Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

(NAAC A++ Accredited & Empowered Autonomous)

Three / Four Year Honours / Honours with Research B.Sc. Degree Program in Zoology (Faculty of Science)

CBCS Syllabus

TYBSc (Zoology) Semester-V

For Department of Zoology

Choice Based Credit System Syllabus

(2024 Pattern)

(As Per NEP-2020)

To be implemented from Academic Year 2026-2027

Title of the Programme: TYBSc (Zoology)

Preamble

AES's Tuljaram Chaturchand College has decided to change the syllabus of various faculties from June, 2023 by taking into consideration the guidelines and provisions given in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcomes for the development of the students. The credit structure and the courses framework provided in the NEP are nationally accepted and internationally comparable.

The rapid changes in science and technology and new approaches in different areas of Zoology and related subjects, Board of Studies in Zoology of Tuljaram Chaturchand College, Baramati - Pune has prepared the syllabus of FYBSc Zoology Semester - I under the Choice Based Credit System (CBCS) by following the guidelines of NEP 2020, NCrF, NHEQF, Prof. R.D. Kulkarni's Report, GR of Gov. of Maharashtra dated 20th April, 16th May 2023 and 13th March, 2024 and Circular of SPPU, Pune dated 31st May 2023.

After completion of B.Sc. in Zoology enrolled students will acquire complete disciplinary knowledge as well as allied branches of Zoology. At the end of programme, students may possess expertise which will provide them competitive advantage in pursuing higher studies within India or abroad; and seek jobs in academia, civil administration, research or industries. Students will be able to define and explain major concepts in the biological sciences. They will be able to correctly use biological instrumentation and proper laboratory techniques; to communicate biological knowledge in oral and written form; to identify the relationship between structure and function at all levels: molecular, cellular, tissue, organ, system and organismal.

Students should be able to identify, classify and differentiate diverse non-chordates and chordates based on their basic morphological, anatomical biochemical and molecular characters. They will also be able to describe economic, ecological and medical significance of various animals in human life. This programme will create a curiosity and awareness among students to explore the animal diversity and take up wild life photography or wild life exploration as a career option. The procedural knowledge about identification and classification of animals will provide students professional advantages in seeking the jobs in fields of teaching, research and taxonomy in various private & public organizations; including Zoological Survey of India and National Parks/Sanctuaries. Students will be able toapply the scientific methods to answer questions in biology

by formulating testable hypotheses, gathering data that address these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their hypotheses. Students will be able to present scientific hypotheses and data both orally and in writing in the conventional formats that are in practice. Students will be able to access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works. Acquired practical skills in biotechnology, biostatistics, bioinformatics and molecular biology can be used to pursue career as a scientist in drug development industry in India or abroad. The students will be acquiring basic experimental skills in various techniques in the fields of genetics; molecular biology; biotechnology; entomology, physiology, qualitative andquantitative microscopy; and analytical biochemistry. These methodologies will provide an extra edge to our students, who wish to undertake higher studies. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped animal morphology,physiology, life history, and behaviour. Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different animals. Students will be able to analyse the ecological relationships of life on earth by tracing energy and nutrient flows through the ecosystems. They will be able to establish the relationship between the physical features of the environment and the structure of populations, communities, and ecosystems. Students undertaking skill enhancement courses like aquaculture, sericulture and apiculture will inculcate skills involved in rearing fish, bees and silk moth which would help them to generate self-employment making them successful entrepreneurs. Acquired skills indiagnostic testing, haematology, histopathology, staining procedures etc. used in clinical and research laboratories will make them eligible to work in diagnostic or research laboratories. B.Sc. Zoology graduates will find opportunities in public services departments, NGOs, environmental agencies, universities, colleges, biotechnological, pharmaceutical, environmental / ecological fields. There are numerous career opportunities for candidates completing their B.Sc, M.Sc and Ph.D. in Zoology in public and private sector. Candidates may find jobs as Animal Behaviourist, Conservationist, Wildlife Biologist, Zoo Curator, Wildlife Educator, Zoology teacher, Forensic experts, Lab technicians, Veterinarians, etc.

Overall, revising the Zoology syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academicand professional goals in a rapidly changing global landscape.

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of Arts, Science & Commerce, Baramati

(NAAC A++ Accredited & Empowered Autonomous)

Board of Studies (BoS) in Zoology

From 2025-26 to 2027-28

Sr. No.	Name of Member	Designation
1.	**Dr. Chordiya Sandip Popatlal**	**Chairperson**
2.	**Dr. Nale Vitthal Baban**	Member
3.	**Dr. Manoorkar Poojawati**	Member
4.	**Dr. Sangale Deepali Maruti**	Member
5.	**Mr. More Kishor U.**	Member
6.	**Dr. Jadhav Sameer Sadashiv**	Member
7.	**Mr. Kare Samadhan**	Member
8.	**Mr. Awaghade Yugandhar**	Member
9.	**Dr. Ravindra D. Chaudhari**	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
10.	**Dr. Gaikwad Sanjay K.**	Subject Expert from Outside the Parent University
11.	**Dr. Deshmukh A. A.**	Subject Expert from Outside the Parent University
12.	**Dr. Karpe Yogesh**	Representative from Industry/Corporate Sector/Allied areas
13.	**Ms. Kumbhar Kamal**	Member of the College Alumni
14.	**Ms. Sakshi Sawant**	UG Student
15.	**Ms. Sanika Nikhale**	PG Student

Course and Credit Distribution Structure for B.Sc. (Zoology) 2024-2025

Level/ Difficulty	Sem	Subject DSC-1				Subject DSC-2	Subject DSC-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2(P)				2(T)+2(P)	2(T)+ 2(P)	2(T)	2 (T/P)	2(T) (Generic)	2(T)	2(T)	--	22
	II	2(T)+2(P)				2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T)	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped.														
Level/ Difficulty	**Sem**	**Credits Related to Major**				**Minor**	**--**	**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/CEP/RP**									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	--	4 (OJT)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2(T)+2(P)	2 (FP)	--	--	--	--	--	--	--	--	22
Total 3Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of **UG Degree in Major** with 132 credits OR Continue with Major and Minor														
6.0/400	VII	6(T)+4(P)	2(T)+2 (T/P)	--	4(RP)	4(RM)(T)	--	--	--	--	--	--	--	22
	VIII	6(T)+4(P)	2(T)+2 (T/P)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		**64**	**16**	**8**	**22**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours with Research Degree** in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		**72**	**16**	**8**	**14**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours Degree** in Major and Minor with 176 credits														

*** T = Theory** *** P = Practical** *** DSC = Discipline Specific Course**

*** OE = Open Elective** *** SEC = Skill Enhancement Course** *** IKS = Indian Knowledge System**

*** AEC = Ability Enhancement Course** *** VEC = Value Education Course** *** CC = Co-curricular Courses**

***VSC= Vocational Skill Course** ***OJT = On Job Training** ***CEP = Community Engagement Project**

***FP = Field Project** ***RP = Research Project**

F.Y.B.Sc. Zoology NEP-2020

Course Structure for F.Y.B.Sc. Zoology (2024 Pattern)

Sem	Course Type	Course Code	CourseName	Theory / Practical	Credits
I	DSC-I (General)	ZOO-101-GEN	Non-chordates	Theory	02
		ZOO-102-GEN	Zoology Practical – I	Practical	02
	DSC-II (General)	-101-GEN		Theory	02
		-102-GEN		Practical	02
	DSC-III (General)	-101-GEN		Theory	02
		-102-GEN		Practical	02
	Open Elective (OE)	ZOO-103-OE	Fresh Water Fishery (गोड्या पाण्यातील मत्स्यशेती)	Theory	02
	Skill Enhancement Course (SEC)	ZOO-104-SEC	Medical Laboratory Technology-I	Practical	02
	Ability Enhancement Course (AEC)	ENG-104-AEC		Theory	02
	Value Education Course (VEC)	ENV-105-VEC		Theory	02
	Generic Indian Knowledge System (GIKS)	GEN-106-IKS		Theory	02
			Total Credits Semester-I		**22**
	DSC-I (General)	ZOO-151-GEN	Fundamentals of Cell Biology	Theory	02
		ZOO-152-GEN	Zoology Practical – II	Practical	02
	DSC-II (General)	-151-GEN		Theory	02
		-152-GEN		Practical	02
	DSC-III (General)	-151-GEN		Theory	02
		-152-GEN		Practical	02
	Open Elective (OE)	ZOO-153-OE	Fresh Water Fishery Practical (गोड्या पाण्यातील मत्स्यशेती- प्रात्यक्षिक)	Theory	02
	Skill Enhancement Course (SEC)	ZOO-154-SEC	Medical Laboratory Technology-II	Practical	02
	Ability Enhancement Course (AEC)	ENG-154-AEC		Theory	02
	Value Education Course (VEC)	ENV-155-VEC		Theory	02
	Co-curricular Course (CC)	YOG/PES/CUL/NS S/NCC-156-CC	To be selected from the CC Basket	Theory	02
			Total Credits Semester-II		**22**
			Cumulative Credits Semester I + Semester II		**44**

S.Y.B.Sc. Zoology NEP-2020

Course Structure for S.Y.B.Sc. Zoology (2024 Pattern)

Sem	Course Type	Course Code	CourseName	Theory / Practical	Credits
III	Major Mandatory	ZOO-201-MRM	Chordates	Theory	02
	Major Mandatory	ZOO-202-MRM	Applied Zoology-I	Theory	02
	Major Mandatory	ZOO-203-MRM	Zoology Practical – III	Practical	02
	Vocational Skill Course (VSC)	ZOO-204-VSC	Biological Techniques	Practical	02
	Field Project (FP)	ZOO-205-FP	Field Project	Practical	02
	Minor	ZOO-206-MN	Apiculture	Theory	02
	Minor	ZOO-207-MN	Practicals in Apiculture	Practical	02
	Open Elective (OE)	ZOO-208-OE	Crop Pests: Types & Management पिकावरील कीड: प्रकार व व्यवस्थापन	Theory	02
	Subject specific Indian Knowledge System (IKS)	ZOO-209-IKS	Animal Diversity & Conservation in Indian Culture	Theory	02
	Ability Enhancement Course (AEC)	MAR-210-AEC /HIN-210-AEC /SAN-210-AEC		Theory (Any one)	02
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC -211-CC	To be continued from the semester-II		02
				Total Credits Semester-III	**22**
IV	Major Mandatory	ZOO-251-MRM	Introduction to Genetics	Theory	02
	Major Mandatory	ZOO-252-MRM	Applied Zoology-II	Theory	02
	Major Mandatory	ZOO-253-MRM	Zoology Practical – IV	Practical	02
	Vocational Skill Course (VSC)	ZOO-254-VSC	Medical Laboratory Techniques	Theory	02
	Community Engagement Project (CEP)	ZOO-255-CEP	Community Engagement Project	Practical	02
	Minor	ZOO-256-MN	Sericulture	Theory	02
	Minor	ZOO-257-MN	Practicals in Sericulture	Practical	02
	Open Elective (OE)	ZOO-258-OE	Crop pests: Types & management(Practical) (पिकावरील किड: प्रकार व व्यवस्थापन) (प्रात्यक्षिक)	Practical	02
	Skill Enhancement Course (SEC)	ZOO-259-SEC	Practicals in Dairy Science	Practical	02
	Ability Enhancement Course (AEC)	MAR-260-AEC /HIN-260-AEC /SAN-260-AEC		Theory (Any one)	02
	Co-curricular Course (CC)	YOG/PES/CUL/ NSS/NCC -261-CC	To be continued from the semester-III		02
				Total Credits Semester-IV	**22**
				Cumulative Credits Semester III + Semester IV	**44**

