction and assessment. Impact evaluation and significance rating. Mitigation measures and impact management plans. Public consultation and participation. Monitoring and auditing. Structure and format of an EIS. Technical writing and report preparation. Data presentation and visualization. Cost-benefit analysis and economic valuation of environmental impacts.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Environmental Impact Assessment Techniques: Checklist method. Matrix method. Network analysis. Overlay mapping. Modeling techniques (e.g., air quality modeling, water quality modeling). Geographic Information Systems (GIS) applications in EIA. Post-Project Monitoring and Evaluation: Monitoring plan development. Data collection and analysis. Evaluation of mitigation measures. Adaptive management and corrective actions. Lessons learned and best practices.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Sector-Specific EIA Considerations: EIA for infrastructure projects (roads, railways, dams, power plants). EIA for industrial projects (mining, manufacturing, chemical industries). EIA for urban development projects (housing, commercial, industrial). EIA for tourism projects. EIA for agricultural and forestry projects.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Anjaneyulu, Y. (2002). Environmental Impact Assessment Methodologies. B.S. Publications.
2. Anthonysamy David, 2024. Environmental Impact Assessment : Ultimate Tools, Techniques and Technology to Natural Resource Management. Notion Press, 356pp.
3. Canter, L. W. (1996). Environmental Impact Assessment (2nd ed.). McGraw Hill.
4. Kulkarni, V. S., S. N. Kaul and R. K. Trivedy, 2002. A Handbook of Environment Impact

Assessment. Scientific Publishers Journals Dept. 203pp.

5. Ministry of Environment and Forests, Government of India (2001). Environmental Impact Assessment Manual. Impact Assessment Division.
6. Petts, J. (1999). Handbook of Environmental Impact Assessment: Volume 1 & 2. Blackwell Science.
7. Reddy, A. M. (2016). Environmental Impact Assessment: Theory and Practice. BS Publications.

Suggested Readings

1. Anjaneyulu Y., Manickam Valli (2011). Environmental Impact Assessment Methodologies, CRC Press. Glasson J., Therivel Riki, Chadwick Andrew (2012). Introduction to Environmental Impact Assessment, Oxford Brookes University.
2. Marriott B (1997). Environmental Impact Assessment: A Practical Guide. McGraw-Hill.
3. Shrivastava A.K., Baxter Nicola, Grimm Jacob (2003). Environmental Impact Assessment, APH Publishers.
4. Wathern P (1990). Environmental Impact Assessment: Theory and Practice. Routledge Publishers.

Web Resources

In India:

1. **Ministry of Environment, Forest and Climate Change (MoEFCC)**
Website for environmental guidelines, EIA notifications, and reports.
<http://www.moef.gov.in>
2. **Centre for Science and Environment (CSE)**
Provides resources on environmental policy, EIA processes, and case studies.
<https://www.cseindia.org>
3. **Indian Institute of Technology (IIT) Bombay - EIA Resources**
Offers training, research, and guidelines on environmental management and impact assessment.
<https://www.iitb.ac.in>
4. **National Environmental Engineering Research Institute (NEERI)**
Focuses on environmental protection and sustainable development through EIA studies.
<http://www.neeri.res.in>
5. **ForumIAS Blog on Environmental Impact Assessment**
Offers articles and educational content on EIA, including its process, legal framework, and case studies.
<https://blog.forumias.com>

International:

1. **International Association for Impact Assessment (IAIA)**
Provides resources, publications, and a network for environmental professionals.
<https://www.iaia.org>
2. **World Bank - Environmental and Social Framework (ESF)**
Focuses on EIA within global development projects funded by the World Bank.
<https://www.worldbank.org>

3. United Nations Environment Programme (UNEP) Offers global guidelines and policies on EIA, focusing on sustainable development. https://www.unep.org
4. European Union - EIA Directive Provides guidelines and legislation related to EIA within EU member states. https://ec.europa.eu/environment/eia

