B.Sc ZOOLOGY

Courses of study

Schemes of Examinations & Syllabi
For the students admitted in the year

2023- 2024

PG & RESEARCH DEPARTMENT OF ZOOLOGY

Bishop Heber College (Autonomous)
(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC

College of Excellence by the UGC)

TIRUCHIRAPPALLI – 620017
TAMIL NADU, INDIA

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,
CHENNAI – 600 005

AUGUST- 2023

Vision

Envisage quality higher education and research in the field of animal sciences with global perspectives by promoting discovery and learning contemporary fields in Zoology inculcating social values for the holistic development and to conserve nature thus contributing for nation building

Mission

- **Bestow quality education emphasizing the cognitive learning and concern towards the animal kingdom.**
- **Enrich field training skills, biodiversity conservation and entrepreneurship in the applied zoological sciences**
- **Enhance highest level of academic accomplishment with interdisciplinary approach through research, industrial collaboration and amalgamate with reputed national and international universities**
- **Foster globally competent individuals with interpersonal skills and environmental consciousness for the betterment of the world.**

CONTENTS

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc., Zoology**
Programme Code:	
Duration:	**UG - 3 Years**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations. **PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

	PO10 Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO 11 Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO 12 Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO 13: Moral and ethical awareness/reasoning**: Ability toembrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstratingthe ability to identify ethical issues related to one‟s work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including „learning how to learn‟, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Specific Outcomes:	**PSO1 – Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations **PSO3 – Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit

Credit Distribution for UG Programmes

Sem I	Credit	H	Sem II	Credit	H	Sem III	Credit	H	Sem IV	Credit	H	Sem V	Credit	H	Sem VI	Credit	H
Part 1. Language – Tamil	3	6	Part.. 1. Language – Tamil	3	6	Part..1. Language – Tamil	3	6	Part.. 1. Language – Tamil	3	6	5.1 Core Course – \CC IX	4	5	6.1 Core Course – CC XIII	4	6
Part.2 English	3	6	Part.. 2 English	3	6	Part..2 English	3	6	Part.. 2 English	3	6	5.2 Core Course – CC X	4	5	6.2 Core Course – CC XIV	4	6
1.3 Core Course – CC I	5	5	2..3 Core Course – CC III	5	5	3.3 Core Course – CC V	5	5	4.3 Core Course – CC VII Core Industry Module	5	5	5. 3.Core Course CC -XI	4	5	6.3 Core Course – CC XV	4	6
1.4 Core Course – CC II	5	5	2.4 Core Course – CC IV	5	5	3.4 Core Course – CC VI	5	5	4.4 Core Course – CC VIII	5	5	5. 4.Core Course –/ Project with viva - voce CC -XII	4	5	6.4 Elective - VII Generic/ Discipline Specific	3	5
1.5 Elective I Gene	3	4	2.5 Elective II Gene	3	4	3.5 Elective III Generi	3	4	4.5 Elective IV Gene	3	3	5.5 Elective V	3	4	6.5 Elective VIII	3	5

ric/ Discipline Specific			ric/ Discipline Specific			c/ Discipline Specific			ric/ Discipline Specific			Generic/ Discipline Specific			Generic/ Discipline Specific		
1.6 Skill Enhancement Course SEC-1	2	2	2.6 Skill Enhancement Course SEC-2	2	2	3.6 Skill Enhancement Course SEC-4, (Entrepreneurial Skill)	1	1	4.6 Skill Enhancement Course SEC-6	2	2	5.6 Elective VI Generic/ Discipline Specific	3	4	6.6 Extension Activity	1	-
1.7 Skill Enhancement - (Foundation Course)	2	2	2.7 Skill Enhancement Course – SEC-3	2	2	3.7 Skill Enhancement Course SEC-5	2	2	4.7 Skill Enhancement Course SEC-7	2	2	5.7 Value Education	2	2	6.7 Professional Competency Skill	2	2
						3.8 E.V.S.	-	1	4.8 E.V.S	2	1	5.8 Summer Internship /Industrial Training	2				
	23	**30**		**23**	**30**		**22**	**30**		**25**	**30**		**26**	**30**		**21**	**30**
Total – 140 Credits																	

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF)

Programme : B.Sc. Zoology - 2023 onwards

Sem.	Part	Course	Course Title	Course Code	Hours / week	Credits	Marks		
							CIA	ESE	Total
I	I	Language I	**பொதுத்தமிழ் I**	U23TM1L1	6	3	25	75	100
	II	English I	Prose and Short Stories	U23EG1L1	6	3	25	75	100
	III	Core I	Invertebrata	U23ZY101	5	5	25	75	100
		Core Prac. I	Invertebrata Lab	U23ZY1P1	3	3	40	60	100
		Allied I	Allied Botany I	U23BY1Y1	3	3	25	75	100
		Allied Prac. I	Allied Botany Practical I	U23BYYP1	3	2	40	60	100
	IV	SEC I	Public Health and Hygeine	U23ZY1E1	2	2	25	75	100
		FC	Animal Preservation Techniques and Laboratory Practices	U23ZY1N1	2	2	100	--	100
					30	23			
II	I	Language II	**பொதுத்தமிழ் II**	U23TM2L2	6	3	25	75	100
	II	English II	Poetry and Shakespeare	U23EG2L2	6	3	25	75	100
	III	Core II	Chordata	U23ZY202	5	5	25	75	100
		Core Prac. II	Chordata Lab	U23ZY2P2	3	3	40	60	100
		Allied II	Allied Botany II	U23BY2Y2	3	3	25	75	100
		Allied Prac. I	Allied Botany Practical II	U23BYYP2	3	2	40	60	100
	IV	SEC II	Industrial Zoology	U23ZY2E2	2	2	25	75	100
		SEC III	Ornamental Fish Farming and Management	U23ZY2S3	2	2	25	75	100
					30	23			
III	I	Language III	**பொதுத்தமிழ் III**	U23TM3L3	6	3	25	75	100
	II	English III	One Act Plays and Abridged Novel	U23EG3L3	6	3	25	75	100
	III	Core III	Cell Biology and Genetics	U23ZY303	5	5	25	75	100
		Core Prac. III	Cytogenetics Lab	U23ZY3P3	3	3	40	60	100

		Allied III	Allied Chemistry - I	U23CH3Y3	3	3	25	75	100
		Allied Prac. I	Allied Chemistry Practical - I	U23CHYP1	3	2	40	60	100
	IV	SEC IV	Apiculture	U23ZY3S4	1	1	100	--	100
		SEC V	Biophysics and Biostatistics	U23ZY3S5	2	2	25	75	100
		EVS I	Environmental Studies	U23EST31	1	--	--	--	--
					30	22			

IV	I	Language IV	**பொதுத்தமிழ் IV**	U23TM4L4	6	3	25	75	100
	II	English IV	Language through Literature	U23EG4L4	6	3	25	75	100
	III	Core IV	Developmental Biology	U23ZY404	5	5	25	75	100
		Core Prac. IV	Environmental Toxicology Lab	U23ZY4P4	3	3	40	60	100
		Allied IV	Allied Chemistry - II	U23CH4Y4	3	3	25	75	100
		Allied Prac. II	Allied Chemistry Practical - II	U23CHYP2	2	2	40	60	100
	IV	SEC VI	Life Skills	U23ZY4S6	2	2	100	--	100
		SEC VII	Integrated Farming System and Management	U23ZY4S7	2	2	100	--	100
		EVS II	Environmental Studies	U23EST42	1	2	25	75	100
					30	25			
V	III	Core V	Evolutionary Biology	U23ZY505	5	4	25	75	100
		Core VI	Animal Physiology	U23ZY506	5	4	25	75	100
		Core VII	Environmental Biology	U23ZY507	5	4	25	75	100
		Core Prac. V	Eco-Physiology	U23ZY5P5	5	4	40	60	100
		Core Project	Core Project with Viva Voce	U23ZY5PJ	4	3	40	60	100
		Elective I	Animal Behaviour	U23ZY5:A	4	3	25	75	100
	IV	VLO	Abundant Life	U23VLO51	2	2	100	--	100
			Human Values	U23VLO52					
		Core Internship	Internship/ Industrial Training(Summer)	U23ZY5I1	--	2	100	--	100
					30	26			

VI	III	Core VIII	Biotechnology	U23ZY608	6	4	25	75	100
		Core IX	Microbiology	U23ZY609	6	4	25	75	100
		Core Prac. VII	Biotechnology Lab	U23ZY6P6	5	3	40	60	100
		Elective II	Wild life Conservation and Management	U23ZY6:A	5	3	25	75	100
		Elective III	Nanobiology	U23ZY6:B	6	4	25	75	100
	V	PCS	Zoology for Competitive Exams	U23ZY6G1	2	2	100	--	100
	VI	Extension Activity	Extension Activities	U23ETA61	--	1	--	--	--
					30	21			
				Total Credits :		140			