T.Y.B.Sc. Zoology NEP-2020

Course Structure for T.Y.B.Sc. Zoology (2024 Pattern)

Sem.	Course Type	Course Code	Course Name	Theory / Practical	Credits
V	Major Mandatory	ZOO-301-MRM	Instrumentation in Biology	Theory	02
	Major Mandatory	ZOO-302-MRM	Genetics	Theory	02
	Major Mandatory	ZOO-303-MRM	Biochemistry	Theory	02
	Major Mandatory	ZOO-304-MRM	Mammalian Histology	Theory	02
	Major Mandatory	ZOO-305-MRM	Zoology Practical-V	Practical	02
	Major Mandatory	ZOO-306-MRM	Zoology Practical-VI	Practical	02
	Major Elective (MJE)	ZOO-307-MJE (A)	Cell Biology	Theory (Any one)	02
	Major Elective (MJE)	ZOO-307-MJE (B)	Organic Evolution and Ecology		
	Major Elective (MJE)	ZOO-308-MJE (A)	Practicals in Cell Biology	Practical (Any one)	02
	Major Elective (MJE)	ZOO-308-MJE (B)	Practicals in Organic Evolution and Ecology		
	On Job Training (OJT)	ZOO-309-OJT	On Job Training	Practical	04
	Minor Course	ZOO-310-MN	Ornamental Fishery	Theory	02
				Total Credits Semester-V	**22**
VI	Major Mandatory	ZOO-351-MRM	Immunology	Theory	02
	Major Mandatory	ZOO-352-MRM	Mammalian Physiology	Theory	02
	Major Mandatory	ZOO-353-MRM	Parasitology	Theory	02
	Major Mandatory	ZOO-354-MRM	Molecular Biology	Theory	02
	Major Mandatory	ZOO-355-MRM	Zoology Practical-VI	Practical	02
	Major Mandatory	ZOO-356-MRM	Zoology Practical-VII	Practical	02
	Major Elective (MJE)	ZOO-357-MJE (A)	Basic Entomology	Theory (Any one)	02
	Major Elective (MJE)	ZOO-357-MJE (B)	General Embryology		
	Major Elective (MJE)	ZOO-358-MJE (A)	Practicals in Basic Entomology	Practical (Any one)	02
	Major Elective (MJE)	ZOO-358-MJE (B)	Practicals in Embryology		
	Vocational Skill Course (VSC)	ZOO-359-VSC	Biostatistics	Theory	02
	Vocational Skill Course (VSC)	ZOO-360-VSC	Practicals in Biostatistics	Practical	02
	Field Project (FP)	ZOO-361-FP	Field Project	Practical	02
				Total Credits Semester-VI	**22**
				Cumulative Credits Semester V + Semester VI	**44**

Programme Specific Outcomes (PSOs)

PSO1. Disciplinary Knowledge: Understand the basic concepts of various branches of Zoology like Cell Biology, Genetics, Taxonomy, Physiology, Biochemistry, Molecular Biology, Embryology, Developmental Biology, Immunology, Ecology and Applied Zoology.

PSO2. Critical thinking and problem solving: Analyse the relationships of animals with abiotic factors and different biotic factors like plants and microbes. They will able to interpret the pathogen based upon symptoms of disease.

PSO3. Individual and Teamwork: Sets up the experiments and performs the same as per laboratory standards in different fields of Zoology like Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Clinical science, tools and techniques of Zoology, Toxicology, Entomology, Nematology, Sericulture, Biochemistry, Ichthyology, Animal biotechnology, Immunology, Physiology and research methodology.

PSO4. Research related skills and scientific temper: Propose hypothesis, formulate tests, use various modern instruments for biological analysis, data collection and field surveys and interprets the data and find answers.

PSO5. Critical Thinking: Recognizes the relationships between structure and functions at different levels of biological organization (e.g., molecules, cells, organs, organisms, populations, and species) for animals.

PSO6. Development of Observation Skills: Distinguishes different ecosystems (e.g., terrestrial, freshwater, marine) based on biological, chemical, and physical features; Correlates the morphology, physiology, behaviour with the properties of habitat.

PSO7. Ethics and Effective Citizenship: Contributes the knowledge for sustainable development and nation building.

PSO8. Management Skills: Exhibits management skills in applied branches of Zoology like Apiculture, Sericulture, Aquaculture and Agriculture.

PSO9. Environmental Ethics and Sustainability: Explains the broad understanding of ecosystems, biodiversity and their conservation.

PSO10. Identification of critical problems and issues: Detect the causes and consequences of biodiversity depletion.

SYLLABUS (CBCS) FOR S. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Theory
Course Code: ZOO-301-MRM
Course Name: Instrumentation in Biology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Understand the principles and applications of basic biological separation and analytical techniques such as chromatography, electrophoresis, centrifugation, and colorimetry used in biological research.
- Acquire knowledge of microtechniques involved in tissue handling, including procurement, fixation, dehydration, clearing, impregnation, embedding, and block preparation.
- Develop skills in the use of microtomes and microtome knives, including section cutting, identification of common faults, and corrective measures.
- Gain conceptual understanding of stains and staining techniques, including classification of stains, Gram staining, and general staining procedures.
- Learn proper mounting techniques and the use of mounting media for permanent preservation and microscopic examination of biological sections.
- Understand the principles and applications of histochemical staining techniques, particularly PAS reaction for carbohydrates and Feulgen reaction for nucleic acids.
- Introduce students to basic biotechnological techniques, including RDT, PCR, and blotting techniques used in molecular biology.

Course Outcomes:-

Student will be able to-

CO1: explain the principles of chromatography, electrophoresis (agarose and PAGE), centrifugation, and colorimetry, and relate their applications in biological analysis.

CO2: demonstrate understanding of tissue procurement methods and precautions, and apply appropriate fixation techniques for effective tissue preservation.

CO3: describe and perform steps involved in dehydration, clearing, impregnation, embedding, and block making for histological preparations.

CO4: identify different types of microtomes and microtome knives, perform section cutting, and diagnose common sectioning faults with suitable remedies.

CO5: classify stains and describe staining procedures, including Gram staining, and perform mounting of stained sections using appropriate mounting media.

CO6: explain the principles of histochemical staining and demonstrate carbohydrate localization using PAS technique and nucleic acid detection using Feulgen reaction.

CO7: describe the basic principles and applications of RDT, PCR, and blotting techniques in biotechnology and molecular biology.

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1	**Introduction to biological techniques:**		07
	Principle and applications of		

	1.1	Chromatography- Paper & Ion-exchange	
	1.2	Electrophoresis- Agarose and PAGE	
	1.3	Centrifugation	
	1.4	Colorimetry & Spectrophotometry	
2	**Microtechniques:**		07
	2.1	Procurement of tissues and precautions to be taken to during procurement	
	2.2	Fixatives: Classification of fixatives, methods of fixation and importance of fixation	
	2.3	Dehydration and clearing	
	2.4	Impregnation, embedding and block making	
3	**Microtomes and Knives:**		05
	3.1	Types of microtomes and microtome knives	
	3.2	Section cutting: Steps, common faults- reasons & remedies	
	3.3	Mounting and spreading of ribbons	
4	**Stains and Staining:**		05
	4.1	Classification of stains	
	4.2	Gram's staining	
	4.3	General procedure for staining of sections	
	4.4	Mounting media & mounting of sections	
5	**Histochemical staining:**		02
	5.1	Demonstration of Carbohydrates by PAS technique	
	5.2	Demonstration of Nucleic acid by Feulgen Reaction	
6	**Biotechnology:**		04
	6.1	Introduction to RDT & PCR	
	6.2	Introduction to Blotting techniques	

REFERENCES

1. Okotore, R. O. (1998). Basic separation techniques in biochemistry. New Age International.
2. Wilson, K., Hofmann, A., Walker, J. M., & Clokie, S. (Eds.). (2018). Wilson and Walker's principles and techniques of biochemistry and molecular biology. Cambridge university press.
3. Kiernan, J. (2015). Histological and histochemical methods. Scion publishing ltd.
4. Sanderson, J. (2020). Biological microtechnique. Garland Science.
5. Histopathological technique and Practical Histochemistry, 1976, 4th Edn, Lillie R. McGraw-Hill, USA
6. Biological Instrumentation and methodology, 2008, 2nd Revised Edition, P.K. Bajpai, S. Chand and Co. Ltd., New Delhi.
7. Thieman, W. J. (2009). Introduction to biotechnology, Pearson Education India.

Course Articulation Matrix of ZOO-301-MRM: Instrumentation in Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	3	1	2	2	2	1	2	2	1
CO2	3	3	1	3	3	1	3	2	1	1	2	3	1
CO3	3	3	1	3	3	1	3	2	1	1	2	3	1
CO4	3	3	1	3	3	1	3	2	1	1	2	3	1
CO5	3	3	1	3	3	1	2	2	1	1	2	3	1
CO6	3	3	2	3	3	1	3	2	2	1	2	3	1
CO7	3	3	3	3	3	2	3	2	3	2	2	2	2

PO1: Comprehensive knowledge and understanding
CO1–CO7 are mapped because the course provides fundamental and advanced knowledge of biological techniques, histological methods, histochemistry, and biotechnology essential for understanding modern biological sciences.

PO2: Practical, professional, and procedural knowledge
CO2–CO7 are mapped strongly as the course emphasizes hands-on laboratory techniques such as tissue processing, microtomy, staining, histochemical reactions, and molecular techniques like PCR and blotting.

PO3: Entrepreneurial mind-set and knowledge
CO6 and CO7 are mapped because histochemical and biotechnological techniques have applications in diagnostics, biomedical industries, research laboratories, and biotechnology-based enterprises.

PO4: Specialized skills and competencies
CO1–CO7 are mapped as students acquire specialized competencies in analytical techniques, histological preparation, staining methods, and molecular biology tools.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO7 are mapped because performing biological techniques, diagnosing sectioning faults, selecting appropriate stains, and interpreting experimental results require analytical thinking and problem-solving skills.

PO6: Communication skills and collaboration
CO7 is moderately mapped as understanding and explaining advanced techniques such as PCR and blotting requires effective scientific communication and teamwork during laboratory work.

PO7: Research-related skills
CO2–CO7 are mapped strongly since tissue processing, histochemistry, and molecular techniques form the foundation of experimental research and data interpretation in biological sciences.

PO8: Learning how to learn skills
CO1–CO7 are mapped because continuous updating of technical knowledge and laboratory practices is essential in rapidly evolving fields like biotechnology and histology.

PO9: Digital and technological skills
CO1, CO6, and CO7 are mapped as modern biological analysis and molecular techniques involve instrumentation, digital data acquisition, and interpretation of technologically generated results.

PO10: Multicultural competence, inclusive spirit, and empathy
CO7 is mapped as diagnostic and molecular techniques contribute to healthcare, disease detection, and societal well-being across diverse populations.

PO11: Value inculcation and environmental awareness
CO1–CO7 are mapped moderately because safe laboratory practices, ethical handling of biological samples, and responsible scientific conduct are integral to the course.

PO12: Autonomy, responsibility, and accountability
CO2–CO6 are strongly mapped as independent handling of specimens, instruments, chemicals, and biological samples requires responsibility, precision, and accountability.