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Recognize and recall foundational concepts in environmental laws and policies in India, including the main regulations governing pollution control and environmental protection. Identify various sources and types of pollution, along with fundamental risk analysis techniques for assessing environmental impacts. Describe the stages of the Environmental Impact Assessment (EIA) process and its importance in sustainable project planning. Additionally, will list and explain sector-specific considerations for EIA, including the unique requirements and techniques applied in industries such as infrastructure, mining, and manufacturing.	K1, K2
CO2	Apply foundational knowledge of environmental laws and policies in India to real-world scenarios, evaluating their role in pollution control and sustainable development. Interpret pollution sources and conduct preliminary analyses of environmental risks, using risk assessment techniques to assess potential hazards. Students will be prepared to examine and distinguish between the stages of the Environmental Impact Assessment (EIA) process, including screening, scoping, impact analysis, and mitigation. Furthermore, they will compare sector-specific EIA techniques and analyze their applications in various industries, such as infrastructure, energy, and mining, to determine the most effective environmental management practices in each context.	K3, K4
CO3	Evaluate the effectiveness of various environmental laws and policies in India, critically assessing their impact on pollution control and sustainable development practices. Synthesize knowledge of pollution sources and risk analysis methodologies to develop comprehensive assessments of environmental hazards and their implications for public health and ecosystems. Students will also be equipped to design and formulate robust Environmental Impact Assessment (EIA) processes tailored to specific projects, integrating sector-specific considerations and methodologies. Furthermore, they will create innovative solutions and recommendations for improving EIA practices in various industries, applying their understanding of legal frameworks and environmental science to promote effective environmental management and policy implementation. Lastly, students will	K5, K6

	advocate for enhanced environmental policies and practices based on their findings, demonstrating leadership in addressing contemporary environmental challenges in India.	
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CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	0	3	3	2	3	3
CO2	2	0	3	3	2	3	3
CO3	2	0	3	3	2	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4NME01
Course Title	Principles of Conservation Biology
Credits	02
Hours/Week	03
Category	Non-major Elective (NME) – Theory
Semester	IV
Regulation	2024
Course Overview This course delves into the intricate world of biodiversity, exploring its significance, the threats it faces, and the strategies employed for its conservation. The students will gain insights into the diverse forms of life on Earth, the ecological processes that sustain them, and the human activities that disrupt these delicate balances. The course will equip them with a comprehensive understanding of conservation principles, restoration techniques, and the global and national initiatives aimed at safeguarding biodiversity.	
Course Objectives 1. To gain knowledge about the different levels of biodiversity (genetic, species, and ecosystem), their ecological significance, and the factors influencing their distribution. 2. To explore the major threats to biodiversity, such as habitat loss, pollution, climate change, overexploitation, and invasive species, and understand their impact on ecosystems. 3. To acquire knowledge about various conservation approaches, including in-situ and ex-situ conservation, protected area management, sustainable resource use, and policy and legislation. 4. To explore the concepts of ecological restoration, habitat restoration, and ecosystem management, and learn about the techniques and tools used to restore degraded ecosystems.	
Prerequisites	Basic knowledge of Environmental Biology.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Biodiversity: Definition, Genetic diversity, Species diversity, Ecosystem diversity: Structural and functional aspects. Bio-geographic classification of India. Value of Biodiversity: Intrinsic, consumptive, productive use, social, ethical, aesthetic and option values. Utilitarian values of biodiversity-goods, services and information. Biodiversity and ecosystem functioning. Biodiversity and stability of ecosystem functioning. Biodiversity at global, national and local levels. India as a Mega Diversity Nation. Hotspots of Biodiversity: Criteria for determining hot spots. Indo-Burma (Eastern Himalaya), Western Ghats and Sri Lanka.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