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	13	13	22	18	92
Part IV	4	4	3	6	4	1	22
Part V	-	-	-	-	-	2	2
Total	23	23	22	25	26	21	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test Assignments / Snap Test / Quiz Seminars Attendance and Class Participation	**25 Marks**
External Evaluation	End Semester Examination	**75 Marks**
Total		**100 Marks**

METHODS OF ASSESSMENT	
Remembering (K1)	• Thelowestlevelofquestionsrequirestudentstorecallinformationfromthecoursecontent • Knowledgequestionsusuallyrequirestudentstoidentifyinformationinthetextbook.
Understanding (K2)	• Understandingoffactsandideasbycomprehendingorganizing,comparing,translating,interpolatingandinterpretingintheirownwords. • Thequestionsgobeyondsimplerecallandrequirestudentstocombinedatatogether
Application (K3)	• Studentshavetosolveproblemsbyusing/applyingaconceptlearnedintheclassroom. • Studentsmust usetheir knowledgetodetermineaexactresponse.
Analyze (K4)	• Analyzingthequestionisonethatasksthestudentstobreakdownsomethingintoitscomponentparts. • Analyzingrequiresstudentstoidentifyreasonscausesormotivesandreachconclusionsorgeneralizations.
Evaluate (K5)	• Evaluationrequiresanindividualtomakejudgmentonsomething. • Questionstobeaskedtojudgethevalueofanidea,acharacter,aworkofart,orasolutiontoaproblem. • Studentsareengagedindecision-makingandproblem–solving. • Evaluationquestionsdonothavesinglerightanswers.
Create (K6)	• Thequestionsofthiscategorychallengestudentstogetengagedincreativeandoriginalthinking. • Developingoriginalideasandproblemsolvingskills

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting a Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest DBMS and Computer software for Analytics.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning abstract Statistics and simulating mathematical concepts to real world.	• Instil confidence among students • Create interest for the subject
I, II, III, IV	**Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial)	• Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		• Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		• Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		• Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment • Create small scale entrepreneurs • Training to girls leads to women empowerment
		• Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	• Strengthening the domain knowledge • Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature • Students are exposed to Latest topics on Computer Science / IT, that require strong statistical background

		• Emerging topics in higher education / industry / communication network / health sector etc. are introduced with hands-on-training, facilitates designing of statistical models in the respective sectors
IV	DBMS and Programming skill, Biostatistics, Statistical Quality Control, Official Statistics, Operations Research	• Exposure to industry moulds students into solution providers • Generates Industry ready graduates • Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	• Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
V Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
VI Semester	Introduction of Professional Competency component	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' –caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: For Advanced Learners / Honors degree		• To cater to the needs of peer learners / research aspirants

Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

SEMESTER - I

Course Code: U23ZY101	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INVERTEBRATA	Core	Y	-	-	-	5	5	25	75	100

Learning Objectives	
CO1	To understand the basic concepts of lower animals and observe the structure and functions.
CO2	To illustrate and examine the systemic and functional morphology of various group of invertebrates.
CO3	To differentiate and classify the various groups of animal modes of life and to estimate the biodiversity.
CO4	To compare and distinguish the general and specific characteristics of reproduction in lower animals.
CO5	To infer and integrate the parasitic and economic importance of invertebrate animals

UNIT	Details	No. of Hours	Course Objectives
I	Introduction to Classification, taxonomy and nomenclature. **Protozoa:** General characters and classification of Phylum Protozoa up to classes. Type study - *Paramecium* - Nutrition in protozoa - Locomotion in protozoa - Host-parasitic interactions in *Entamoeba* and *Plasmodium*.	12	CO1
II	**Porifera:** General characters and classification up to Classes. - Canal system in sponges **Coelenterata :** General characters and classification up to classes – Type study - *Obelia* - corals and coral reefs types and its Economic importance. Polymorphism in Hydrozoa.	12	CO2

		12	CO3
III	**Platyhelminthes:** General characters and classification of up to classes. Type study – *Fasciola hepatica*. **Aschelminthes :** General characters and classification up to classes - Nematode Parasites and diseases - *Wuchereria bancrofti*, *Enterobius vermicularis*, *Ancylostome duodenale*, *Ascaris lumbricoides*	12	CO4
IV	**Annelida:** General characters and classification up to Classes. Type study: *Nereis* - Metamerism - Modes of life in Annelids. **Arthropoda:** General characters and classification of Phylum Arthropoda up to orders. Detailed study: *Penaeus indicus*. Affinities of *Peripatus* – Larval forms in Crustacea.	12	CO5
V	**Mollusca:** General characters and classification of Phylum Mollusca up to Classes. Torsion in Mollusca - Cephalopoda as the most advanced invertebrate **Echinodermata:** General characters and classification of Phylum Echinodermata up to Classes. Detailed study: *Asterias.* Water vascular system in Echinodermata – Larval forms of Echinoderms.		
	.	**60**	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Understand the basic concepts of invertebrate animals and recall its structure and functions.	PO1
CO2	Illustrate and examine the systemic and functional morphology of various groups of invertebrata.	PO1, PO2

CO3	Differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.	PO4, PO6
CO4	To compare and distinguish the various physiological processes and organ systems in lower animals.	PO4, PO5, PO6
CO5	Infer and integrate the parasitic and economic importance of invertebrate animals.	PO3, PO8
Text Books (Latest Editions)		
1.	Ekambaranatha Iyer, 2000. A Manual of Zoology, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd	
2.	Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12th edn. S. Chand& Co.	
3.	Kotpal, R.L, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.	
2.	**Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science**	
3.	Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson	
4.	Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co.	
5.	Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.	
Web Resources		
1.	https://www.nationalgeographic.com/animals/invertebrates/	
2.	https://bit.ly/3kABzKa	
3.	https://www.nio.org/	
4.	https://greatbarrierreef.org/	
Methods of Evaluation		

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1) B N

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY1P1	INVERTEBRATA LAB COURSE	Core	Y	-	-	-	3	3	40	60	100

Learning Objectives	
CO1	To identify the different groups of invertebrate animals by observing their external characteristics.
CO2	To understand the organs, organ system and their functions in lower animals.
CO3	To get knowledge about the different modes of life and their adaptation based on the environment.
CO4	Able to dissect and display the internal organs and mount the mouthparts and scales of invertebrates.

UNIT	Details	No. of Hours	Course Objectives
I	**Major Dissection:** Cockroach: Digestive system, Nervous system, Earthworm: Digestive system and Nervous System.	12	CO1
II	**Minor Dissection :** *Pila globosa*: Digestive system (Including radula). Freshwater mussel: Digestive system	12	CO2
III	**Mounting:** Earthworm: Body setae; *Pila globosa*: Radula. Prawn: Appendages.	12	CO3
IV	**Mounting :** Mouth parts: Cockroach, House fly and Mosquito.	12	CO4
V	**Spotters :(i). Protozoa:** Amoeba, Paramoecium - Conjugation, Entamoeba histolytica, Plasmodium vivax **(ii). Porifera:** Sycon - Spicules, Gemmule **(iii). Coelenterata:** Obelia – Colony & Medusa, Aurelia, Physalia, Gorgonia, **(iv). Platyhelminthes:** Planaria, Fasciola hepatica, Fasciola larval forms – Miracidium, Redia, Cercaria, Taenia solium **(v). Nemathelminthes:** Ascaris (Male & Female), Ancylostoma, Wuchereria **(vi). Annelida:** Nereis, Aphrodite, Chaetopteurs, Hirudinaria, Trochophore larva **(vii). Arthropoda:** Palaemon, Scorpion, Scolopendra, Limulus, Peripatus, Larvae - Nauplius, Mysis, Zoea,	12	CO5

	(viii). Mollusca: Chiton, Pila, Murex, Sepia, Octopus, Glochidium larva **(ix). Echinodermata:** Asterias, Ophiothrix, Echinus, Cucumaria, Antedon, Bipinnaria larva		
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Identify and label the external features of different groups of invertebrate animals.	PO1	
CO2	Illustrate and examine the circulatory system, nervous system and reproductive system of invertebrate animals.	PO1, PO2	
CO3	Differentiate and compare the structure, function and mode of life of various groups of animals.	PO4, PO6	
CO4	To compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6	
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8	
Text Books (Latest Editions)			
1.	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, 2) S. Viswanathan, Chennai		
2.	Ganguly, Sinha an d A dhikari , 2 0 11 . Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition. 1008 pp.		
3.	Sinha, Chatterjee and Chattopadhyay, 2 0 1 4. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.		
4.	Lal ,S. S, 2016 . Practical Zoology Invertebrate, Rastogi Publications.		
5.	Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, 4 97pp.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.		
2.	Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition. Holt Saunders International Edition.		
3.	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson		
4.	Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students.* Asia Publishing Home.		
5.	Lal, S.S. 2005. A text Book of Practical Zoology: Invertebrate, Rastogi, Meerut		
Web Resources			