PO13: Community engagement and service
CO7 is mapped because applications of biotechnology and diagnostics contribute to public health awareness, disease prevention, and community-oriented services.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Theory
Course Code: ZOO-302-MRM
Course Name: Genetics
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Define and differentiate classical and modern Gene, Cistron, Muton, Recon, Replicon concepts.
- Categorize gene mutations, including spontaneous, induced, somatic, gametic, forward and reverse mutations, and point mutations.
- Explain the principles of Non-Mendelian Inheritance, focusing on cytoplasmic inheritance and extra-nuclear (mitochondrial) inheritance, and how they differ from classical Mendelian genetics.
- Explain basic population genetics concepts: Mendelian population, gene pool, gene frequency, chance mating, and Hardy-Weinberg law equilibrium.
- Define and explore linkage and crossing over, covering types of linkage, types of crossing over, and the mechanism and molecular basis of recombination.
- Present evidence supporting DNA as genetic material, along with describing chromatin structure.
- Analyze patterns of human inheritance through pedigree construction and interpretation, understanding autosomal, sex-linked, and mitochondrial inheritance patterns.

Course Outcomes:-

Student will be able to

CO1: differentiate classical and modern gene concepts, including cistrons, mutons, recons, and replicons.
CO2: classify and understand gene mutations, distinguishing spontaneous, induced, somatic, and gametic mutations. Identify point mutation types.
CO3: understand the impact of extra-nuclear inheritance and how it differs from Mendelian inheritance patterns.
CO4: apply population genetics principles, including Mendelian populations, gene pools, gene frequencies, and Hardy-Weinberg equilibrium.
CO5: explain linkage and crossing over, categorizing linkage types and understanding the molecular basis of recombination.
CO6: analyze DNA and RNA as genetic material, understanding chromatin structure and examples like Griffith's, Avery et al, and Hershey-Chase experiments.
CO7: construct and analyze a family pedigree to identify the mode of inheritance (autosomal and mitochondrial) for a specific trait.

TOPICS:

UNIT	SUBUNIT	SYLLABUS	NO. OF LECTURES
1	**Introduction to genetics:**		02
	1.1	Classical and Modern concepts of Gene, Cistron, Muton, Recon, Replicon	
2	**Non-Mendelian inheritance**		02
	2.1	Cytoplasmic inheritance	
3	**Gene Mutation**		06
	3.1	Definition Types of mutations: spontaneous, induced, somatic, gametic, forward, and reverse mutation Point mutation & Types: deletion, insertion, Frameshift, substitution, transversion, transition	
	3.2	Mutagenic agents: Physical Mutagen: UV radiation and ionizing radiation Chemical Mutagen: Base analogs, alkylating and intercalating agents	
4	**Population Genetics**		04
	4.1	Basic Concepts in population genetics: Mendelian population, gene pool, gene frequency, chance mating (Panmictic mating), Hardy-Weinberg's law and its applications	
5	**Linkage and crossing over**		05
	5.1	Types of Linkage, crossing over & its types, mechanism, and molecular basis of recombination (Holiday model)	
6	**The Genetic material**		02
	6.1	DNA as genetic material- evidences (Griffith's, Avery *et al*, and Hershey-Chase experiment)	
7	**Chromatin Structure-**		03
	7.1	Heterochromatin (Example Barr bodies), Euchromatin, histones, nucleosome arrangement, packaging of DNA	
8	**Introduction to Human Genetics**		06
	8.1	Definition, Pedigree- gathering family history, pedigree symbols, construction of pedigrees, Autosomal inheritance-Dominant & Recessive, Sex linked inheritance	

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Course Articulation Matrix of ZOO-302-MRM: Genetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	3	3	2	3	2	1	1	2	2	1
CO2	3	3	2	3	3	2	3	2	1	1	2	2	1
CO3	3	2	2	3	3	1	3	2	1	1	2	2	1
CO4	3	2	2	3	3	2	3	3	1	1	2	2	2
CO5	3	3	2	3	3	2	3	2	1	1	2	2	1
CO6	3	3	2	3	3	2	3	3	1	1	2	2	1
CO7	3	2	2	3	3	3	3	2	1	1	2	2	2

PO1: Comprehensive knowledge and understanding
CO1–CO7 are mapped because genetics requires fundamental understanding of gene concepts, mutations, inheritance, linkage, and molecular biology.

PO2: Practical, professional, and procedural knowledge
CO2, CO5, and CO6 are mapped because understanding mutations, genetic material, and recombination involves experimental and analytical skills.

PO3: Entrepreneurial mind-set and knowledge
CO3 and CO7 are mapped as knowledge of genetic inheritance and pedigree analysis has applications in genetic counseling, biotechnology, and personalized medicine.

PO4: Specialized skills and competencies
CO1–CO7 are mapped because genetic studies require expertise in population genetics, gene frequency analysis, pedigree construction, and chromatin structure analysis.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1–CO7 are mapped because analyzing genetic phenomena, identifying inheritance patterns, and predicting genetic disorders require strong analytical and problem-solving skills.

PO6: Communication skills and collaboration
CO4, CO6, and CO7 are mapped since presenting findings, interpreting genetic patterns, and discussing family pedigrees require effective communication and teamwork.

PO7: Research-related skills
CO2, CO3, CO4, CO6, and CO7 are mapped as studying mutations, extra-nuclear inheritance, and molecular experiments demand research skills and data validation.

PO8: Learning how to learn skills
CO1–CO7 are mapped because genetics is a rapidly evolving field that requires continuous learning of new theories, technologies, and applications.

PO9: Digital and technological skills
CO5 and CO6 are mapped as bioinformatics tools, genetic databases, and molecular modeling software are essential for analyzing genetic data and predicting inheritance patterns.

PO10: Multicultural competence, inclusive spirit, and empathy
CO3 and CO7 are mapped since understanding diverse genetic traits, hereditary diseases, and genetic counseling promotes inclusivity and social responsibility.

PO11: Value inculcation and environmental awareness
CO4 and CO6 are mapped as genetic knowledge contributes to biodiversity conservation, ethical decision-making, and awareness of genetic impact on ecosystems.

PO12: Autonomy, responsibility, and accountability
CO1–CO7 are mapped because conducting genetic experiments, analyzing hereditary conditions, and making ethical genetic decisions require individual accountability and precision.

PO13: Community engagement and service
CO3, CO5, and CO7 are mapped since genetics plays a crucial role in public health awareness, genetic counseling, and educating communities about hereditary conditions.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Theory
Course Code: ZOO-303-MRM
Course Name: Biochemistry
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Differentiate between the different types of bonds (ionic, covalent, non-covalent) and explain their roles in the structure and function of biomolecules.
- Classify carbohydrates based on their structure and complexity (monosaccharides, disaccharides, polysaccharides).
- Describe the classification of amino acids, including the functional groups and side chains.
- Explain the crucial roles of proteins in various biological processes, including catalysis, transport, and immune response.
- Classify enzymes based on their substrate specificity and reaction type.
- Describe the components of nucleic acids (nucleotides, nucleosides, nitrogenous bases, pentose sugars).
- Apply the knowledge of basic biochemistry to real-world situations, such as interpreting laboratory results, understanding the basis of medical treatments, and analyzing the impact of environmental factors on biological processes.

Course Outcomes:-

Student will be able to-

CO1: analyze and differentiate between ionic, covalent, and non-covalent bonds, explaining their contributions to the stability of various biomolecules (proteins, carbohydrates, lipids and nucleic acids).

CO2: classify carbohydrates as monosaccharides, disaccharides, and polysaccharides based on their structural composition, size, and complexity. Apply this knowledge to understand the functional roles of different carbohydrates in cells and organisms.

CO3: explain the structure of amino acids, including the central core, functional groups, and diverse side chains. Relate this structure to the classification of amino acids (polar, non-polar, acidic, basic) and their specific properties.

CO4: evaluate the diverse roles of proteins in biological processes like catalysis (enzyme action), transport, and immune response. Analyze the relationship between protein structure and function.

CO5: categorize enzymes based on their substrate specificity (lock-and-key model) and reaction type (oxidation, reduction, hydrolysis etc.). Apply this knowledge to interpret enzyme activity in metabolic pathways and drug action.

CO6: deconstruct the components of nucleic acids (nucleotides, nucleosides, nitrogenous bases, pentose sugars), understanding their assembly and roles in DNA and RNA structures.

CO7: bridge the gap between theoretical biochemistry and real-world applications by interpreting laboratory results related to biomolecules, analyzing the rationale behind medical treatments targeting specific biochemical processes, and evaluating the impact of environmental factors on cellular biochemistry.

TOPICS:

UNIT	SUBUNIT	SYLLABUS	NO.OF LECTURES
1	**Basic Biochemistry:**		06
	1.1	Chemical Bonds: Types: covalent & non-covalent bonds - hydrogen, ionic, hydrophobic, electrostatic, Van der Waal forces, dipole interactions and their functions in biomolecules.	
	1.2	Structure of water molecule - Liquid and ice	
	1.3	Physico-chemical properties of water.	
	1.4	Concept of acid and base, pH, Sorenson's scale, derivation of Concept of Buffer, titration curve, Henderson–Hasselbalch equation, and its applications	
2	**Carbohydrates:**		04
	2.1	Definition and classification of carbohydrates	
	2.2	Isomerism in carbohydrates- Structural and stereoisomerism.	
	2.3	Biological significance of carbohydrates.	
3	**Proteins:**		05
	3.1	Essential and non-essential amino acids	
	3.2	Classification of amino acids	
	3.3	Peptide bond, types of proteins, Protein structures - primary, secondary, tertiary and quaternary structure with suitable examples	
	3.4	Bonds stabilizing the protein structure	
	3.5	Biological significance of proteins	
4	**Lipids:**		05
	4.1	Introduction, classification of lipids	
	4.2	Clinical significance – Obesity & atherosclerosis	
	4.3	Biological significance of lipids	
5	**Enzymes:**		05
	5.1	Classification and properties of enzymes	
	5.2	Factors influencing enzyme activity - pH, temperature, substrate concentration & enzyme concentration	
	5.3	Enzyme kinetics & Michaelis-Menten equation	
6	**Nucleic Acids:**		05
	6.1	Introduction, definition, nitrogen bases, pentose sugar, nucleosides, nucleotides.	
	6.2	DNA: Watson & Crick's model, Comparative study of DNA: A, B & Z; Chargaff's rule.	
	6.3	RNA: Types & structure- mRNA, rRNA, tRNA	

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Course Articulation Matrix of ZOO-303-MRM: Biochemistry
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	3	3	2	2	3	2	1	2	2	1
CO2	3	2	2	3	3	2	2	3	2	1	2	2	1
CO3	3	2	2	3	3	2	2	3	2	1	2	2	1
CO4	3	3	2	3	3	2	3	3	2	1	2	2	1
CO5	3	3	2	3	3	2	3	3	2	1	2	2	1
CO6	3	2	2	3	3	2	3	3	2	1	2	2	1
CO7	3	3	2	3	3	2	3	3	2	1	2	3	2

PO1: Comprehensive knowledge and understanding
CO1 – CO7 are mapped to PO1 as they provide fundamental biochemical knowledge, including molecular interactions, biomolecule classification, enzyme mechanisms, and nucleic acid structure.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO4, CO5, CO6, and CO7 are mapped to PO2 because they involve hands-on biochemical concepts such as laboratory techniques, enzyme kinetics, and biomolecule analysis.