II	Threats to Biodiversity: Habitat loss, pollution, alien species, global climate change, overexploitation, poaching of wildlife. Rare species, genetic diversity of rare species, habitat loss, and fragmentation. Extinction: mass extinction, extinction process, ecosystem degradation, over-exploitation, invasive species. Human factors: social factors, economics, politics, and action. Human-wildlife conflicts. Endangered and endemic species of India.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
III	Conservation of Biodiversity: Strategies for conservation: <i>Ex situ</i> conservation-Managed ecosystems, biological resources and gene banks, botanical gardens, bio-parks, ecotourism, Botanical Gardens, Seed banks, Field gene banks, Test tube gene banks, pollen banks, DNA bank. <i>In situ</i> conservation.- Top-down and bottom- up protocols for conservation. Protected areas, Wildlife sanctuaries, National parks, Biosphere reserves.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Eco-restoration and Management Practices: Global biodiversity and its importance, Different approaches of biodiversity conservation and management, registering biodiversity. Valuing biodiversity resources and their contribution to agriculture, community health and environment. Causes of biodiversity loss. Techniques of species reintroduction and restoration of the degraded habitat. Biodiversity policy and legislation. Wildlife conservation and management: Status of biodiversity conservation in India.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Conservation Practices in India and World: Organizations involved in resource conservation IUCN, WWF, UNEP, UNESCO, Biodiversity International, IPGRI, FAO, BSI, ZSI. Phytogeography – Hotspots of India and world. General account on activities of DBT, BSI, NBPGR, ZSI, FSI, NBFGR and NBAGR NFPTCR, Sacred groves, Biodiversity Register.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Aggarwal, P. K., & Lal, M. (2001). Climate Change and India's Biodiversity: Impacts and Adaptation. Tata McGraw Hill.
2. Bawa, K. S., Primack, R. B., & Oommen, M. A. (2011). Conservation Biology: A Primer for South Asia. Universities Press.
3. Daniel, J. C., & Deshmukh, S. (1986). The Conservation of Wildlife in India. Natraj Publishers.
4. Gabriel M (2000). Biodiversity and conservation Oxford and IBH publishing company.
5. Gadgil, M., & Guha, R. (1995). Ecology and Equity: The Use and Abuse of Nature in Contemporary India. Penguin Books India.
6. Gupta, A. (2016). Biodiversity Conservation in India. Agrobios.

7. Joshi, P., & Joshi, P. (2020). Textbook of Conservation Biology. Scientific Publishers.
8. Kareiva, P., & Marvier, M. (2011). Conservation Science: Balancing the Needs of People and Nature. W.H. Freeman.
9. Krishnamoorthy, K.V (2004). An Advanced text book on Biodiversity- principles and Practice: Oxford and IBH publishing company.
10. Krishnamurthy, K.V (2003). Textbook on Biodiversity, Science Publishers, Hampshire.
11. Kumar, U. and Sharma, A.K (2008). Plant Biotechnology and Biodiversity conservation. Agrobios.
12. Mukherjee, S. K. (2012). Biodiversity in Indian Context: Threats and Conservation Strategies. Mittal Publications.
13. Sharma P.D (2003). Ecology and Environmental Sciences, Rastogi Publications.
14. Singh, H. S. (2001). Indian National Parks and Sanctuaries: A Living Wonderland. Bombay Natural History Society.
15. Singh, R. J. (2017). Biodiversity and Conservation: A Critical Analysis. Pointer Publishers.
16. Trivedi, P. C (2007). Global Biodiversity status and conservation. Pointer publishers.
17. Wani, M. A., & Dhar, B. K. (2013). Environmental Conservation and Sustainable Development in India. APH Publishing.

Suggested Readings

1. Novacek, M. J. (ed.) (2001) The Biodiversity Crisis: Losing What Counts. New York: American Museum of Natural History Books.
2. Swaminathan, M.N. & Jain, R.S (1982). Biodiversity: Implications for global security, Macmillan.
3. Singh, J. S., & Singh, S. P. (2002). Forest Biodiversity and Its Conservation in India. Springer-Verlag.
4. Sutherland, W. J. (2000). The Conservation Handbook: Research, Management, and Policy. Blackwell Science.
5. Daniel, J. C. (1983). The Book of Indian Reptiles and Amphibians. Oxford University Press.

Web Resources

India:

1. **Centre for Wildlife Studies (CWS) India**
CWS is a prominent organization dedicated to wildlife research, conservation, policy, and education in India. They focus on human-wildlife conflict, biodiversity research, and conservation initiatives.
[Centre for Wildlife Studies - CWS India](#)
2. **The Ashoka Trust for Research in Ecology and the Environment (ATREE)**
ATREE works on the conservation of biodiversity and ecosystems, focusing on sustainable livelihoods for local communities.
[ATREE](#)
3. **Wildlife Institute of India (WII)**
WII provides research, training, and consultancy in conservation biology and wildlife

management.

[Wildlife Institute of India](#)

4. **Drishti IAS - Biodiversity Conservation in India**

Drishti IAS offers insightful resources and discussions on the importance of biodiversity and conservation efforts in India.

[Drishti IAS - Biodiversity Conservation](#)

Abroad:

1. **International Union for Conservation of Nature (IUCN)**

IUCN is a global authority on the status of the natural world and the measures needed to safeguard it. They provide resources and data on global conservation efforts.