1.	https://nbb.gov.in/
2.	http://www.agshoney.com/training.htm
3.	https://icar.org.in/
4.	http://www.csrtimys.res.in/
5.	http://csb.gov.in/
	https://iinrg.icar.gov.in/
	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1)

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23BY1Y1	**Allied Zoology I** **Biology of Invertebrates & Chordates**	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives	
CO1	To acquire a basic knowledge of diversity and organization of Protozoa, Coelenterata, Helminthes and Annelida
CO2	To acquire a basic knowledge of diversity and organization of Arthropoda, Mollusca and Echinodermata
CO3	To comprehend the taxonomic position and diversity among Protochordata, Pisces and Amphibia
CO4	To comprehend the taxonomic position and diversity among Reptilia, Aves and Mammalia
CO5	To acquire detailed knowledge of select invertebrate and chordate forms

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Diversity of Invertebrates–I Principles of taxonomy. Criteria for classification–Symmetry and Coelom–Binomial nomenclature. Classification of Protozoa and Coelenterata Helminthes and Annelida upto classes with two examples.	12	CO1
II	Diversity of Invertebrates–II Classification of Arthropoda, Mollusca and Echinodermata upto class level with examples.	12	CO2
III	Diversity of Chordates–I Classification of Prochordata, Pisces and Amphibia upto orders giving two examples.	12	CO3
IV	Diversity of Chordates–II	12	CO4

	Classification of Reptilia, Aves and Mammalia upto orders giving two examples.		
V	Animal organization Structure and organization of (i)Earthworm (ii)Rabbit (iii)Fish	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Recall the characteristic features invertebrates and chordates.	PO1	
CO2	Classify invertebrates up to class level and chordates up to order level	PO1, PO2	
CO3	Explain and discuss the structural and functional organisation of some invertebrates and chordates	PO4, PO6	
CO4	Relate the adaptations and habits of animals to their habitat	PO4, PO5, PO6	
CO5	Analyse the taxonomic position of animals.	PO3, PO8	
Text Books (Latest Editions)			
1.	Ekambaranatha Iyer,-Outlines of Zoology Viswanathan Publication		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Ekambaranatha Iyar and T.N.Ananthakrishnian - A Manual ofZoologyInvertebrata–VolI:ViswanathanPublishers.		
2.	Ekambaranatha Iyar and T.N. Ananthakrishnan, - A Manual of Zoology- Invertebrata –VolII: Viswanathan Publishors.		
3.	EkambaranathaIyarandT.N.Ananthakrishnan,-AManualofZoology:ChordataViswanathanPublishers.		
4.	Jordan E. L. and P.S. Verma-Invertebrate Zoology, S. Chand & Co.		
Web Resources			
1.	www.sanctuaryasia.com		
2.	www.iaszoology.com		

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23BY1Y1	**BIOLOGY OF INVERTEBRATES AND CHORDATES**	**Allied practical I**	Y	-	-	-	3	3	25	75	100

COURSE OUTCOMES:
On completion of this course, the students will be able to

CO.No	COURSE OUTCOME	LEVEL	PRACTICALS
CO1	Analyse the structural organization of the different systems in Earthworm, Cockroach and Frog	K4	I
CO2	Assess the organ systems of insects through dissection and virtual labs.	K6	I
CO3	Explain the structural organization of mouthparts	K4	I
CO4	Identify the body setae in a muscle squash of earthworm and show under the compound microscope Create a mount on Placoid scale	K4 K5	I
CO5	Identify the specimen and write their classification and its significance	K3,K4	II
CO6	Analyse the antigen and antibody reaction and identified the blood group	K4	II

DISSECTION
Earthworm: Digestive system and Nervous system

VIRTUAL DISSECTION
Frog:
Digestive system, Respiratory system, Arterial system, Venous system, Nervous system, Male and Female reproductive systems

MOUNTINGS
Housefly: Mouth parts

Mosquito: Mouth parts
Earthworm: Body setae
Shark: Placoid scale

SPOTTERS
Amoeba, Paramecium, Paramecium conjugation, Obelia colony,
Taenia *solium*, Scolex of *Taenia solium*, *Ascaris (Male & Female)*, Hirudinaria, *Eurymerodesmus,* s*colopendra*, *Pila*, Sepia, Asterias, Scoliodon, *Hyla*, Calotes, Columba, *Oryctolagus*

REFERENCE BOOKS:
Lal S.S., A Textbook of Practical Zoology Invertebrate, Rastogi Publication, 2004
Lal S.S., A Textbook of Practical Zoology Vertebrate, Rastogi Publication, 2004
Sinha J.,Chatterjee A.K., Chattopadhyay., Advanced Practical Zoology, Books and Allied (P) Ltd., 2011.

WEB-LINKS:
1. https://doi.org/10.1016/B978-0-12-374144-8.00241-1
2. https://krishijagran.com/agripedia/sericulture-an-introduction-to-silk-cultivation-and-production-in-india-along-with-its-policy-initiatives/
3. https://www.youtube.com/watch?v=_y1CHEytZr0

MAPPING (CO, PO, PSO)

L-Low M-Moderate H- High

U20ZYYP1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	H	H	H	L	-	H	H	-	-	H
CO2	H	H	M	H	H	M	-	L	H	H	M	-	H
CO3	H	M	M	M	H	H	-	L	H	H	M	-	H
CO4	H	L	L	H	H	H	-	-	H	M	-	-	M
CO5	H	H	M	H	-	H	-	-	H	H	M	-	H
CO6	H	M	H	L	H	H	M	-	M	-	H	-	H

COURSE ASSESSMENT METHODS

DIRECT
1. Continuous Assessment Test I, II **2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc.(as applicable)** **3. End Semester Examination**
INDIRECT
1. Course-end survey

Course	**:**	**SEC I- NME**
Course title	**:**	**Public Health nad Hygiene**
Credits	**:**	**2** **COURSE CODE: U23ZY1E1**

Learning Objective

- To impart health education among non-major students.
- To create health awareness
- To maintain health and hygeine

UNIT I – HEALTH (6 Hrs)
Health: Definition and concepts, spectrum, indicators: morbidity and mortality - determinants of health.

UNIT II – NUTRITION (6 Hrs)
Nutrition: major nutrients - food types - balanced diet- malnutrition and its effects -hypertension - cardio vascular diseases, obesity and diabetes.

UNIT III - MATERNAL AND CHILD HEALTH (6 Hrs)
Maternal and child health: Maternity - Genetic screening test - Amniocentesis
MCH problems- antenatal, intra natal – Post natal care.

UNIT IV - MENTAL HEALTH (6 Hrs)
Mental health: Types, causes of mental illness and prevention of mental health- crucial points in the life of human beings- Addiction: Alcoholism, Smoking - deaddiction and rehabilitation
UNIT V - HEALTH EDUCATION (6 Hrs)
Health education: Definition- objectives - practices of health education. Methods of family welfare.

COURSE OUTCOMES
On completion of the course, the student will be able to

CO.NO	COURSE OUTCOMES	LEVEL	UNIT
CO1	Compare the spectrum of health	**K2**	**I**
CO2	Classify the nutrients in food and assess the importance of balanced diet	**K4**	**II**
CO3	Explain the effects of malnutrition	**K5**	**II**
CO4	Interpret the maternal and child health	**K5**	**III**
CO5	Inspect about mentalilleness and its causes	**K4**	**IV**
CO6	Appraise the practices of health education	**K5**	**V**

Text Books:
1. Park, J.E and Park.K, **Text Book** of preventive and social medicine, 13thEdn- Banarsidas.

Bhanot, Jabalpur -1990.