PO3: Entrepreneurial mindset and knowledge
CO4, CO5, and CO7 are mapped to PO3 because understanding protein functions, enzyme applications, and biochemical problem-solving skills can lead to innovations in biotechnology, pharmaceuticals, and healthcare entrepreneurship.

PO4: Specialized skills and competencies
CO1 – CO7 are mapped to PO4 because mastering biochemical concepts requires a specialized understanding of molecular interactions, enzymatic reactions, and metabolic pathways, which are crucial for research and industry applications.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1 – CO7 are mapped to PO5 as they involve the application of biochemical principles to understand metabolism, enzyme activity, and biomolecular interactions, which require strong problem-solving abilities.

PO6: Communication skills and collaboration
CO4, CO6, and CO7 are mapped to PO6 as students need to interpret biochemical results, collaborate on experiments, and present findings in scientific discussions.

PO7: Research-related skills
CO1 – CO7 are mapped to PO7 since the course includes experimental techniques, enzyme assays, biomolecule analysis, and understanding biochemical pathways, which are crucial for research in medical and environmental sciences.

PO8: Learning how to learn skills
CO1 – CO7 are mapped to PO8 as students develop independent learning skills, engage with biochemical literature, and apply theoretical concepts in experimental settings.

PO9: Digital and technological skills
CO1 – CO7 are mapped to PO9 because biochemical research relies on computational tools, databases, and laboratory instruments for data analysis and molecular modeling.

PO10: Multicultural competence, inclusive spirit, and empathy
CO4 – CO7 are partially mapped to PO10 as biochemistry is applied in healthcare and environmental sciences, where understanding global perspectives and ethical considerations is important.

PO11: Value inculcation and environmental awareness
CO4 – CO7 are mapped to PO11 as biochemical principles help address environmental issues, sustainability in biotechnology, and ethical practices in scientific research.

PO12: Autonomy, responsibility, and accountability
CO1 – CO7 are mapped to PO12 because students develop independent research skills, follow ethical guidelines in biochemical experiments, and take responsibility for scientific accuracy.

PO13: Community engagement and service
CO7 is strongly mapped to PO13 as biochemical knowledge is applied in medical diagnostics, nutritional science, and environmental sustainability projects that benefit society.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Theory
Course Code: ZOO-304-MRM
Course Name: Mammalian Histology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Gain a comprehensive understanding of the principles and techniques of histology, including tissue processing, microscopy, and staining methods.
- Differentiate and describe the structure, function, and location of various epithelial tissues (simple, stratified, transitional) and their subtypes.
- Classify and analyze the diverse range of connective tissues (proper, loose, dense, and reticular) with emphasis on their components, organization, and roles in different organs.
- Distinguish and explain the functional features of striated, smooth, and cardiac muscle tissues, including their cellular organization and contractile mechanisms.
- Identify and understand the types of neurons (multipolar, bipolar, and pseudounipolar) and non-medullated and medullated nerve fibers, recognizing their significance in neural transmission.
- Perform detailed histological analyses of major organs (skin, alimentary canal, respiratory system, kidneys, and reproductive organs) through micrographs, interpreting normal structure and potential pathological alterations.
- Apply histological knowledge to identify and comprehend the microscopic features of common cancers (colon, lung, and uterus) for diagnostic purposes and to understand their potential origins and progression.

Course Outcomes:-

Student will be able to-

CO1: demonstrate proficiency in tissue processing techniques, microscopy operation (including light and electron microscopy), and various staining methods used to visualize different tissue components.
CO2: differentiate and describe the structure, function, and location of various epithelial tissues (simple, stratified, transitional) and their subtypes (squamous, columnar, cuboidal, etc.), understanding their roles in different organ systems.
CO3: classify and analyze the diverse range of connective tissues (proper, loose, dense, reticular) with a thorough grasp of their components (fibers, cells, ground substance), organization patterns, and specific functions within various organs.
CO4: distinguish & explain the functional features of striated, smooth, & cardiac muscle tissues, including their cellular organization, contractile mechanisms, & roles in movement and organ function.
CO5: identify and understand the types of neurons (multipolar, bipolar, pseudounipolar) and non-medullated and medullated nerve fibers, recognizing their significance in neural transmission and information processing.
CO6: perform detailed histological analyses of major organs (skin, alimentary canal, respiratory system, kidneys, and reproductive organs) through micrographs, interpreting normal structures and potential pathological alterations, correlating them to functional consequences.
CO7: apply histological knowledge to identify & comprehend the microscopic features of endocrine glands.

TOPICS:

UNIT NO	SUBUNIT NO.	SYLLABUS	NO. OF LECTURES
1	**Introduction**		01
	1.1	Definition and scope of histology	
	1.2	Applications of histology	
2	**Tissues**		04
	2.1	Epithelial tissue	
	2.2	Connective tissue	
	2.3	Muscle tissue	
	2.4	Nervous tissue	
3	**Histological study of following organs:**		19
	3.1	Skin & tooth	
	3.2	Tongue: Mucosa papillae and taste buds	
	3.3	Alimentary canal: Basic histological organization with reference to T. S of oesophagus, stomach, duodenum, ileum and rectum	
	3.4	Associated digestive glands: Basic histological organization with reference to T.S. of liver and pancreas	
	3.5	Respiratory organs: T. S of trachea and lung	
	3.6	Blood vessels: T.S. of artery and vein	
	3.7	L. S. of Kidney; Juxtaglomerular complex	
	3.8	Reproductive organs: T. S. of testis and ovary	
4	**Histology of endocrine glands:**		06
	4.1	Pituitary gland	
	4.2	Thyroid gland	
	4.3	Adrenal gland	

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Course Articulation Matrix of ZOO-304-MRM: Mammalian Histology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	2	3	2	3	2	2	1	2	1	1
CO2	3	2	1	3	3	2	2	2	1	1	1	1	1
CO3	3	2	1	3	2	1	3	2	1	1	1	1	1
CO4	3	2	1	3	3	1	2	2	1	1	1	1	1
CO5	3	2	1	3	3	1	2	2	1	1	1	1	1
CO6	3	3	1	3	3	2	3	3	2	2	2	2	2
CO7	3	2	1	3	3	1	3	2	2	1	2	1	2

PO1: Comprehensive knowledge and understanding
CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly mapped to PO1 because understanding tissue processing techniques, microscopy, histological structures, staining methods, and endocrine tissue analysis is fundamental to mastering histology.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO3, CO5, CO6 & CO7 are directly mapped to PO2 because practical skills in microscopy operation, tissue sectioning, staining procedures, and histopathological analysis are essential for laboratory-based histological studies.

PO3: Entrepreneurial mindset and knowledge
CO4, CO7 are directly mapped to PO3 because expertise in histological processing and molecular techniques (such as PCR and blotting) has applications in diagnostic pathology, biotechnology startups, and forensic investigations.

PO4: Specialized skills and competencies
CO1, CO2, CO3, CO4 & CO6 are directly mapped to PO4 because mastering tissue identification, microscopy techniques, histological processing, and staining methods requires precision and technical expertise critical for clinical and research applications.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO5 because troubleshooting tissue processing errors, analyzing histological sections, and interpreting staining results require critical thinking and problem-solving skills.

PO6: Communication skills and collaboration
CO4, CO6 & CO7 are directly mapped to PO6 because presenting histological findings, documenting tissue staining results, and collaborating on laboratory-based research require effective communication and teamwork.

PO7: Research-related skills
CO2, CO3, CO4, CO6 & CO7 are directly mapped to PO7 because conducting histological studies, utilizing microscopy techniques, applying staining principles, and analyzing molecular methods are essential for biomedical research and clinical investigations.

PO8: Learning how to learn skills
CO1, CO2, CO5 & CO6 are directly mapped to PO8 because acquiring expertise in histological techniques, continuously improving tissue staining proficiency, and adapting to new laboratory protocols promote lifelong learning.

PO9: Digital and technological skills
CO7 is directly mapped to PO9 because molecular biology techniques like PCR and blotting rely on

computational tools, digital imaging, and advanced laboratory equipment.

PO10: Multicultural competence, inclusive spirit, and empathy
CO1, CO2, CO3, CO4, CO5 & CO6 are directly mapped to PO10 because biological and medical research requires ethical considerations, collaboration across diverse teams, and sensitivity to patient-oriented histopathological analysis.

PO11: Value inculcation and environmental awareness
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO11 because safe laboratory practices, ethical tissue handling, and minimizing environmental impact through responsible chemical usage are essential for sustainable biological research.

PO12: Autonomy, responsibility, and accountability
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO12 because maintaining histological precision, ensuring accuracy in staining and microscopy, and handling laboratory equipment responsibly require accountability in research and clinical settings.

PO13: Community engagement and service
CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly mapped to PO13 because histological techniques and biomedical research contribute to healthcare advancements, diagnostic pathology, and community-based medical awareness programs.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Practical
Course Code: ZOO-305-MRM
Course Name: Zoology Practical - V
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop competence in maintaining laboratory records, accurate observation, scientific data interpretation, and ethical practices during biological experimentation.
- To familiarize students with the principles and working of essential laboratory instruments used in biological and genetic analysis.
- To develop hands-on skills in separation, detection, and analysis of biomolecules using standard biochemical techniques.
- To train students in histological techniques including tissue collection, fixation, sectioning, staining, and permanent slide preparation.
- To impart practical understanding of optical and quantitative analytical methods used in biological experiments.
- To enhance competency in genetic analysis through experimental verification of classical genetic laws and linkage analysis.
- To introduce cytogenetic techniques and molecular visualization methods for studying chromosome structure and nucleic acids.

Course Outcomes:-

Student will be able to

CO1: maintain proper laboratory records, make accurate observations, interpret experimental data scientifically, and adhere to ethical and safety practices during biological experimentation.

CO2: explain the principles and demonstrate the working of essential laboratory instruments used in biological and genetic analysis.

CO3: perform separation, detection, and analysis of biomolecules using standard biochemical techniques such as chromatography, electrophoresis, and staining methods.

CO4: collect biological tissues, apply appropriate fixation methods, and prepare histological sections, stained slides, and permanent mounts for microscopic examination.

CO5: apply optical and quantitative analytical methods to experimentally verify biological laws and analyze absorbance-based data accurately.

CO6: analyze genetic data to determine linkage, crossing over, and population genetic equilibrium through experimental verification of classical genetic laws.

CO7: demonstrate cytogenetic and molecular visualization techniques to study chromosome structure and nucleic acids using appropriate laboratory methods.