[IUCN](#)

2. **World Wildlife Fund (WWF)**

WWF is one of the world's largest conservation organizations, working globally to protect endangered species and ecosystems.

[WWF](#)

3. **The Nature Conservancy**

This U.S.-based global environmental organization works on large-scale conservation efforts aimed at protecting nature for future generations.

[The Nature Conservancy](#)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define biodiversity and explain its significance at different levels (genetic, species, and ecosystem). Identify the major threats to biodiversity, such as habitat loss, pollution, climate change, overexploitation, and invasive species. Describe the various in-situ and ex-situ conservation strategies employed to protect biodiversity. Explain the principles and practices of ecological restoration and habitat rehabilitation. Recognize the importance of international and national conservation initiatives and policies. Analyze the impact of human activities on biodiversity and ecosystem services. Evaluate the effectiveness of different conservation strategies in addressing specific threats to biodiversity. Apply ecological principles to assess the health and resilience of ecosystems. Propose solutions to biodiversity loss and degradation, considering local and global contexts. Interpret scientific data and research findings related to biodiversity and conservation.	K1, K2
CO2	Compare and contrast different biodiversity conservation approaches, such as in-situ and ex-situ conservation. Critically analyze the effectiveness of various conservation policies and regulations in protecting biodiversity. Evaluate the role of technology in monitoring and managing biodiversity. Assess the impact of climate change on biodiversity and develop adaptation	K3, K4

	strategies. Interpret complex ecological data to identify trends and patterns in biodiversity. Design and implement biodiversity conservation projects, considering ecological, social, and economic factors. Develop innovative solutions to address emerging threats to biodiversity. Create effective communication strategies to raise awareness about biodiversity conservation. Evaluate the long-term sustainability of conservation initiatives. Propose evidence-based recommendations for policy makers to improve biodiversity conservation efforts.	
CO3	Conceptualize novel approaches to biodiversity conservation, such as citizen science initiatives or innovative financing mechanisms. Design creative educational programs to promote environmental awareness and stewardship. Develop innovative technologies to monitor and assess biodiversity. Propose groundbreaking research questions to advance knowledge in biodiversity science. Explore futuristic scenarios to anticipate future challenges and opportunities for biodiversity conservation. Critically evaluate the ethical implications of biodiversity conservation practices. Identify emerging trends and challenges in biodiversity conservation and propose solutions. Analyze the socio-economic factors influencing biodiversity loss and develop equitable conservation strategies. Synthesize information from diverse sources to formulate evidence-based policy recommendations. Make informed decisions about the trade-offs between economic development and biodiversity conservation.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	3	3	3	3
CO2	2	2	3	3	3	3	3
CO3	3	2	3	3	3	3	3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

Course Code	UAZ4NME02
Course Title	Sexual and Reproductive Health
Credits	02
Hours/Week	03
Category	Non-major Elective (NME) – Theory
Semester	IV
Regulation	2024
Course Overview This course provides a comprehensive overview of sexual and reproductive health, encompassing topics such as family planning, fertility, contraception, common sexually transmitted infections, and public health policies. The students will delve into the importance of sexual health education, counseling, and advocacy, exploring the role of effective communication and access to healthcare services.	
Course Objectives 1. To gain knowledge about the various aspects of sexual and reproductive health, including anatomy, physiology, and psychology. 2. To explore different contraceptive methods, their effectiveness, side effects, and appropriate usage. 3. To understand the causes, symptoms, prevention, and treatment of sexually transmitted infections (STIs) and other sexual health problems. 4. To develop the ability to provide accurate and sensitive information about sexual health, counsel individuals and couples, and advocate for policies that promote sexual health and well-being.	
Prerequisites	Basic knowledge of human anatomy.