Reference Books:

1.M, Bappco, Hand book of food and Nutrition, Bangalore -1989.
2. Swaminathan, M., Essentials of food and Nutrition. Vol.I and II 1989

WEB-LINKS:

1. https://www.who.int/health-topics/nutrition
2. https://jamanetwork.com/journals/jama/article-abstract/289200
3. https://www.sciencedirect.com/topics/social-sciences/health-education
4. https://www.cdc.gov/healthyschools/sher/characteristics/index.htm

MAPPING (CO, PO, PSO

L-Low M-Moderate H- High

U19ZY3E1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	H	-	M	H	H	M	H	-	H	-	H
CO2	H	-	H	-	M	H	H	M	H	-	H	-	H
CO3	H	-	H	-	M	H	H	M	H	-	H	-	H
CO4	H	-	H	-	M	H	H	M	H	-	H	-	H
CO5	H	-	H	-	M	H	H	M	H	-	H	-	H
CO6	H	-	H	-	M	H	H	M	H	-	H	-	H

COURSE ASSESSMENT METHODS

DIRECT
1. Continuous Assessment Test I,II 2. AssignmentGroup Presentation, Posterpreparation, 3. End SemesterExamination
INDIRECT
1. Course-end survey

Course	**:**	**FOUNDATION COURSE**
Course title	**:**	**Animal Preservation Techniques And Laboratory Practices**
Credits	**:**	**2** **COURSE CODE: U23ZY1N1**

Learning Objectives:

- To provide knowledge on the Animal Preservation Techniques.
- To acquire skills on taxidermy techniques.
- To inculcate good laboratory practices

UNIT I **(6 Hrs)**

Methods To Preserve Specimens : Importance of animal preservation - Types of specimens- Entire fluid-preserved animals - Mounted skins with partial or entire skeleton-Vertebrate preservation -fishes, Amphibians, Reptiles, Birds and Mammals. Invertebrate preservation – Annelids, Arthropods, Molluscs and Echinoderms.

UNIT II **(6 Hrs)**

Steps for Specimen Preservation -Killing and relaxing of animal. Fixation -- Storage in bottles, jar vials and trays. Preservatives and their usage: Formalin- Industrial Alcohol- Isopropyl alcohol- Ethyl alcohol for Invertebrates- Liquid hand sanitizer - Pouring Hand Sanitizer

UNIT III **(6 Hrs)**

Taxidermy: Types- Skin Mounts & Freeze dried methods– Taxidermy techniques- skinning, fleshing, wiring, mounting, and grooming- Precautionary Measures - Museum maintenance

UNIT IV **(6 Hrs)**

Good Laboratory Practices: Guide lines, Laboratory symbols; Cleaning and sterilization of labware and reagents; handling and care of laboratory animals; Laminar flow hood: types and use.

UNIT V **(6 Hrs)**

Preparation of Solutions: Concepts of molecular weight, atomic weight, preparation of solutions of a particular molarity and percentage; Buffers: definition and preparation of buffers, pH meter; Safety and ethical issues in laboratory settings

REFERENCE BOOKS

1.Basu, S.K. & Zandi, P. (2015). Taxidermy as an important tool in bird education, awareness and conservation

2.Hossain, M.D. (2016). Modern Technologies in Taxidermy (in Bangla). Publisher Md. Delwar Hossain.

3.SabariGhosal and Anupama Sharma Avasthi, 2018. Fundamentals of Bioanalytical Techniques and Instrumentation, 2nd Ed., Phi Learning Pvt. Ltd., New Delhi, India.

3.Veerakumari L., 2015. Bioinstrumentation, MJP Publishers, Chennai, India.

SEMESTER - II

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY202	**CHORDATA**	Core	Y	-	-	-	5	5	25	75	100

Learning Objectives	
CO1	To understand the structures and distinct features of Phylum Chordata.
CO2	To understand and able to distinguish the characteristic features of each subphylum and class.
CO3	To understand the economic importance of vertebrates
CO4	To know about the adaptations of vertebrates
CO5	To understand the evolutionary position of different groups of vertebrates

UNIT	Details	No. of Hours	Course Objectives
I	**General Characters and Classification of Phylum Chordata**: Origin of Chordata, Differences between non-chordates and chordates, General characters, Affinities and Systematic position of Hemichordata (*Balanoglossus*), Cephalochordata (*Amphioxus*) Urochordata (*Ascidia*)	12	CO1, CO2
II	**Pisces:** General characters, classification and origin, type study: *Scoliodon sorrakowah*, Affinities of Dipnoi - Accessory respiratory organs - Parental care - Migration -	12	CO1, CO2, CO4, CO5
III	**Amphibia** : General characters, classification and origin, Type study - *Rana hexadactyla* - Neoteny in Urodela - Parental care in Amphibia.	12	CO1, CO2, CO3, CO4, CO5

IV	**Reptilia** : General characters classification and origin, Type study – (*Calotes versicolor)* Extinct reptiles. Snakes of India. Poison apparatus and biting mechanism of poisonous snakes.	12	CO1, CO2, CO4, CO5
V	**Aves:** General characters, classification and origin, Type study - *Columba livia* - Flight adaptations, Migration. **Mammalia:** General characters and classification - Type study - Rabbit - Egg laying mammals, Marsupials, Flying mammals, Aquatic mammals.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Classify, Identify and recall the name and distinct features of different subphylum belonging to phylum Chordata.	PO1
CO2	Explain, and relate the origin, structural organization and evolutionary aspects of vertebrates.	PO1, PO2
CO3	Analyze, compare and distinguish the developmental stages and describe the important biological process.	PO3, PO4, PO5
CO4	Correlate the different modes of life and parental care among different vertebrates.	PO3, PO5, PO6
CO5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	PO2, PO3, PO5, PO8

Text Books
(Latest Editions)

1.	Ayyar, E.K. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 891p.
2.	Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
3.	Nigam, H.C., 1983. Zoology of Chordates, Vishal Publications, Jalandhar - 144008, 942.
4.	Ganguly, Sinha,. Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.
5.	Kotpal. R.L. A, Modern text book of Zoology Vertebrates- Rastogi publications. 2009

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
2.	Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
3.	Hickman, C.P. Jr., F.M.Hickman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065 pp.
4.	Newman, H.H., 1981. The Phylum Chordata, Satish Book Enterprise, Agra – 282 003, 477 pp.
5.	Parker and Haswell, 1964. Text Book of Zoology, Vol II (Chordata), A.Z.T,B.S. Publishers and Distributors, New Delhi - 110 051, 952 pp.
6.	Pough H. Vertebrate life, VIII Edition, Pearson International.
7.	Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York, 587 pp.
8.	Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
Web Resources	
1.	http://tolweb.org/Chordata/2499
2.	https://www.nhm.ac.uk/
3.	https://bit.ly/3Av1Ejg
4.	https://bit.ly/3kqTfYz
5.	https://biologyeducare.com/aves/
6.	https://www.vedantu.com/biology/mammalia

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge

Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3		S	S	S	S	S		S
CO 4			S	S	S	M		
CO 5			S		S			S

S-Strong(3) M-Medium (2) L-Low (1)

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY2P2	CHORDATA LAB COURSE	Core	Y	-	-	-	3	3	40	60	100

Learning Objectives	
CO1	To understand the structures and distinct features of phylum chordata.
CO2	To understand and able to distinguish the characteristic features of each subphylum and class.
CO3	To understand and compare the structure of various internal organs in different classes of vertebrates.
CO4	To know about the classification, adaptations and affinities of chordate animals.

UNIT	Details	No. of Hours	Course Objectives
I	**Dissections**:Frog(virtual **Dissections** / Fish:External features,Digestivesystem, Arterialsystem,Venoussystem,5thCranialnerve, Male and female urinogenital system.	12	CO1
II	**Mounting**: Fish: Placoid and Ctenoid scales, Frog: Hyoid apparatus and Brain (Demo).	12	CO2
III	**Osteology**:Frog:SkullPectoral girdle,Pelvicgirdle,Forelimb,Hindlimb. Skull and lower jaw, synsacrum, Chelonia.	12	CO3
IV	**Specimen and Slides**:**(i) Hemichordata:** Balanoglossus, **(ii). Protochordata:** Amphioxus, **(iii). Cyclostomata:** Petromyzon, **(iv). Pisces:** Sphyrna Pristis, Torpedo, Channa, Hippocampus, Exocoetus, Echieneis, Labeo, Catla, Clarius, Auguilla, Scales: Placoid, Cycloid, Ctenoid **(v). Amphibia:** Ichthyophis, Amblystoma, Hyla, Bufo, Axolotal larva **(vi). Reptilia :** Draco, Chemaeleon, Gecko, Vipera russelli, Naja, **(vii). Aves:** Archaeopteryx, Passer, Psittacula, Bubo, Alcedo, Columba, Collection and study of different types of feathers: Quill, Contour, Filoplume, Down **(viii). Mammalia:** Bat, Rabbit, bat, Loris	12	CO4

V	**Embryology**: Stages in the development of Frog and Chick- Placenta in shark and mammals.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Identify and recall the name and distinct external and internal features of animals belonging to phylum Chordata.	PO1
CO2	Explain the structural organization of various organs and systems in different classes of vertebrates.	PO1, PO2
CO3	Analyse, compare and distinguish the morphological features and developmental stages of chordates	PO4, PO6
CO4	Dissect and explain various organs and internal systems in different vertebrates and correlate its function.	PO4, PO5, PO6
CO5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	PO3, PO8

Text Books (Latest Editions)	
1.	Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing, 484pp.
2.	VermaP.S,2000.AManual ofPracticalZoology:Chordates,S.ChandLimited, 627pp.