Practicals:

Practical No.	Name of the practical	E/D	Teaching Hours
1.	Principle & working of Camera Lucida	E	4
2.	Separation of amino acid by paper chromatography	E	4
3.	Separation of DNA by using Agarose gel electrophoresis	E/D	8

4.	Tissue collection, fixation and Block making	E	8
5.	Sectioning, staining & mounting (Submission of two permanent slides from any two different organs)	E	8
6.	Experimental verification of Beer's and Lambert's Law	E	4
7.	PCR – Principle, Steps & Applications	D	4
8.	Quantitative estimation of carbohydrates by Anthrone method	E	4
9.	Determination of linkage and cross over analysis through two point test cross	E	4
10.	To study the Hardy-Weinberg law with suitable recording of genetic traits	E	4
11.	Culturing of *Drosophila*	E	4
12.	Study of life cycle and sexual dimorphism of *Drosophila*	E	
13.	Temporary preparation of polytene chromosome from suitable material	E	4
14.	Study of pedigree symbols and nomenclature	D	4
15.	Pedigree analysis to identify mode of inheritance	E	4
16.	Solving numerical pedigree problems	E	4
E – Experimental		**D- Demonstrative**	

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Course Articulation Matrix of ZOO-305-MRM: Zoology Practical - V
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	2	2	1	1	2	1	1	2	3	1
CO2	3	3	1	2	2	1	1	1	2	1	1	2	1
CO3	3	3	1	3	2	1	2	1	2	1	1	2	1
CO4	3	3	1	3	2	1	2	1	1	1	1	2	1
CO5	3	3	1	2	3	1	2	1	2	1	1	2	1
CO6	3	2	1	2	3	1	3	1	1	1	1	2	1
CO7	3	3	1	3	2	1	3	1	2	1	1	2	1

PO1: Comprehensive knowledge and understanding
All COs are directly mapped to PO1 because the practical course develops a strong conceptual foundation in laboratory techniques, biomolecular analysis, histology, genetics, cytogenetics, and experimental biology, which are essential for comprehensive understanding in applied zoology.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO3, CO4, CO5, and CO7 are directly mapped to PO2 because the course emphasizes hands-on

laboratory practices, correct use of instruments, biochemical separation techniques, histological preparations, and adherence to professional laboratory procedures.

PO3: Entrepreneurial mindset and knowledge
All COs show low-level mapping to PO3 as the acquired practical skills in biomolecule analysis, genetics, and histology can be indirectly applied in biotechnology laboratories, diagnostic centers, research startups, and applied biological services.

PO4: Specialized skills and competencies
CO1, CO3, CO4, CO5, and CO7 are directly mapped to PO4 because the course develops specialized laboratory skills such as chromatography, electrophoresis, microscopy, tissue processing, cytogenetic techniques, and molecular visualization methods.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, CO3, CO5, and CO6 are directly mapped to PO5 because students apply experimental principles, analyze quantitative data, interpret genetic results, verify biological laws, and solve experimental problems using analytical reasoning.

PO6: Communication skills and collaboration
All COs show indirect mapping to PO6 as students maintain laboratory records, discuss experimental observations, work collaboratively during practical sessions, and communicate results through practical records and viva examinations.

PO7: Research-related skills
CO3, CO4, CO5, CO6, and CO7 are directly mapped to PO7 because the course introduces research-oriented techniques such as biomolecular separation, genetic analysis, cytogenetics, data interpretation, and experimental validation.

PO8: Learning how to learn skills
CO1, CO2, CO3, and CO6 are directly mapped to PO8 as the course promotes continuous learning through experimental observation, interpretation of results, self-correction, and adaptation of laboratory techniques.

PO9: Digital and technological skills
CO2, CO3, CO5, and CO7 are directly mapped to PO9 because students use modern laboratory instruments, electrophoresis units, colorimeters, microscopes, and molecular visualization tools that require technological proficiency.

PO10: Multicultural competence, inclusive spirit, and empathy
All COs show indirect mapping to PO10 as ethical laboratory conduct, biosafety practices, and responsible handling of biological material foster inclusivity, sensitivity, and respect for life sciences across diverse contexts.

PO11: Value inculcation and environmental awareness
CO1, CO3, CO6, and CO7 are directly mapped to PO11 because ethical experimentation, biosafety, responsible disposal of biological waste, and sustainable laboratory practices promote value-based and environmentally responsible scientific behavior.

PO12: Autonomy, responsibility, and accountability
CO1, CO2, CO4, CO5, CO6, and CO7 are directly mapped to PO12 as students independently perform experiments, maintain records, ensure accuracy, and take responsibility for laboratory outcomes.

PO13: Community engagement and service
All COs show indirect mapping to PO13 as practical knowledge in genetics, biomolecules, and cytogenetics contributes to applications in healthcare, diagnostics, education, and community-based biological services.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Mandatory) Practical
Course Code: ZOO-306-MRM
Course Name: Zoology Practical - VI
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop the ability to identify, observe, and differentiate various epithelial tissues and organ systems using temporary and permanent histological preparations.
- To train students in the preparation, staining, and microscopic examination of cells, tissues, nerve fibres, muscle fibres, and blood components.
- To impart practical knowledge of histological reagents, stains, and laboratory techniques used in tissue and cellular studies.
- To develop skills in basic hematological techniques including blood smear preparation and quantitative analysis of blood components.
- To introduce biochemical techniques for preparation, standardization, and quantitative estimation of biologically important molecules.
- To enable students to experimentally study enzyme activity and the influence of physical and chemical factors on enzymatic reactions.
- To enhance competency in separation, detection, and estimation of biomolecules using chromatographic and colorimetric methods.

Course Outcomes:-

Student will be able to

CO1: identify and differentiate epithelial tissues, organs, and glandular structures using temporary and permanent histological slides.
CO2: prepare and microscopically examine squamous cells, nerve fibres, muscle fibres, and blood smears using appropriate staining techniques.
CO3: prepare commonly used histological reagents and stains and apply them correctly in tissue and cellular studies.
CO4: perform hematological experiments including blood smear preparation and platelet count with accuracy and proper laboratory practices.
CO5: prepare and standardize acids and alkalis and estimate carbohydrates, glucose, glycogen, and proteins from biological samples using biochemical methods.
CO6: study enzyme activity experimentally and analyze the effects of pH, temperature, and inhibitors on salivary amylase.
CO7: separate and detect biomolecules such as amino acids, sugars, and lipids using chromatographic techniques and qualitative chemical tests.

Practicals:

Practical No.	Name of the practical	E/D	Teaching Hours
1.	Study of preparation of standard acid and alkali and its standardization	E	4
2.	To study the effect of pH, temperature and inhibition on salivary amylase	E	4

3.	Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests	E	4
4.	Estimation of total Glucose from blood sample	E	4
5.	Estimation of proteins from suitable biological sample by Lowry's method	E	4
6.	Separation of amino acids by thin layer chromatography	E	4
7.	To detect the presence of amino acids in the given samples by Ninhydrin test.	E	4
8.	Study of epithelial tissues using permanent slides	D	4
9.	Study of squamous cells from buccal mucosa	E	4
10.	Temporary mounting of medullated nerve fibre and striated muscle fibre	E	4
11.	Study of permanent histological slides of skin, tooth, tongue, stomach, duodenum, ileum, liver and pancreas	D	4
12.	Study of permanent histological slides of trachea, lung, kidney, testis, ovary, thyroid and adrenal gland	D	4
13.	Study and preparation of different reagents / stains for histology	D/E	4
14.	Preparation of human blood smear to observe different cells	E	4
15.	To perform platelet count	E	4

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Course Articulation Matrix of ZOO-306-MRM: Zoology Practical - VI
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	2	1	1	2	1	1	1	2	1
CO2	3	3	1	3	2	1	2	1	1	1	1	2	1
CO3	2	3	1	2	1	1	1	1	1	1	2	2	1
CO4	3	3	1	2	2	1	2	1	1	1	1	3	1
CO5	3	3	2	2	3	1	2	1	2	1	1	2	1
CO6	3	2	1	2	3	1	3	2	1	1	1	2	1
CO7	3	3	2	3	2	1	3	1	2	1	1	2	1

PO1: Comprehensive knowledge and understanding
All COs are directly mapped to PO1 because the course builds strong conceptual understanding of epithelial tissues, organ histology, hematology, enzyme activity, biochemical estimations, and biomolecular separation techniques, which form the foundation of applied biological sciences.

PO2: Practical, professional, and procedural knowledge
CO2, CO3, CO4, CO5, and CO7 are directly mapped to PO2 because the course emphasizes hands-on laboratory skills such as slide preparation, staining, reagent preparation, hematological techniques, biochemical estimations, and chromatographic procedures.

PO3: Entrepreneurial mindset and knowledge
CO5 and CO7 are directly mapped to PO3 because biochemical estimations, enzyme studies, and chromatographic techniques have applications in diagnostic laboratories, food industries, pharmaceuticals, and biotechnology-based entrepreneurial ventures.

PO4: Specialized skills and competencies
CO1, CO2, CO4, and CO7 are directly mapped to PO4 as they involve specialized microscopic skills, histological identification, hematological analysis, and chromatographic separation techniques requiring technical competence.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO4, CO5, and CO6 are directly mapped to PO5 because students analyze histological structures, interpret hematological data, perform quantitative biochemical estimations, and evaluate the effects of variables on enzyme activity.

PO6: Communication skills and collaboration
All COs show indirect mapping to PO6 as students record observations, discuss experimental outcomes, work in laboratory groups, and communicate findings during practical examinations and viva-voce.

PO7: Research-related skills
CO2, CO4, CO5, CO6, and CO7 are directly mapped to PO7 because the course introduces experimental design, data interpretation, enzyme kinetics, biochemical analysis, and chromatographic techniques that form the basis of biological research.

PO8: Learning how to learn skills
CO1, CO3, and CO6 are directly mapped to PO8 as repeated laboratory practice, error analysis, and experimental observation encourage self-learning and continuous skill development.

PO9: Digital and technological skills
CO5 and CO7 are directly mapped to PO9 because biochemical estimations, colorimetric analysis, and chromatography require the use of laboratory instruments and technological tools for data generation and interpretation.

PO10: Multicultural competence, inclusive spirit, and empathy
All COs show indirect mapping to PO10 as ethical handling of biological samples, human blood, and laboratory safety practices promote respect for life and inclusive scientific responsibility.

PO11: Value inculcation and environmental awareness
CO3, CO4, and CO6 are directly mapped to PO11 because proper reagent handling, biosafety, waste disposal, and responsible experimentation encourage ethical values and environmental consciousness.

PO12: Autonomy, responsibility, and accountability
CO1, CO4, CO5, CO6, and CO7 are directly mapped to PO12 as students independently perform experiments, maintain accuracy, follow safety protocols, and take responsibility for experimental outcomes.

PO13: Community engagement and service
CO4 and CO5 are indirectly mapped to PO13 because hematological tests and biochemical estimations have applications in healthcare diagnostics and community health services.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Elective) Theory
Course Code: ZOO-307 MJE (A)
Course Name: Cell Biology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Introduce the fundamental concepts of cell biology, including the differences between prokaryotic and eukaryotic cells.
- To understand the structure, composition, and models of biological membranes, along with their transport mechanisms.
- Study the structure and functions of major cell organelles, such as the endoplasmic reticulum, Golgi complex, lysosomes, and mitochondria.
- Explore the organization and functions of the nucleus, including nuclear membrane, pore complexes, nucleolus, and nucleo-cytoplasmic interactions.
- Analyze the cytoskeletal components (microfilaments, intermediate filaments, and microtubules) and their roles in cellular structure and function.
- To examine the cell cycle, cell division mechanisms (mitosis & meiosis), and their regulation, including checkpoints and the role of centrioles.
- Understand cellular ageing, apoptosis, necrosis, and modern techniques in animal cell culture, including stem cell research and applications.