SYLLABUS

Unit	Content	Hrs	COs	Cognitive Levels
I	Introduction to Sexual and Reproductive Health: Historical and Cultural Perspectives on Sexual Health. Anatomy and Physiology of the Reproductive System. Sexual Development and Puberty. Theories of Sexual Health and Behavior. Sexual Rights, Identity, and Ethics: Understanding Sexual Rights and Human Rights Framework. Gender Identity and Sexual Orientation. Consent, Boundaries, and Ethical Considerations in Sexual Health. Cultural and Religious Influences on Sexual Health Rights. Preventing Sexual Violence and Abuse.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
II	Family Planning, Fertility, and Contraception: Introduction to Family Planning and Reproductive Choices. Contraceptive Methods (Barrier, Hormonal, Intrauterine	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

	Devices, Natural Methods). Fertility Awareness and Assisted Reproductive Technologies. Access to Family Planning Services. Communication and Counseling in Family Planning.			
III	Common Sexual Health Issues and Infections: Overview of Sexually Transmitted Infections (STIs). HIV/AIDS: Prevention, Treatment, and Social Stigma. Common Reproductive Health Disorders (PCOS, Endometriosis, Erectile Dysfunction). Maternal Health and Pregnancy Complications. Psychological Aspects of Sexual Health and Illness.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
IV	Public Health Policies, Advocacy, and Access: Overview of National and International Sexual and Reproductive Health Policies. The Role of Government, NGOs, and International Organizations. Equity and Access in Sexual Health Services. Health System Approaches to Sexual Health. Case Studies on Policy Implementation and Challenges.	08	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6
V	Communication, Counseling, and Sexual Health Advocacy: Principles of Effective Communication in Sexual Health Counseling. Approaches to Counseling for Sexual Health and Family Planning. Developing Sexual Health Education Programs. Media, Advocacy, and Public Education on Sexual Health. Ethical Issues in Sexual Health Advocacy.	07	CO1 CO2 CO3	K1,K2,K3, K4,K5,K6

Text Books

1. Jejeebhoy, S., Santhya, K. G., & Xavier, A. J. (2020). Sexual and Reproductive Health in India. Oxford Research Encyclopedia of Global Public Health.
2. National Council of Educational Research and Training (NCERT). (2023). Reproductive Health. New Delhi: NCERT.
3. NCERT. (2023). Reproductive Health. New Delhi: NCERT.
4. Pachauri, S., Pachauri, A., & Mittal, K. (2022). Sexual and Reproductive Health and Rights in India: Self-care for Universal Health Coverage. SpringerBriefs in Public Health.
5. Ussher, J. M., Chrisler, J. C., & Perz, J. (Eds.). (2019). Routledge International Handbook of Women's Sexual and Reproductive Health (1st ed.). Routledge.

Suggested Readings

1. Chatterjee, A., & Kottai, S. R. (2018). Gender, Sexuality, and Reproductive Health in India. Routledge India.
2. Jejeebhoy, S. J., & Kulkarni, S. (2016). Improving Reproductive and Sexual Health in India: Opportunities and Challenges. Oxford University Press.
3. Malhotra, A., & Ramachandran, P. (2020). Confronting Sexual Health Challenges in India: Policies and Interventions. Macmillan Publishers India.
4. Mehrotra, S., & Gupta, R. (2018). Sexuality Education and Health in India. Sage Publications.
5. Pachauri, S. (2022). Sexual and Reproductive Health and Rights in India. Springer.

6. Pachauri, S., & Sharma, N. (2019). Reproductive Health: Transforming Challenges into Opportunities. Academic Foundation.
7. Population Foundation of India. (2024). Family Planning and Sexual and Reproductive Health Resources. Population Foundation of India.
8. Rao, K. S., & Sinha, R. (2021). Reproductive Health in Indian Perspective: An Analytical Overview. Prentice Hall India.
9. Sundararaman, T. (2020). Reproductive Health in India: Progress and Challenges. OUP India.
International Institute for Population Sciences (IIPS). (2021). National Family Health Survey Population Council. (2019). Adolescent Reproductive and Sexual Health in India: Status and Prospects. Population Council India.
10. WHO Regional Office for South-East Asia. (2015). Adolescent Sexual and Reproductive Health Toolkit for Peer Educators in India. WHO.