References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Robert William Hegner, 2015. Practical Zoology, BiblioLife, 522pp.
2.	Young, J,Z., 1972. The life of vertebrates. OxfordUni. London.

Web Resources	
1.	https://www.youtube.com/watch?v=b04hc_kOY10
2.	https://bit.ly/3CzTEy8
3.	http://tolweb.org/Chordata/2499
4.	https://www.nhm.ac.uk/
5.	https://bit.ly/3Av1Ejg

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23BY2Y2	**Allied Zoology II HUMAN PHYSIOLOGY AND ECONOMIC ZOOLOGY**	Core	Y	-	-	-	3	3	25	75	100

Learning Objectives	
CO1	To enable students to learn basic concepts relating to aspects of respiratory, circulatory, excretory nervous and sensory physiology.
CO2	To enable students to comprehend the processes involved during development
CO3	To enable students to learn basic concepts of immunity and the working of immune organs and familiarize them with the recommended vaccination schedule
CO4	To enable students to comprehend the basic concepts of human genetics and patterns of inheritance
CO5	To enable students to learn about aspects of animal behaviour such as foraging, courtship, nest construction, parental care and learning

UNIT	Details	No. of Hours	Course Objectives
I	Respiration- Respiratory pigments and transport of gases.Mechanismofbloodclotting.Typesofexcretory products–OrnithineCycle.Structureofneuron–Conductionof nerve impulse, Mechanism of vision and hearing.	12	CO1
II	Human Genetics: Human Chromosomes – Sex Determination in Humans; Patterns of Inheritance: Autosomal Dominant, Autosomal Recessive, X-linked , Y-linked, Mitochondrial, Multiple Allelic and Polygenic; Genetic Counselling	12	CO2
III	IInnate and Acquired - Active and Passive; Antigens and Antibodies; Immunological organs–responsesinhumans; Vaccination schedule	12	CO3

IV	**Economic Zoology** **Vermiculture**: Introduction –Ecological classification of earthworm - Preparation of vermibed– management- Pit method and Heap method - vermiwash - Economic Importance. **Apiculture**: Introduction - species of honeybees - bee colony – Newton's beehive - care and management- extraction of honey - nutritive and medicinal value of honey	12	CO4
V	**Sericulture**: Introduction - types of silkworm - life cycle of silkworm (*Bombyx mori*). Mulberry varieties - rearing – reeling - Economic importance of silk. **Pisciculture**: types of ponds: Nursery, stocking - management of a pond- Freshwater cultivable fishes: Indian Major carps: *Catla, Rohu, Mrigala*- induced breeding.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Recall the parts and working of body organs and developmental stages, name the patterns of inheritance and list different types of animal behaviour	PO1
CO2	Analyse the different developmental stages	PO1, PO2
CO3	Analyse the working of body and immune systems	PO4, PO6
CO4	Analyse the different patterns of inheritance	PO4, PO5, PO6
CO5	Relate the behaviour of animals to physiology. Analyse the different types of behaviour	PO3, PO8

Text Books
(Latest Editions)

1. Verma P.S. & Agarwal - Developmental Biology, Chordata embryology S. Chand & Co.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1. Owen, J. A., Punt, J. & Stranford, S. A. - Kuby Immunology. New York: W.H. Freeman & Company
2. Klug, W. S., Cummings, M. R. & Spencer, C - Concepts of Genetics. (12th ed.). New Jersey: Pearson Education
3. Mathur, R.- Animal Behaviour. Meerut: Rastogi.
4. VermaP.S.&Agarwal-DevelopmentalBiology,ChordataembryologyS.Chand&Co.

Web Resources

1.	Continuous Internal Assessment Test	
2.	Assignments	
3.	Seminars	
4.	Attendance and Class Participation	
5.	End Semester Examination	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Simple definitions, MCQ, Recall steps, Concept definitions	
	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
External Evaluation	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	75 Marks
	Longer essay/ Evaluation essay, Critique or justify with pros and cons	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZYBYYP2	HUMAN PHYSIOLOGY AND ECONOMIC ZOOLOGY	Allied Practical II	Y	-	-	-	3	3	40	60	100

1. Differential count of WBC
2. ABO blood grouping in man
3. Estimation of Haemoglobin by Sahil's Method
4. Total erythrocyte count by hemocytometer.
5. Qualitative tests for Carbohydates, Protein, and lipids.
6. Qualitative tests for ammonia, urea and uric acid

SPOTTERS

HUMAN PHYSIOLOGY

Hemoglobinometer, Haemocytometer, pH Meter, Sphygmomanometer

Slides: Nerve cell, Striated muscle, Non-Striated, squamous epithelium, Cardiac muscle

ECONOMIC ZOOLOGY

Eudrilus eugeniae, Lampito mauritii Vermicasts, Vermiwash
Apis *indica*, Honey, Wax,
Bombyx *mori*, Cocoon, Silk gland, Silk thread,
Catlacatla, Lobeo *rohita* , Cirrhinus *cirrhosis*, Oreochromis *mossambicus*

REFERENCE BOOKS:

Lal S.S., A Textbook of Practical Zoology Vertebrate, Rastogi Publication, 2004
Sinha J.,Chatterjee A.K., Chattopadhyay., Advanced Practical Zoology, Books and Allied (P) Ltd., 2011.

WEB-LINKS:

1. https://doi.org/10.1016/B978-0-12-374144-8.00241-1

2.https://krishijagran.com/agripedia/sericulture-an-introduction-to-silk-cultivation-and-production-in-india-along-with-its-policy-initiatives/
3. https://www.youtube.com/watch?v=_y1CHEytZr0

MAPPING (CO, PO, PSO)

L-Low M-Moderate H- High

U20ZYYP1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	H	H	H	L	-	H	H	-	-	H
CO2	H	H	M	H	H	M	-	L	H	H	M	-	H
CO3	H	M	M	M	H	H	-	L	H	H	M	-	H
CO4	H	L	L	H	H	H	-	-	H	M	-	-	M
CO5	H	H	M	H	-	H	-	-	H	H	M	-	H
CO6	H	M	H	L	H	H	M	-	M	-	H	-	H

COURSE ASSESSMENT METHODS

DIRECT
4. Continuous Assessment Test I, II **5. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Project report, Poster preparation, Prototype or Product Demonstration etc.(as applicable)** **6. End Semester Examination**
INDIRECT
1. Course-end survey

Course	**:**	**SEC- II: NME**
Course title	**:**	**INDUSTRIAL ZOOLOGY**
Credits	**:**	**2** **COURSE CODE: U23ZY2E2**

1. COURSE OUTCOMES

On completion of this course, the students will be able to

CO.NO	COURSE OUTCOMES	LEVEL	UNIT
CO1	Analyse the economic importance of earthworms, apiculture, sericulture, Poultry and Pisciculture	K4	I
CO2	Classify the earthworms,honey bees, silkworms, fowls and fishes based on ecological and morphological concepts.	K4	II
CO3	Importance of vermicompost,honey,silk,fowls and fishes and agriculture.	K5	III
CO4	Construct vermicompost, Apiculture,sericulture, Poultry, Pisciculture unit based on the gained expertise.	K4	IV
CO5	Develop the skills in establishing a above mention unit through field visit.	K3	V
CO6	Identify the various diseases of various forming organisms	K3	V

2. SYLLABUS

UNIT IINTEGRATED FARMING SYSTEM (6 Hrs)

Introduction: scope and economics of Industrial zoology - Integrated Farming System. Vermiculture: Ecological classification of earthworm: Preparation of vermibed - management: vermiwash - Economic Importance

UNIT II APICULTURE (6 Hrs)

Apiculture: - species of honeybees - bee colony – Newton's beehive - care and management extraction of honey - nutritive and medicinal value of honey

UNIT III SERICULTURE (6 Hrs)

Sericulture: Introduction - types of silkworm - life cycle of silkworm (Bombyx mori) Species of Mulberry- rearing – reeling - Economic importance of silk

UNIT IV POULTRY FARMING (6 Hrs)

Poultry farming: Classes of poultry: Desi: Aseel,Gagus, Exotic: leghorn. Rhode Island - housing ofchicken: deep litter system, cage system, brooder housings, and grower housings - poultry equipments: feeder, waterer, brooder, cages.