Course Outcomes:-

Student will be able to-

CO1: explain the fundamental concepts of cell biology, including the structure and differences between prokaryotic and eukaryotic cells.
CO2: describe the structure, composition, and models of biological membranes, along with the mechanisms of passive and active transport.
CO3: identify and explain the structure and functions of major cell organelles such as the endoplasmic reticulum, Golgi complex, lysosomes, and mitochondria.
CO4: analyze the ultrastructure of the nucleus, nuclear membrane, pore complexes, nucleolus, and their role in nucleo-cytoplasmic interactions.
CO5: illustrate the components of the cytoskeleton (microfilaments, intermediate filaments, and microtubules) and their functional significance.
CO6: demonstrate an understanding of the cell cycle, mitosis, meiosis, cell division checkpoints, and the role of centrioles in cell regulation.
CO7: explain cellular ageing, apoptosis, necrosis, and the principles and applications of animal cell culture and stem cell research.

TOPICS:

UNIT	SUB UNIT	SYLLABUS	NO. OF LECTURES
1	**Introduction to Cell biology**		01
	1.1	Definition and scope	
	1.2	Prokaryotic and eukaryotic cell	
2	**Bio membrane system:**		03
	2.1	Fluid mosaic model	
	2.2	Membrane transport: Passive and active	
3	**Study of following cell organelles with respect to structure and functions in brief**		05
	3.1	Endoplasmic reticulum	
	3.2	Golgi complex	
	3.3	Lysosomes	
	3.4	Mitochondria	
	3.5	Ribosomes	
4	**Nucleus**		05
	4.1	Ultrastructure of nuclear membrane and pore complex	
	4.2	Nucleolus: General organization, chemical composition and functions	
	4.3	Nucleo-cytoplasmic interactions	
5	**Cytoskeleton: Structure and functions-** Microfilaments, intermediate filament, & microtubules		03
6	**Cell cycle and cell division**		05
	6.1	Phases of cell cycle; Mitosis and meiosis	
7	**Cellular ageing and cell death**		04
	7.1	Intracellular changes: Free radicals	
	7.2	Extra cellular changes	
	7.3	Cell death: Apoptosis & necrosis	
8	**Introduction to Cancer Biology**		02
	8.1	Characteristics of cancer cell; Types of cancers	
9	**Stem Cells: Introduction to stem cells & their potency**		02

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Course Articulation Matrix of ZOO-307 MJE (A): Cell Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	2	1	1	1	1	1	1	1	1
CO2	3	2	2	2	3	1	3	2	1	2	2	1	1
CO3	3	2	1	2	3	1	2	1	1	1	2	1	1
CO4	3	1	2	2	3	2	2	2	1	1	1	1	1
CO5	3	2	1	2	3	1	2	1	1	1	2	1	1
CO6	3	1	1	2	3	3	3	3	1	2	2	1	1
CO7	2	2	2	1	1	2	2	1	2	1	1	1	1

PO1: Comprehensive knowledge and understanding
All COs are directly mapped to PO1 because understanding the fundamental concepts of cell biology, including prokaryotic and eukaryotic cells, cell organelles, membrane structure, cytoskeleton, cell cycle, and cell death, is essential for developing a strong foundation in biological sciences.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO3, CO5 & CO7 are directly mapped to PO2 because practical knowledge of cell organelles, membrane transport, cytoskeleton, cell culture techniques, and experimental procedures is crucial for hands-on biological research and laboratory applications.

PO3: Entrepreneurial mindset and knowledge
CO4 & CO7 are directly mapped to PO3 because knowledge of nuclear structures, cell cycle regulation, apoptosis, necrosis, and stem cell research has potential applications in biotechnology, regenerative medicine, and biomedical entrepreneurship.

PO4: Specialized skills and competencies
CO1, CO2, CO3, CO4 & CO6 are directly mapped to PO4 because mastering cellular structures, membrane dynamics, nuclear interactions, and cell cycle checkpoints requires specialized knowledge and technical skills for biological experimentation and research.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO5 because analyzing cellular structures, understanding transport mechanisms, troubleshooting cell cycle abnormalities, and interpreting experimental results require critical thinking and problem-solving abilities.

PO6: Communication skills and collaboration
CO4, CO6 & CO7 are directly mapped to PO6 because presenting findings, discussing cell cycle checkpoints, apoptosis, and stem cell applications, and collaborating in research studies are essential for scientific communication and teamwork.

PO7: Research-related skills
CO2, CO4 & CO6 are directly mapped to PO7 because investigating membrane models, studying nuclear interactions, and analyzing cell division mechanisms involve research-based approaches essential for experimental biology.

PO8: Learning how to learn skills
CO1, CO2, CO3 & CO6 are directly mapped to PO8 because understanding fundamental cell structures, division processes, and cellular aging promotes continuous learning and adaptation in advanced biological studies.

PO9: Digital and technological skills
CO2, CO6 & CO7 are directly mapped to PO9 because using digital tools for cell imaging, analyzing cell

cycle progression, and applying technology in cell culture and stem cell research are crucial for modern biological sciences.

PO10: Multicultural competence, inclusive spirit, and empathy
CO2 & CO7 are directly mapped to PO10 because ethical considerations in stem cell research, biomedical applications, and understanding the global impact of cell biology research foster inclusivity and empathy in scientific studies.

PO11: Value inculcation and environmental awareness
CO3, CO6 & CO7 are directly mapped to PO11 because knowledge of cellular organization, cell division, and cell culture techniques contributes to ethical considerations in biological research and sustainable scientific practices.

PO12: Autonomy, responsibility, and accountability
CO1, CO4 & CO7 are directly mapped to PO12 because understanding cell structures, nuclear interactions, and apoptosis requires independent learning, responsible experimentation, and accountability in research methodologies.

PO13: Community engagement and service
CO6 & CO7 are directly mapped to PO13 because cell biology knowledge, particularly in cell division regulation and stem cell applications, has direct implications for healthcare, medical advancements, and societal well-being.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Elective) Theory
Course Code: ZOO-307 MJE (B)
Course Name: Ecology and Organic Evolution
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives: -

- To introduce students to the basic concepts, scope, and importance of ecology in understanding living organisms and their environment.
- To develop understanding of the structure, function, and types of ecosystems and their ecological processes.
- To explain the principles of population ecology, including population growth, regulation, and life-history strategies.
- To familiarize students with community structure, species interactions, and ecological succession.
- To provide knowledge about the origin of life, evolution of cells, and evidences supporting organic evolution.
- To explain the mechanisms of isolation, speciation, and evolutionary change leading to biodiversity.
- To introduce students to the geological time scale, evolution of man, and zoogeographical distribution of animals.

Course Outcomes: -

Student will be able to-

CO1: define and explain fundamental ecological terms such as ecology, autecology, synecology, and ecological niche.
CO2: describe the structure and functions of ecosystems, including food chains, food webs, ecological pyramids, and major biogeochemical cycles.
CO3: analyze population characteristics such as population density, dispersion, natality, mortality, survivorship curves, and r- and K-selection strategies.
CO4: explain community characteristics, various types of species interactions, and the process of ecological succession with suitable examples.
CO5: discuss the origin of life, evolution of eukaryotic cells, and evidences of organic evolution from anatomy, embryology, physiology, and paleontology.
CO6: understand the mechanisms of isolation and speciation, including pre-zygotic and post-zygotic isolating barriers and major types of speciation.
CO7: interpret the geological time scale, trace the evolutionary history of man, and recognize major zoogeographical realms along with their characteristic fauna.

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1	**Introduction to Ecology**		02
	1.1	Basic concept and scope of ecology	
	1.2	Definitions: Ecology, autecology, synecology.	
	1.3	Concept and types of niches	
2	**Ecosystem**		08

	2.1	Definition, Concept, structure and functions of ecosystem	
	2.2	Types of ecosystems: Forest, grassland, aquatic, desert & wetlands	
	2.3	Food chain, food web and Ecological pyramids	
	2.4	Biogeochemical cycle- Carbon, nitrogen.	
3	**Population Ecology**		03
	3.1	Concept of population & meta population, r- & k- selection	
	3.2	Density, dispersion, natality, mortality and survivorship curves	
4	**Community Ecology**		04
	4.1	Community Characteristics: keystone species, ecotone and edge effect	
	4.2	Species interactions: Mutualism, commensalism, amensalism, predation, competition, parasitism, mimicry, herbivory.	
	4.3	Ecological succession: Primary and secondary successions, stages of succession, examples of succession	
5	**Introduction and Origin of life**		06
	5.1	Origin of Biomolecules, Miller's experiment, origin of prokaryotic & eukaryotic cell (origin of mitochondria, plastids and symbionts.)	
	5.2	Evidences from: anatomy, embryology, paleontology, physiology.	
	5.3	Theories of Organic Evolution-Lamarckism, Darwinism, Modern Synthetic theory	
6	**Isolation and Speciation**		03
	6.1	Isolating mechanism, pre-zygotic and post-zygotic isolating mechanism.	
	6.2	Types of speciation (Allopatric and Sympatric), Factors influencing speciation	
7	**Geological Time Scale and evolution of man**		03
	7.1	Definition-Eras, Periods and Epochs, Notable changes in geographical time	
	7.2	Evolution of man	
8	**Zoo-Geographical Realms**		01
	8.1	Geographical regions and fauna	

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Course Articulation Matrix of ZOO-307-MJE (B): Ecology and Organic Evolution
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	2	1	1	1	2	1	1	2	1	1
CO2	3	2	1	3	3	1	2	2	1	1	3	2	2
CO3	3	2	1	2	3	1	2	2	1	1	2	2	1
CO4	3	2	2	3	3	2	2	2	1	2	3	2	2
CO5	3	1	1	2	2	1	2	2	1	1	2	1	1
CO6	3	2	1	2	3	1	2	2	1	1	2	2	1
CO7	3	1	2	1	2	2	1	1	1	2	2	1	2

PO1: Comprehensive knowledge and understanding
All COs are directly mapped to PO1 because the course provides fundamental and advanced knowledge of ecological principles, ecosystem functioning, population and community ecology, evolutionary theories, speciation, geological time scale, human evolution, and zoogeographical distribution.

PO2: Practical, professional, and procedural knowledge
CO2, CO3, CO4, and CO6 are directly mapped to PO2 because ecosystem analysis, population dynamics, community interactions, and speciation concepts are essential for professional applications in ecology, conservation biology, wildlife management, and environmental assessment.

PO3: Entrepreneurial mindset and knowledge
CO4 and CO7 are directly mapped to PO3 because understanding community ecology, succession, zoogeographical realms, and biodiversity distribution supports entrepreneurship in ecotourism, environmental consultancy, biodiversity conservation projects, and sustainable resource management.

PO4: Specialized skills and competencies
CO2, CO3, CO4, and CO6 are directly mapped to PO4 as the study of ecosystems, population regulation, species interactions, and speciation develops specialized analytical and interpretative skills necessary for ecological research and environmental sciences.

PO5: Capacity for application, problem-solving, and analytical reasoning
CO2, CO3, CO4, and CO6 are directly mapped to PO5 because analyzing ecosystem processes, population trends, community stability, and evolutionary mechanisms requires strong problem-solving and analytical reasoning abilities.

PO6: Communication skills and collaboration
CO4 and CO7 are directly mapped to PO6 as explaining ecological succession, species interactions, human evolution, and zoogeographical patterns requires effective scientific communication and collaborative discussions in academic and conservation settings.

PO7: Research-related skills
CO2, CO3, CO4, CO5, and CO7 are directly mapped to PO7 because ecological and evolutionary studies involve hypothesis formulation, data interpretation, evolutionary evidence analysis, and understanding large-scale biodiversity patterns.

PO8: Learning how to learn skills
CO1, CO2, CO3, CO5, and CO6 are directly mapped to PO8 because ecology and evolution are dynamic fields requiring continuous learning, conceptual integration, and adaptation to new scientific developments.