Web Resources

India:

1. **Ministry of Health and Family Welfare, Government of India (MoHFW)**
Provides official policies, guidelines, and schemes related to sexual and reproductive health, including family planning, maternal health, and adolescent health.
[Visit Website](#)
2. **National Health Mission (NHM)**
NHM aims to improve healthcare delivery, including sexual and reproductive health services, across India, particularly for vulnerable populations.
[Visit Website](#)
3. **UNFPA India - Sexual and Reproductive Health**
Focuses on youth reproductive health, family planning, and maternal health. It also includes research and publications on SRH status in India.
[Visit Website](#)
4. **Population Foundation of India**
Works on SRH issues, gender equality, family planning, and reproductive rights. The foundation conducts research and advocacy in India.
[Visit Website](#)
5. **Sahayog (India)**
Sahayog focuses on promoting SRH education and services for marginalized women and children, particularly in rural and underserved regions of India.
[Visit Website](#)

Global:

1. **World Health Organization (WHO) - Sexual and Reproductive Health**
WHO offers extensive guidelines, resources, and research on global SRH topics including family planning, safe abortion, HIV/AIDS prevention, and maternal health.
[Visit Website](#)
2. **United Nations Population Fund (UNFPA)**
UNFPA provides resources on global reproductive health, rights, maternal health, and gender equality.

[Visit Website](#)

3. **International Planned Parenthood Federation (IPPF)**

Focuses on advocating for and providing sexual and reproductive health services worldwide, with a strong emphasis on human rights and access to healthcare.

[Visit Website](#)

4. **Guttmacher Institute**

Guttmacher conducts research on sexual and reproductive health, focusing on reproductive rights, contraception, and abortion policies around the world.

[Visit Website](#)

5. **The Sexual and Reproductive Health and Rights (SRHR) Network**

Provides information on SRHR across the world, including research, case studies, and policy advocacy resources.

[Visit Website](#)

Academic and Research Institutes:

1. **Johns Hopkins Bloomberg School of Public Health - Center for Communication Programs**

Offers research and training materials related to SRH education and communication Strategies for better public health outcomes.

[Visit Website](#)

2. **Harvard T.H. Chan School of Public Health - Reproductive Health**

Offers courses, publications, and research materials focused on sexual and reproductive health topics.

[Visit Website](#)

3. **London School of Hygiene and Tropical Medicine (LSHTM)**

LSHTM provides courses and research opportunities in global sexual and reproductive Health issues, particularly in low-income settings.

[Visit Website](#)

Course Outcomes (COs) and Cognitive Level Mapping

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

COs	CO Description	Cognitive Levels
CO1	Define key terms related to sexual and reproductive health, such as fertility, contraception, and sexually transmitted infections (STIs). Identify various family planning methods and their mechanisms of action. Describe the anatomy and physiology of the male and female reproductive systems. Recognize common symptoms and risk factors associated with STIs. Explain the role of public health policies in promoting sexual and reproductive health. Apply knowledge of sexual and reproductive health to personal decision-making. Utilize counseling techniques to provide accurate and sensitive information to clients. Interpret health information and communicate it effectively to diverse audiences. Evaluate the effectiveness of different family	K1, K2

	planning methods. Analyze the impact of cultural and societal factors on sexual health behaviors.	
CO2	Compare and contrast different family planning methods based on their effectiveness, side effects, and suitability for various individuals. Critically analyze the impact of cultural and societal norms on sexual health behaviors and attitudes. Evaluate the effectiveness of public health interventions in addressing sexual health issues. Assess the role of gender and sexuality in shaping sexual health outcomes. Interpret research findings on sexual health trends and disparities. Design comprehensive sexual health education programs tailored to specific populations. Develop strategies to promote sexual health equity and reduce health disparities. Create effective communication materials to raise awareness about sexual health issues. Evaluate the impact of sexual health interventions and propose improvements. Propose evidence-based policy recommendations to enhance access to sexual and reproductive health services.	K3, K4
CO3	Conceptualize innovative approaches to sexual health education and promotion. Design creative and engaging tools to address sensitive topics related to sexual health. Develop new strategies to overcome barriers to accessing sexual and reproductive health services. Propose groundbreaking research questions to advance the field of sexual and reproductive health. Explore futuristic scenarios to anticipate future challenges and opportunities in sexual and reproductive health. Critically evaluate the ethical implications of sexual health interventions. Identify emerging trends and challenges in sexual and reproductive health and propose solutions. Analyze the socio-economic factors influencing sexual health disparities and develop equitable interventions. Synthesize information from diverse sources to formulate evidence-based policy recommendations. Make informed decisions about the trade-offs between individual rights and public health concerns in the context of sexual and reproductive health.	K5, K6

CO-PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	2	3	2	2
CO2	1	1	3	2	2	3	2
CO3	1	1	3	2	2	2	2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Advanced Zoology and Biotechnology