UNIT V PISCICULTURE (6 Hrs)

Pisciculture: types of ponds: Nursery, stocking -management of a pond- Freshwater cultivable fishes: Major carps: Catlacatla, Rohu, Mrigala - induced breeding

Text Books:

1. Shukla G.S and UpadhayV.B.,Economic Zoology ,Rastogi Publications 2004.
2. Jordon E.L and Verma, P.S.,Chordate zoology and elements of Animal Physiology, 1995.

Reference Books:

1. FAO Sericulture Training Manual, Oxford and IBH,1992
2. Gnanamani M.R, Poultry Keeping ,Deepam Publication, 1978
3. SrinivasauluReddy.M ,A**Text Book** of Aquaculture, Sambasiva Rao KRS.,DPH 1994

Web-Links:

1. https://www.sciencedirect.com/topics/nursing-and-health-professions/pisciculture
2. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/apiculture

4. MAPPING (CO, PO, PSO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	H	H	H	H	H	H	H	H	M	H	H
CO2	H	H	H	H	H	H	H	H	H	H	H	H	H
CO3	H	H	H	H	H	H	H	H	H	H	H	H	H
CO4	M	H	H	H	H	H	H	H	M	H	-	H	H
CO5	H	H	H	H	H	H	H	H	M	H	H	H	H
CO6	M	H	H	H	H	H	H	H	M	H	H	H	H

L-Low M-Moderate H- High

5. COURSE ASSESSMENT STUDIES

DIRECT
1. Continuous Assessment Test I,II **2. Cooperative learning report, Assignment; Group Presentation,Projectreport,Posterpreparation, Field Visit and Field Visit Report** **3. End SemesterExamination**
INDIRECT
1. Course-end survey

Course	**:**	**SEC-III**
Course title	**:**	**Ornamental Fish Farming & Management**
Credits	**:**	**2** **COURSE CODE: U23ZY2S3**

Learning Objectives:

- To highlight the importance of ornamental fish culture in relation to entrepreneurship development.
- To enable the identification, culture and maintenance of commercially important ornamental fishes.
- To provide the knowledge on the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

Unit I:
Scope and importance of ornamental fish culture.
Introduction to ornamental fish keeping.
Commercially important ornamental fishes - Indigenous and exotic varieties.
Domestic and global scenario of ornamental fish trade and export potential.

Unit II:
Biology of egg layers and live bearers.
Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture.
Breeding, hatchery and nursery management of egg layers (eg. Goldfish) and live bearers (eg. Guppy).

Unit III:
Aquarium design and construction; Accessories - aerators, filters and lighting.
Aquarium plants and their propagation.
Maintenance of aquarium and water quality management.
Ornamental fish diseases, their prevention, control and treatment methods.

Unit IV
Conditioning, packing, transport and quarantine methods.
Economics, trade regulations, domestic and export marketing strategies.

Unit V
Practical
1) Identification of locally available ornamental fishes - Egg layers and live bearers.
2) Identification of locally available live feed organisms.
Field visit to Aquariculture unit

References:

1. Swain SK., Sarangi N. and Ayyappan S. 2010. Ornamental fish farming. ICAR, New Delhi.
2. Living Jewels – A handbook on freshwater ornamental fish, MPEDA, Kochi.
3. Dey V.K.A. 1997. A handbook on aquafarming ornamental fishes. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. 2008. Text book of aquariculture. Daya Publishing House, New Delhi.

Web links:

1. **http://ecoursesonline.iasri.res.in/course/view.php?id=297**
2. **https://www.ofish.org/**
3. **https://krishijagran.com/agripedia/income-generation-by-ornamental-fish-culture/**
4. https://99businessideas.com/ornamental-fish-farming/

Course Outcome:

- The students will be able to identify, culture, maintain and market the commercially important ornamental fishes.
- The knowledge and skills gained on the different aspects of ornamental fish keeping will enable the students to develop entrepreneurship potential and help in self employment.

SEMESTER – III

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY303	**CELL BIOLOGY AND GENETICS**	Core	Y	-	-	-	5	5	25	75	100

Learning Objectives	
CO1	To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
CO2	To understand how these cellular components are used to generate and utilize energy in cells.
CO3	To understand the cellular components underlying mitotic cell division.
CO4	To apply the knowledge of cell biology to selected examples of changes or losses in cell function.

UNIT	Details	No. of Hours	Course Objectives
I	**History of Cell Biology**- Cell theory - Ultra structure of Animal cell - Cytoplasm - Structure and Composition, Function - Cytoplasmic Inclusions. **Cell components** - Plasma Membrane Ultra Structure - Different Models - Functions-Ultrastructure, Composition and Function of Endoplasmic reticulam, Ribosomes, Golgi Complex, Lysosomes, Centrioles, Microtubules Microfilaments, Mitochondria and Microsomes.	12	CO1, CO2
II	**Nucleus** - Ultrastructure, Composition and Functions -Nuclear Membrane - Nucleoplasm - Chromosomes - Heterochromatin and Euchromatin - Nucleolus - DNA and RNAs. **Cell Divisions and Cell Cycle** - Amitosis, Mitosis and Meiosis and their Significance - Cancer, Biology – Characteristics of cancer cells, types, theories on Carcinogenesis, Ageing of Cells – Apoptosis and Stem cell studies.	12	CO1, CO2, CO4, CO5
III	**Mendelian Genetics and Inheritance:** Mendelian genetics: Mendelian experiments, laws of Mendel, Monohybrid, Dihybrid, back and test cross; Interaction of genes: Incomplete dominance, co dominance, complementary genes, supplementary genes, inhibiting	12	CO1, CO2, CO3, CO4, CO5

	genes, lethal genes and atavism. Inheritance: Polygenic inheritance- skin colour; multiple alleles- ABO blood groups and coat colour in rabbit; extra chromosomal inheritance- shell coiling, kappa particles; sex linked inheritance – eye colour in Drosophila, colour blindness and hemophilia in man.		
IV	**Linkage and Crossing Over**: Linkage: Linked genes, complete and incomplete linkage. Crossing over: molecular mechanisms of crossing over, kinds of crossing over, models of recombination-Chromosome mapping. **Cytogenetics**: Variation in chromosome number and structure: position effect, chromosomal mutation and evolution. Gene mutation: types, molecular basis of mutation, mutational hot spots, reversion; radiation and chemical agents as mutagens; Detection of mutation - ClB method and muller-5 method	12	CO1, CO2, CO4, CO5
V	**Human Genetics:** Karyotype and ideogram; sex determination - Barr body technique, drumstick method; chromosomal abnormalities in humans, Pedigree analysis; diagnosis of genetic abnormalities; Hardy-Weinberg law of equilibrium. **MolecularGenetics:** Protein Synthesis in Prokaryotes- Insertion elements, transposable elements, retroelements; integrons and antibiotic resistance cassettes; the lactose system and operon model, tryptophanoperon.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	To understand and recall the basic structure, origin and development of cell organelles.	PO1
CO2	To integrate and assess the biochemical, cytological and histological tools to infer cellular basis of organization.	PO1, PO2, PO3
CO3	To analyze and differentiate organisms based on structure, composition and inter and intra cellular interactions.	PO3, PO4, PO5
CO4	To explain the role of cells and cell organelles in various biological processes.	PO2, PO3, PO5, PO6, PO8

CO5	To construct and simulate the role of different cytological tools to explain the structure and complexity of cells and cell organelles.	PO3, PO4, PO5, PO6, PO7, PO8
Text Books (Latest Editions)		
1.	Ambrose, E.J. and Dorothy, M. Easty, 1970. Cell Biology, Thomas Nelson & Sons Ltd., 500 pp.	
2.	Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication. p.608.	
3.	VeerBala Rastogi, Introductory cytology. Kedar Nath Ram Nath. Meerut 250 001.	
4.	Verma, P.S. and V. K.Agarwal, 1995. Cell and Molecular Biology, 8th Edition, S.Chand & co., New Delhi - 110 055, 567 pp.	
5.	Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018) Essential Cell Biology 5th Edn.,(paperback) W.W. Norton & Company p.864.	
2.	Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.	
3.	Challoner J. (2015) The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193.	
4.	Cohn, N. S., 1979, Elements of Cytology, Freeman Book Co., New Delhi – 110007, 495 pp	
5.	Cooper G.M. (2019) The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.	
6.	DeRobertis, E.D.P. and E.M.F. De Robertis, 1988. Cell and Molecular Biology, 8th Edition, International Edition, Info med, Hong Kong, 734pp.	
7.	Dowben, R., 1971. Cell Biology, Harper International Edition. Harper and Row Publisher, New York, 565 pp.	
8.	Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.	
9.	Hardin J. and Bertoni G. (2017) Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923	
10.	Karp G., Iwasa J. and Masall W. (2015) Karp's Cell and Molecular Biology Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.	
11.	Loewy, A.G. and P.Sickevitz, 1969. Cell Structure and Function, Amerind Publishing Co., NewDeihi - 110 020, 516 pp.	
12.	Mason K.A., Losos J.B. and Singer S.R. (2011) Raven and Johnson's Biology. 9th Edn. Mc Graw Hill publications. p.1406.	