PO9: Digital and technological skills
CO3 is partially mapped to PO9 because population studies and survivorship analysis increasingly use statistical tools, ecological modelling, and digital datasets.

PO10: Multicultural competence, inclusive spirit, and empathy

CO4 and CO7 are directly mapped to PO10 because ecological balance, conservation ethics, human evolution, and biodiversity studies emphasize respect for life, cultural diversity, and inclusive environmental responsibility.

PO11: Value inculcation and environmental awareness
CO1, CO2, CO4, CO6, and CO7 are directly mapped to PO11 as the course promotes environmental ethics, conservation values, sustainable use of natural resources, and awareness of human impact on ecosystems.

PO12: Autonomy, responsibility, and accountability
CO2, CO3, CO4, and CO6 are directly mapped to PO12 because ecological and evolutionary studies demand responsible interpretation of data, independent thinking, and accountability in environmental decision-making.

PO13: Community engagement and service
CO2, CO4, and CO7 are directly mapped to PO13 because ecological knowledge, conservation awareness, human evolution studies, and zoogeography contribute directly to community education, biodiversity conservation, and sustainable development initiatives.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Elective) Practical
Course Code: ZOO-308 MJE (A)
Course Name: Practicals in Cell Biology
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives: -

- To familiarize students with the structure, function, and visualization of major cell organelles using microscopic and staining techniques.
- To develop practical understanding of cell division by studying mitosis and meiosis through permanent and temporary cytological preparations.
- To train students in the preparation and analysis of cytological slides including squashes, temporary mounts, and permanent preparations.
- To impart knowledge of chemical and physical factors affecting cell division and cell viability through experimental studies.
- To develop competence in the use of microscopes, micrometry, and microscopic measurements for cellular analysis.
- To introduce immunological and haematological techniques for studying cellular components and blood cell characteristics.
- To enhance understanding of chromosome organization, genetic material, and karyotype analysis using advanced cytogenetic methods.

Course Outcomes: -

Student will be able to-

CO1: identify and visualize cell organelles and cellular structures using appropriate staining methods, temporary mounts, and microphotographs.
CO2: recognize and differentiate various stages of mitosis and meiosis from permanent slides, squashes, and temporary cytological preparations.
CO3: prepare cytological slides such as onion root tip squashes, temporary mounts, and stained preparations for microscopic observation.
CO4: evaluate the effects of chemical agents, osmotic stress, and viability stains on cells during experimental studies.
CO5: operate simple and compound microscopes and perform micrometry to accurately measure microscopic cellular components.
CO6: demonstrate basic immunological and hematological techniques including antigen–antibody interaction, blood smear preparation, and differential leucocyte count.
CO7: analyze chromosome structure and number using polytene chromosome preparations and human karyotype photographs.

Practicals:

Sr. No.	Name of the Practical	E/D	Teaching Hours
1	To measure the length and breadth of the given cell sample by using micrometer	E	04
2	Visualization of bacterial cell by suitable method	E	04
3	Visualization of plant and animal cell	E	04
4	Preparation of onion root tip squash and observation of different stages of	E	04

	cell division		
5	Study of temporary preparation of different meiotic stages from grasshopper testes / onion floral bud	E	04
6	To study the effect of Colchicine on mitosis	E	04
7	To visualize chloroplasts in *Elodea* leaves	E / D	04
8	To study the effect of temperature on membrane permeability	E / D	04
9	Calculation of Mitotic index	E	04
10	To study the plasmolysis with the help of suitable material	E	04
11	To study the effect of alcohol and acetone on cell membrane	E	04
12	To study the role of stem cells in Planaria regeneration	E	04
13	Visualization of microtubules from suitable material	E	08
14	Study of Cell organelles by using electron microphotographs	D	04

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4. Cooper, G. M., & Hausman, R. E. (2019). *The Cell: A Molecular Approach* (8th ed.). Sinauer Associates.
5. Alberts, B. (2017). *Essential Cell Biology* (5th ed.). Garland Science.

Course Articulation Matrix of ZOO-308-MJE (A): Practical in Cell Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	1	3	2	1	1	2	1	1	1	2	1
CO2	3	2	1	3	3	1	2	2	1	1	1	2	1
CO3	2	3	1	3	2	1	2	1	1	1	1	2	1
CO4	3	2	1	2	3	1	2	1	1	1	2	2	1
CO5	2	3	1	3	2	1	1	1	2	1	1	2	1
CO6	3	3	2	2	2	2	2	1	1	1	2	2	1
CO7	3	2	2	3	3	1	3	2	1	1	1	2	1

PO1: Comprehensive knowledge and understanding
All COs are strongly mapped to PO1 because the course provides foundational and applied understanding of cell organelles, cell division, chromosome structure, immunology, hematology, and cytogenetics.

PO2: Practical, professional, and procedural knowledge
CO3, CO5, and CO6 are strongly mapped to PO2 as the course emphasizes hands-on laboratory skills including slide preparation, microscopy, micrometry, blood analysis, and immunological techniques.

PO3: Entrepreneurial mindset and knowledge
CO6 and CO7 are moderately mapped to PO3 because immunological assays, cytogenetic analysis, and diagnostic techniques have applications in clinical laboratories, biotechnology industries, and healthcare entrepreneurship.

PO4: Specialized skills and competencies
CO1, CO2, CO3, CO5, and CO7 are strongly mapped to PO4 since identification of organelles, analysis of mitosis and meiosis, cytological preparations, micrometry, and karyotype analysis require specialized technical competence.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO2, CO4, and CO7 are strongly mapped to PO5 as students analyze cell division abnormalities, interpret effects of chemical agents and osmotic stress, and evaluate chromosomal organization using cytogenetic data.

PO6: Communication skills and collaboration
CO6 is moderately mapped to PO6 because hematological and immunological experiments involve teamwork, result discussion, and presentation during practical sessions and viva-voce.

PO7: Research-related skills
CO2, CO4, CO6, and CO7 are strongly mapped to PO7 since cytological analysis, cell viability assays, immunological methods, and karyotype interpretation form the basis of experimental and research-oriented biology.

PO8: Learning how to learn skills
CO1, CO2, and CO7 are moderately mapped to PO8 as repeated observation, interpretation of stages, and chromosome analysis promote independent learning and conceptual reinforcement.

PO9: Digital and technological skills
CO5 is moderately mapped to PO9 because micrometry, microscope calibration, and image-based karyotype analysis require technological proficiency.

PO10: Multicultural competence, inclusive spirit, and empathy
All COs are indirectly mapped to PO10 due to ethical handling of human samples, respect for life forms, and responsible laboratory behavior.

PO11: Value inculcation and environmental awareness
CO4 and CO6 are moderately mapped to PO11 as safe handling of chemicals, biological samples, and laboratory waste promotes ethical values and environmental responsibility.

PO12: Autonomy, responsibility, and accountability
CO3, CO4, CO5, CO6, and CO7 are strongly mapped to PO12 because students independently perform experiments, ensure accuracy, follow biosafety norms, and take responsibility for results.

PO13: Community engagement and service
CO6 and CO7 are indirectly mapped to PO13 since blood analysis, immunological testing, and cytogenetic studies contribute to medical diagnostics and societal health services.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Major (Elective) Practical
Course Code: ZOO-308 MJE (B)
Course Name: Practicals in Ecology and Organic Evolution
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives: -

- To develop practical understanding of abiotic factors such as soil and water characteristics and their influence on ecosystems.
- To train students in quantitative and qualitative ecological methods for studying aquatic and terrestrial ecosystems.
- To familiarize students with biodiversity assessment techniques including plankton analysis and population sampling methods.
- To impart knowledge of evolutionary concepts through the study of fossils, connecting links, homologous and analogous organs, and adaptations.
- To enhance understanding of human evolution and comparative anatomy through morphological studies.
- To develop skills in interpreting evolutionary relationships and constructing phylogenetic trees using morphological data.
- To promote field-based learning, environmental awareness, and scientific reporting through ecosystem visits and biodiversity documentation.

Course Outcomes: -

Student will be able to-

CO1: identify and measure physical and chemical characteristics of soil and water samples and interpret their ecological significance.
CO2: estimate dissolved oxygen, primary productivity, and population parameters using standard ecological methods and analytical techniques.
CO3: assess biodiversity by studying zooplankton diversity, insect population attributes, and species associations in natural ecosystems.
CO4: explain evolutionary concepts by identifying fossils, connecting links, homologous and analogous organs, and adaptive features in animals.
CO5: compare morphological features of humans and apes and describe successive stages of human evolution based on fossil evidence.
CO6: construct and interpret phylogenetic trees using morphological characteristics to understand evolutionary relationships among organisms.
CO7: conduct field visits, record ecological and zoogeographical data, prepare scientific reports, and demonstrate environmental responsibility.

Practicals:

Sr. No.	Name of the Practical	E/D	Teaching Hours
1.	Study of physical characteristics of soil – texture, colour and temperature.	E	04
2.	Determination of pH of soil and water samples.	E	04

3.	Estimation of Dissolved Oxygen (DO) in water samples.	D/E	04
4.	Study of zooplankton diversity in a freshwater ecosystem.	E	04
5.	Estimation of primary productivity in an aquatic ecosystem using the Light and Dark Bottle Method.	E	04
6.	Determination of frequency, density and abundance of insects by Quadrat method.	E	04
7.	Study of phoretic association of species from the surrounding area.	E	04
8.	Study of types of fossils with the help of specimens / charts / photographs.	E	04
9.	Study of connecting links / transitional forms – *Euglena*, *Balanoglossus*, *Archaeopteryx*.	D	04
10.	Study of living fossils – *Peripatus* and *Sphaenodon*.	D	04
11.	Study of homologous organs: Forelimbs of Frog and Bird, Mouthparts of Cockroach and Mosquito, Serial homology in crustacean appendages	D	04
12.	Study of analogous organs: Vertebrate eye and Cephalopod eye, Wing of Bird and Insect	D	04
13.	Study of animal adaptations in: Turtle, *Draco*, *Exocoetus*, Bat and Parrot.	D	04
14.	Study of morphological similarities and differences between man and ape.	D	04
15.	Study of successive stages of evolution of man: a) *Australopithecus* b) *Homo erectus* c) *Homo neanderthalensis* d) Cro-Magnon man e) *Homo sapiens*	D	04
16.	Construction of phylogenetic tree using morphological characteristics.	D	04
17.	Recording zoogeographical distribution of animals in different realms on a world map (Any ten).	E	04
18.	Visit to a forest / grassland / aquatic ecosystem and submission of report	D	04

REFERENCES

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Course Articulation Matrix of ZOO-308-MJE (B): Practical in Ecology and Organic Evolution
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	1	2	3	1	2	1	1	1	2	2	1
CO2	3	3	2	2	3	1	3	1	2	1	2	2	1
CO3	3	3	2	2	3	1	3	1	1	1	2	2	1
CO4	3	2	1	3	2	1	2	2	1	1	1	1	1
CO5	3	1	1	2	3	1	2	2	1	1	1	1	1
CO6	3	2	2	3	3	1	3	2	1	1	1	2	1
CO7	3	2	2	2	2	2	3	2	1	2	3	3	3

PO1: Comprehensive knowledge and understanding
All COs are strongly mapped to PO1 because the course provides integrated understanding of ecology, biodiversity, evolution, human ancestry, and biogeography, forming a strong conceptual foundation in

biological sciences.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO3, and CO7 are strongly mapped to PO2 as students perform soil and water analysis, productivity estimation, biodiversity assessment, and field-based ecological studies using standard scientific procedures.