First Continuous Internal Assessment Test, August 2024

UAZ1MC02 INVERTEBRATA II

Class: I BSc

Date: 23.08.2024

Time: 12.30 PM – 2.00 PM

Max. Marks: 50

SECTION A (CO1)

Answer ALL the questions

5 x 2 = 10

1	K1	Define statocyst.
2		State the importance of pheromones.
3	K2	Comment on Ommatidia.
4		Describe the mouth parts of an insect.
5		Write down the importance of Biomimetics

SECTION B (CO2)

Answer ALL the questions

2 x 10 =20

6	K3	Compare the types of appendages of Prawn
OR		
7	K3	Illustrate the social behaviour in insects.
8	K4	Discuss the economically and medically important arthropods
OR		
9	K4	Explain the external morphology of <i>Periplaneta americana</i>

SECTION C (CO3)

Answer ALL the questions

2 x 10 =20

10	K5	Compare the systematic position of Phylum Arthropoda.
11	K6	Interpret the evolutionary significance of metamorphosis in insects.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Advanced Zoology and Biotechnology

Semester Examination, November 2024

UAZ1MC02 INVERTEBRATA II

Duration: 3 hrs

Max. Marks: 100

SECTION A (CO1)

Answer ALL the questions

10 x 2 = 20

1	K1	Define statocyst.
2		State the importance of pheromones.
3		Comment on Uropod.
4		What is called a tube feet?
5		What is called a coelom?
6	K2	Comment on Ommatidia.
7		Describe the mouth parts of an insect.
8		Write down the importance of Biomimetics
9		Mention the significance of siphon in Cephalopoda.
10		Recall the significance of tentacles in holothurians.

SECTION B (CO2)

Answer ALL the questions

4 x 10 =40

11	K3	Compare the types of appendages of Prawn
OR		
12	K3	Illustrate the social behaviour in insects.
13	K3	Discuss the economically and medically important arthropods.
OR		
14	K3	Explain the external morphology of <i>Periplaneta americana</i>
15	K4	Analyze the adaptive features of arthropods.
OR		
16	K4	Summarize the general organization of <i>Sagitta</i> .
17	K4	Explain the systematic position of the Phylum Mollusca.
OR		
18	K4	Discuss the evolutionary significance of Echinoderms.

SECTION C (CO3)**Answer ALL the questions****2 x 20 =40**

19	K5	Compare the systematic position of Phylum Arthropoda.
OR		
20	K5	Interpret the evolutionary significance of metamorphosis in insects.
OR		
21	K6	Compile information on the arthropod vectors.
OR		
22	K6	Discuss in detail the characteristic features of the Phylum Mollusca.

COMPONENT III ASSESSMENTS AND RUBRICS**Mini Project**

The project work is included as part of the curriculum to impart research skills. The students are encouraged to select research problems relevant to society and environment. The project report will be evaluated by external examiners and the students will present their work in viva voce.

Rubrics for evaluation

S. No	Criteria	Max. Marks
1.	Review of Literature	10
2.	Hypothesis Design	10
3.	Materials and Methodology	5
4.	Experimental Design	10
5.	Validation of scientific Data	10
6.	Discussion and Recommendation	10
7.	Report/Dissertation	20
8.	Presentation	10
9.	Relevance of the study	15

Seminar/Assignment

Topics for the seminar are suggested by the course teacher and the students are encouraged to collective exhaustive information on the chosen topic, arrange them in order and make a presentation. They are expected to use visual aids, models, tools for the presentation and circulate relevant literature to the students.

Rubrics for evaluation

S. No	Criteria	Max. Marks
1.	Topic introduction	10
2.	Collection of literature (primary, secondary and tertiary)	10
3.	Presentation methodology	20

4.	Articulation and Communication skills	10
5.	Time management	10
6.	Discussion and Interaction	20
7.	Summary and Conclusion	20

Internship/Field visit

Internship allows the students to gain hands on experience and industry exposure. The internship for UG is conducted during the Christmas Vacation for minimum of 15 days. The students will be sent to industries/organization the department signed MoU with.

Rubrics for evaluation of Internship

S. No	Criteria	Max. Marks
1.	Industry/Organization profile	10
2.	Thrust areas and specialization	10
3.	Internship module and participation	20
4.	Expertise of the industry/organization	10
5.	Regularity and hands on training	10
6.	Presentation/Demonstration	20
7.	Report writing	20