13.	Powar, C.B., 1989. Essential of Cytology, Himalaya Publishing House, Bombay - 400 004, 368 pp.
14.	Swansen, C.P. and P.L.Webster, 1989. The Cell, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 pp.
15.	Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014) Campbell Biology in Focus. Pearson Education. p.1080.
Web Resources	
1.	http://www.microscopemaster.com/organelles.html
2.	https://bit.ly/3tXwDSB
3.	https://bit.ly/3tWNpRX
4.	https://bit.ly/3AuYR9M
5.	https://rsscience.com/cell-organelles-and-their-functions/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2		S	S	S	S			S
CO 3		S	S	S	S	S		S
CO 4		S	M			M		
CO 5				S	S	S		S

S-Strong(3) M-Medium (2) L-Low (1)

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY3P3	**CYTOGENETICS LAB**	Core	Y	-	-	-	4	4	25	75	100

Learning Objectives	
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.
CO2	To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
CO3	To study the changes in genetic material and to predict and consider the consequences of those changes.
CO4	To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

UNIT	Details	No. of Hours	Course Objectives
I	Preparation and Identification of slides of Mitotic divisions with onion root tips. Preparation and Identification of different stages of Meiosis in Grasshopper Testes. Identification and study of different stages of Mitosis and Meiosis. Buccal epithelium (Barr body) preparation.	12	CO1
II	Staining and observation of polytene chromosomes in salivary glands of chironomous larva. Karyotyping (with the help of photographs) – normal male and female karyotypes and study of karyotypes of different genetic syndromes. Verification of the Mendelian laws of inheritance using coloured beads. Observation on genetic traits.	12	CO2
III	Histochemistry and Micro technique- Fixation and Fixatives: Types of fixatives, Chemistry of fixation, Choice of Fixatives Tissue processing: Dehydration, Clearing and Embedding Microtomy: Types of	12	CO3

	microtomes, Sectioning of Paraffin blocks Staining of paraffin sections: Principle and methods of staining. Histological stains: Haematoxylin and Eosin.		
IV	(1) Culturing and Handling of Drosophila: a) Media Preparation b) Cleaning and Sterilization of bottles c) Handling of Drosophila (2) Morphology and Sexual dimorphism, Study of at least five types of Drosophila, Body color mutant- Ebony body and Yellow body. Wing mutant- Curly wing and Vestigial wing. Eye color mutant- Bar eye, White eye, Sepia eye. Mounting of Sex Comb of Drosophila melanogaster.	12	CO4
V	Study of flower colour in Antirrhinum/ Mirabilis. Coat colour in Mice. Comb pattern in Poultry. Blood Typing. Biometrical Computation of: Mean, Median and Mode, Variance, Standard Deviation. Problems on: Student's 't' test and Chi square test. Genetic problems on Multiple alleles, Gene Interactions (Complemetary/ Supplementary/ Dominant Epistasis gene interactions). Genetic Problems on Linkage and Crossing over: 03 Prs. a) Drosophila. b) Maize. c) Human (Sex Linkage).	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6
CO5	To report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.	PO3, PO8

Text Books
(Latest Editions)

1.	Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
2.	Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
3.	Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.
4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.
2.	Bancroft, J.D. and Gamble, M (2007) Theory and Practice of Histological Techniques, 6 th Edition, Churchill Livingstone.
3.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.
4.	John Kiernan (2008) Histological and Histochemical Methods: Theory and Practice, 4th edition, Cold Spring Harbor Laboratory Press.
5.	Kerr, J. (2013) Functional Histology, Elsevier 6. Kiernan, J.A. (2008) Histological & Histochemical methods: Theory & Practice (4th Ed). Cold Spring Harbor Laboratory Press.
6.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.
	Luiz Carlos (2005) Basic Histology: Text and Atlas (11th Ed). Mc Graw Hill Medical.
7.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.
	Ross, M.H,, Kaye, G.I. & Pawlina, W. (2002) Histology: A text and atlas (4th ed). Lippincoat Williams & Wilkins.
	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.
Web Resources	
1.	https://www.jove.com/

2.	https://vlab.amrita.edu/?sub=3&brch=77	
3.	http://cbii-au.vlabs.ac.in/	
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html	
5.	https://www.ibiology.org/biology-techniques/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
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Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Apiculture.	
Course I	**:**	**SEC IV (Entrepreneurial Based)**
Course title	**:**	**Apiculture**
Credits	**:**	**2** **COURSE CODE: U23ZY3S4**
Pre-requisite:		
Students should be aware of importance of honey bees and their impacts on the ecosystem.		
Expected Course Outcome:		
Upon completion of this course, Students would have		

I	Clear understanding of morphology, life cycle, characteristics of honey bees and bee keeping.	**K1, K2 & K3**
II	Acquired skills to perform bee keeping from managing colonies of bees in order to harvest honey and other Bee related by-products in different setups and as an Entrepreneurial venture.	**K3, K4 & K5**
III	Knowledge on the harvesting, preserving and processing of bee products and identification of the appropriate markets to sell the produce.	**K5 & K6**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Units	
I	Introduction to Apiculture. History, classification, types, life Cycle of different species of Honey Bees and their behavioural patterns. Social organization of bee colony
II	Bee-keeping system, tools and equipment's needed for bee keeping. Types of bee hives, structure and functional features. Criteria for site selection for apiculture and factors affecting them.
III	Identification and characteristics and Preventive measures to be taken against of different bee enemies. Diseases affecting honey bees and their control measures. Colony collapse disorder and its management.
IV	Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom. Harvesting, Processing, Packaging and Marketing of bee products.
V	Apiculture industry around the world and Role of Central Bee Research & Training institute in India.

Reading list

1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA)
2. Sharma P.L. and Singh, S.H. Book of Bee keeping.
3. Cherian and Ramanathan, S. Bee keeping in south India.
4. Prospective in Indian Apiculture - R.C. Mishra.

Recommended texts

1. Caron, D.W. 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT, 368 pp.
2. Kaspar, R., C. Cook, and M. D. Breed. 2018. Animal Behaviour 142: 69-76.
3. Hendriksma, H. P., A. L. Toth, and S. Shafir. 2019. Individual and Colony Level Foraging decisions of Bumble Bees and Honey Bees in Relation to Balancing of Nutrient Needs. Frontiers in Ecology and Evolution 7: 177.
4. Steinhauer, N. et al. 2018. Drivers of Colony Loss. Current Opinion in Insect Science 26: 142-148.
5. Technology and value addition of Honey - Dr. D. M. Wakhle and K. D. Kamble.
6. ABC & XYZ of Bee culture - A. I. Root.

Mapping with Programme Outcomes*										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	L	L	S	L	S	S	L	M
CO2	S	S	S	S	S	S	L	L	S	S
CO3	S	L	M	M	S	M	M	L	L	L
CO4	M	S	L	S	L	M	L	M	M	M
CO5	S	L	L	S	L	M	L	L	M	L

*S - Strong; M - Medium; L-Low

Course	**:**	**SEC- V**
Course title	**:**	**BIOPHYSICS AND BIOSTATISTICS**
Credits	**:**	**2** **COURSE CODE: U23ZY3S5**

Learning objectives

1. To understand the concepts of diffusion, osmosis, centrifugal force, surface tension.
2. To understand the techniques for the separation of biomolecules.
3. To understand radiology, sonography, Laser techniques for biological and medical application.
4. To know to calculate standard deviation, correlation coefficient, chi-square analysis and student 't' test using the formula.

Unit I: Biophysical Principles: Physical laws in living system: Biological significance of diffusion–Osmosis–Osmoticpressure- Principles of viscosity–Brownianmovement–surfacetension—Centrifugation: Principle–types–applications.

Unit II: Applications of Biophysics: Principle and applications of colorimeter – electrophoresis –principle, instrumentation – applications of gel electrophoresis– Radioactive isotopes – Autoradiography. Medical and biological uses of X-rays, Ultrasound and Laser

Unit III: Collection and Classification of Data:. Collection of data: Primary – secondary data. Statistical population and sampling in biological studies. Types of Classification: Qualitative – quantitative. Variables: discrete – continuous. Frequency distributions.