PO3: Entrepreneurial mindset and knowledge
CO2, CO3, CO6, and CO7 are moderately mapped to PO3 because ecological assessment, biodiversity documentation, environmental monitoring, and evolutionary interpretation have applications in environmental consultancy, wildlife management, and eco-tourism enterprises.

PO4: Specialized skills and competencies
CO4 and CO6 are strongly mapped to PO4 as evolutionary analysis, comparative anatomy, fossil interpretation, and phylogenetic tree construction require specialized analytical and conceptual skills.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO2, CO3, CO5, and CO6 are strongly mapped to PO5 because students analyze ecological data, population parameters, evolutionary trends, and morphological evidence to solve biological problems.

PO6: Communication skills and collaboration
CO7 is moderately mapped to PO6 because field visits, group observations, report writing, and presentations enhance teamwork and scientific communication skills.

PO7: Research-related skills
CO2, CO3, CO6, and CO7 are strongly mapped to PO7 as students apply research methods such as sampling, productivity estimation, biodiversity analysis, phylogenetic reconstruction, and scientific documentation.

PO8: Learning how to learn skills
CO4, CO5, and CO6 are moderately mapped to PO8 because evolutionary concepts and comparative studies promote self-learning and conceptual integration.

PO9: Digital and technological skills
CO2 and CO6 are moderately mapped to PO9 as data analysis, graphical representation, and phylogenetic interpretation may involve digital tools and software.

PO10: Multicultural competence, inclusive spirit, and empathy
CO7 is moderately mapped to PO10 because environmental studies, conservation awareness, and global biogeographical understanding foster respect for biodiversity and inclusive ecological responsibility.

PO11: Value inculcation and environmental awareness
CO1, CO2, CO3, and CO7 are strongly mapped to PO11 as the course emphasizes ecosystem conservation, sustainable resource use, and ethical environmental practices.

PO12: Autonomy, responsibility, and accountability
CO1, CO2, CO3, CO6, and CO7 are strongly mapped to PO12 because students independently conduct experiments, field observations, data analysis, and report preparation with accountability.

PO13: Community engagement and service
CO7 is strongly mapped to PO13 as field studies, ecological documentation, and environmental awareness activities directly contribute to community engagement and conservation initiatives.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: On Job Training
Course Code: ZOO-309- OJT
Course Name: On Job Training
Number of Credits: 04
Number of Teaching hours: 120

Course Objectives: -

- To provide students with hands-on exposure to real workplace environments relevant to their discipline of study.
- To bridge the gap between theoretical knowledge and practical application through structured industrial or institutional training.
- To develop technical skills and operational competence required for professional scientific work.
- To enhance students' problem-solving abilities and analytical thinking by engaging them in real-time tasks and projects.
- To inculcate professional ethics, discipline, safety awareness, and responsibility at the workplace.
- To improve communication skills, teamwork, and interpersonal abilities essential for professional growth.
- To prepare students for career readiness, employability, and higher research opportunities by providing industry-relevant experience.

Course Outcomes: -

Student will be able to-

CO1: demonstrate practical understanding of workplace functioning by actively participating in real professional environments relevant to their discipline.

CO2: apply theoretical concepts to practical situations during industrial or institutional training, thereby effectively integrating academic knowledge with real-world practice.

CO3: perform technical tasks efficiently by using appropriate tools, instruments, techniques, and standard operating procedures required for professional scientific work.

CO4: analyze real-time problems and propose logical solutions using critical thinking, analytical reasoning, and subject-specific knowledge.

CO5: adhere to professional ethics, safety protocols, discipline, and workplace responsibilities while carrying out assigned tasks during training.

CO6: communicate effectively and work collaboratively with supervisors and team members, demonstrating improved interpersonal skills and professional behavior.

CO7: assess career pathways and research opportunities, exhibiting enhanced employability skills, confidence, and readiness for professional or higher academic pursuits.

The filed OJT course would involve:

The On-Job Training Program will provide valuable work experience to the students, help them explore a career path and develop and refine skills that will eventually give themselves an edge in the job market. **OJT should start at V** semester and **will be assessed at the end of V semester**. The work during the OJT should be equivalent to minimum **120 hours** in the semester.

Framework of the On-Job Training:

1. The area in which a student has to undergo On-Job Training Program will be finalized by the concerned teacher in consultation with the On-Job Training Program providing organization.
2. This will help a student to have hands - on experience of the important aspects of the Discipline Specific Special Subject chosen by him / her.
3. The contents of the On-Job Training Program should be adequate and students should be able to understand various concepts and put it into practice within a time frame of 120 hours.
4. On-Job Training Program is of 120 hours net.

The student will prepare a plan for proposed On-Job Training Program. The plan may contain following aspects: -

Sr. No.	Particulars
1	Name of the organization where the On-Job Training is proposed to be carried out.
2	Details of the organization
3	The areas in which he/ she is planning to undergo On-Job Training.
4	Details of the various subject specific concepts learnt by the student before joining the On-Job Training.
5	Allocation of **120 hours** of On-Job Training Program.
6	List of the skills that he/she is planning to acquire during On-Job Training Program.
7	A brief note on how the On-Job Training Program may benefit him/her to develop better skills in his / her subject.
8	Details of the primary discussion that the student had with any officer/ authority of the On-Job Training Program providing organization about the proposed work.
9	Proposed outcome of the On-Job Training Program

Evaluation of OJT:

Particulars	Marks	Internal Examiner (50 Marks)	External Examiner (50 Marks)
Duration of Training	30	15	15
Practical skills	20	10	10
Report based on Training	20	10	10
Knowledge assessments through oral presentation	30	15	15

***Note –**

1) There shall be three hard copies of the report. The original shall be kept by the student and another report to be submitted to the department.

SYLLABUS (CBCS) FOR T. Y. B. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2026)

Name of the Program: B.Sc. Zoology
Program Code: USZOO
Class: T.Y.B.Sc.
Semester: V
Course Type: Minor (Mandatory) Theory
Course Code: ZOO-310-MN
Course Name: Ornamental Fishery
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- Understand the basic concepts and scope of ornamental fish keeping.
- Familiarize students with the diversity of exotic and endemic ornamental fish species.
- Gain detailed knowledge about the biology of popular aquarium fishes
- Give an overview of the global aquarium trade and its present status
- Train students in the design, construction, and maintenance of different types of aquaria.
- Develop an understanding about various aquarium accessories and water quality management
- Enable students to identify common ornamental fish diseases and their management

Course Outcomes:-

Student will be able to-

CO1: understand the significance and potential of the ornamental fish industry.

CO2: distinguish between exotic and endemic ornamental fish species.

CO3: gain comprehensive knowledge of the biology and specific requirements of selected aquarium fishes

CO4: analyze the trends and challenges in the global aquarium trade.

CO5: develop skills in designing and setting up freshwater and marine aquaria.

CO6: select appropriate aquarium accessories and maintain optimal water quality.

CO7: diagnose and manage common diseases in ornamental fishes.

TOPICS:

UNIT	SYLLABUS	NO. OF LECTURE
1.	**Introduction and scope**	02
2.	**Exotic and Endemic species of aquarium fishes**	02
3.	**Biology of Aquarium Fishes** • Guppy • Molly • Gold fish • Anemone fish • Butterfly fish	08
4.	**Introduction to aquarium** • World aquarium trade and present status	02
5.	**Design and construction of home and public aquaria** • Freshwater • Marine	04
6.	**Aquarium accessories** • Aerators	04

	• Filters (different types) • Lighting • Water quality requirements	
7.	**Criteria of selection for aquarium fishes**	**02**
8.	**Types of aquarium feed** • Live feed • Artificial feed	**02**
9.	**Ornamental Fish Diseases** (One each) • Bacterial • Viral • Protozoan • Fungal	**04**

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Course Articulation Matrix of ZOO-310-MN: Ornamental Fishery
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2	3	3	1	2	1	2	2	2	2	2
CO2	3	3	1	3	3	1	2	1	2	2	2	2	2
CO3	3	2	2	2	3	2	3	2	1	3	2	2	3
CO4	3	1	2	2	3	2	2	2	1	2	2	2	2
CO5	3	2	3	2	3	2	2	2	3	2	2	2	3
CO6	3	2	2	2	3	3	3	2	2	2	2	2	2
CO7	3	2	1	2	2	3	3	1	2	1	1	2	2

PO1: Comprehensive knowledge and understanding
All COs are directly mapped to PO1 because understanding the significance of the ornamental fish industry, species differentiation, biology, aquarium trade, and disease management is fundamental to mastering aquaculture and fisheries sciences.

PO2: Practical, professional, and procedural knowledge
CO1, CO2, CO3, CO5, CO6 & CO7 are directly mapped to PO2 because practical skills in aquarium setup, species identification, water quality maintenance, and disease diagnosis are essential for professional competency in ornamental fish management.

PO3: Entrepreneurial min-dset and knowledge
CO3, CO5 & CO7 are directly mapped to PO3 because knowledge of aquarium trade trends, designing aquaria, and disease management has potential applications in ornamental fish farming, aquaculture entrepreneurship, and pet industry businesses.

PO4: Specialized skills and competencies
CO1, CO2, CO3, CO4 & CO6 are directly mapped to PO4 because expertise in fish biology, aquaria design, water quality management, and species identification requires specialized skills for sustainable ornamental fish farming and research.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1, CO3, CO4, CO5 & CO6 are directly mapped to PO5 because troubleshooting aquarium conditions, analyzing water quality, managing fish diseases, and maintaining ecosystem balance require problem-solving and analytical skills.

PO6: Communication skills and collaboration
CO4, CO6 & CO7 are directly mapped to PO6 because presenting research on aquarium trade trends, explaining disease management techniques, and collaborating on ornamental fish conservation projects require strong communication and teamwork skills.

PO7: Research-related skills
CO3, CO4, CO6 & CO7 are directly mapped to PO7 because conducting research on aquarium trade, water chemistry, fish diseases, and biological aspects of ornamental fish requires research aptitude and critical analysis.

PO8: Learning how to learn skills
CO1, CO2, CO3, CO5 & CO6 are directly mapped to PO8 because acquiring expertise in aquarium design, species selection, disease control, and water quality management promotes continuous learning in aquaculture sciences.

PO9: Digital and technological skills
CO5 is directly mapped to PO9 because aquarium management and disease monitoring involve using digital tools, automated water quality control systems, and data analysis for efficient fish farming.

PO10: Multicultural competence, inclusive spirit, and empathy
CO1, CO2, CO3, CO4, CO5 & CO6 are directly mapped to PO10 because the global ornamental fish trade requires cultural awareness, ethical considerations, and collaboration across diverse markets and conservation efforts.

PO11: Value inculcation and environmental awareness
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO11 because sustainable aquarium practices, ethical sourcing of fish, responsible pet trade, and conservation awareness are essential for maintaining biodiversity.

PO12: Autonomy, responsibility, and accountability
CO1, CO2, CO4, CO5 & CO6 are directly mapped to PO12 because handling aquaria, maintaining water quality, and managing fish health require responsibility, precision, and adherence to ethical aquaculture practices.

PO13: Community engagement and service
CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly mapped to PO13 because ornamental fish farming, disease management, and responsible aquarium trade contribute to community engagement, conservation projects, and public awareness programs.