Unit IV: Presentation of Data: Tabulation: Types – Components – advantages. Diagrammatic and graphical representations of data: Bar diagrams (Simple, multiple, subdivided and percentage) – Pie diagram – Frequency diagram: histograms – frequency polygon – frequency curve – line graphs.

Unit V: Descriptive & Inferential Statistics: Measure of central tendency: Arithmetic mean – median– mode. Measures of dispersion: Standard deviation – Standard error– Coefficient of variance.– Student 't' test.

Text Books

1. Das,D.,1996.BiophysicsandBiophysicalChemistryforMedicaland Biology students, Academic,Calcutta. 302pp.
2. Subramanian,M.A.,2016.Biophysics–PrinciplesandTechniques,MJP,Chennai. 324pp.
3. Gurumani,N.,2005.AnintroductiontoBiostatistics,MJP,Chennai, 250pp.
4. Palanichamy,SandM.Shanmugavelu,1991.PrinciplesofBiostatistics.Palani Paramount.India. 350pp

5. Roy, R.N. 1996. A Text Book of Biophysics, New Central Book Agency Ltd, Calcutta. 992pp.

Suggested Readings

1. Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, 2011. Biostatistics:Principlesandpractices.MacGrawHillEducationPvt.Ltd.New Delhi. 349pp.
2. BettyKarasek,2015.Advancedconceptsofbiophysics,CallistroReference, 198pp.
3. Daniel,W.W.,2000.Biostatistics:Afoundationforanalysisinthehealthsciences, 7thEd.JohnWiley&SonsLtd.NewYork. 328pp.
4. EdwardK.Yeargers,2018.BasicBiophysicsforBiology,CRCPress,USA.195pp
5. Gurumani, N., 2006. Research methodology for biological sciences, MJP, Chennai. 753pp.
6. Harvey Motulsky, 2015. Essentials of Biostatistics. A non mathematical approach.OxfordUniversityPress.NewYork. 208pp.
7. MichaelC.,WhitlockandDolphSchluter,2009.Theanalysisofbiologicaldata, 2ndEd.MacMillanPublishers,NewYork,USA.818pp.
8. Narayanan, R., 2010. Essentials of biophysics, II Ed., New age International publishers,Chennai. 546pp.
9. Pranab Kumar Banerjee, 2014. Introduction to biostatistics (A Text Book of Biometry,S. Chand&CompanyLtd.NewDelhi,India. 208pp.
10. RodneyM.J,Cotterill,2002.Biophysics:Anintroduction,JohnWiley&SonsLtd. NewYork. 400pp.
11. Ronser,B.,2006.FundamentalsofBiostatistics, ThomsonBrooks/Cole,6thEd. Duxbury press,Singapore.784pp
12. Sail Bose, 2000, Elementary Biophysics, Vijaya printers, Maduari.
13. Tanford,C.,1961.Physicalchemistryofmacromolecules,JohnWiley&SonsLtd. England. 710pp.
14. Yadav,B.S.,2020.Textbookofbiophysics,ArjunPublishingHouse,NewDelhi.

Web Resources:

1. https://bit.ly/2XGFuML
2. http://www.life.uiuc.edu/molbio/geldigest/electro.html
3. http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf
4. http://www.biostathandbook.com/analysissteps.html
5. https://bit.ly/3nXUIrD
6. https://onlinecourses.nptel.ac.in/noc19_bt19

Course outcomes (COs)

1. Understand and recall the basic biophysical concepts, statistical data and formula.

2. Apply suitable physical techniques and statistical methods to solve biological problems.
3. Identify and relate the bioanalytical techniques and statistical principles for the application of biological experiments.
4. Select suitable biophysical techniques to study the biological process and statistical approach to assess the experimental results.
5. Integrate the bioanalytical techniques and statistical methods to validate research investigations.

SEMESTER -IV

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY404	**Developmental Biology**	Core	Y	-	-	-	5	5	25	75	100

Learning Objectives	
CO1	To create an awarenessto the students about the theories, concepts and basics of Developmental Biology.
CO2	To provide students about the idea of sex cells, fertilization, cleavage, differentiation and development of organs.
CO3	To make an awareness of the induction, organizers and development of extra embryonic structures.
CO4	To provide adequate explanation to students about the late embryonic developments and post embryonic development and ageing
CO5	To give an idea about teratogenesis, invitro fertilization, stem cells and amniocentesis to the students

UNIT	Details	No. of Hours	Course Objectives
I	**Gametogenesis & Fertilization** Basic concepts of developmental biology. Structure& types of Spermatozoa, Mammalian egg - Egg membranes. types of egg - Spermatogenesis – Oogenesis. Fertilization – mechanism, theories and significance – Parthenogenesis.	12	CO1
II	**Blastulation& Gastrulation** Cleavage - Planes and Patterns, Factors controlling cleavage - Fate map and its construction. Blastulation – types of blastula. Morphogenetic movements - Gastrulation of frog	12	CO2
III	**Organogenesis** Development of Brain, Eye and Heart in frog.. Foetal membranes in chick and mammals. Development of Pro, Meso Metanephric kidneys. Placentation in Mammals.	12	CO3
IV	**Applied Embryology** Organizer concept –Structure – mechanism of induction and competence. Nuclear transplantation - teratogenesis – Regeneration: types - events and factors. Embryonic stem cells & significance. Methods to culture embryo	12	CO4

V	**Human embryology** Menstrual cycle and menopause - Erythroblastosis foetalis -Twins – types. Infertility – causes - Test tube baby and Assisted Reproductive Technology – Embryo transfer – Amniocentesis.	12	CO5
		60	

Course Outcomes		
CO1	To describe and illustrate the significance of cellular processes in embryonic development.	PO1
CO2	To relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.	PO1, PO2
CO3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.	PO4, PO6
CO4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.	PO4, PO5, PO6
CO5	To justify and validate the role of environment and genetics in influencing embryonic development	PO3, PO8

Text Books
(Latest Editions)

1.	Lewis Wolpert 2007. Principles of development, 3rd edition, Oxford University Press, New Delhi, India
2.	Subramoniam, T. 2003. Developmental Biology, Narosa Publishing House, New Delhi, India.
3.	Verma, P.S., Agarwal, V. K.2010.Chordate Embryology: Developmental Biology, S. Chand & Company, New Delhi., India.

References Books
(Latest editions, and the style as given below must be strictly adhered to)

1.	Gilbert S.F. 2010. Developmental Biology, Sinauer Associates, Massachusetts, USA.
2.	Balinsky, B.I. 1970. Introduction to Embryology, Philadelphia & London, UK.
3.	Berril, N.J.1971. Developmental Biology, McGraw Hill, New York, USA.
4.	Russ Hodge 2010. Developmental Biology, Facts on File, Inc., New York, USA.
5.	Carlson, Bruce, M. 2009. Human embryology and Developmental Biology, Elsevier, Philadelphia, USA

Web Resources

1.	https://www.ncbi.nlm.nih.gov/books/NBK10052/

2.	https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html	
3.	https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468	
4.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) M-Medium (2) L-Low (1) B N

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY4P4	ENVIRONMENTAL TOXICOLOGY LAB COURSE	Core	Y	-	-	-	3	3	40	60	100

Learning Objectives	
CO1	To explain the main mechanisms of environmental toxicants in causing a toxic response in living organisms.
CO2	To describe the optimal use of nature, in the form of plants, animals, bacteria, fungi and algae, to produce renewable energy, food and nutrients in a synergistic integrated cycle of profit-making processes
CO3	To provide practical knowledge and hands on tools and techniques for dose-response assessment of hazardous substances.
CO4	The use of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes.
CO5	To develop data that can ensure appropriate protection of public health from the adverse effects of exposures to environmental agents.

UNIT	Details	No. of Hours	Course Objectives
I	**Estimation Methods**: Estimation of Ammonia, Nitrites, Determination of hardness of water. Environmental Determinants: Estimation of BOD/ Estimation of COD.	12	CO1
II	**Toxicity Testing**: Methodology of toxicity testing – acute and chronic tests (demonstration), Use of LC50 values – sub lethal effects of critical pollutants on fish.	12	CO2
III	**Preparation of nutrient agar medium**. Settling rate of bacteria from air. Bacterial Gram staining. Culture techniques- Streak plate, spread plate, pour plate,agar slant -Identification of bacteria from air up to colony characteristics. Enumeration of bacteria from air. Study of collection, concentration and preservation techniques of algae. Identification techniques of algae (Study of morphological characteristics of algae). Antibiotic sensitivity tests- Kirby Bauer Disc Diffusion method. Calculation of Nygaard's Indices. Calculation of species diversity - Estimation of Standard Plate Count (SPC) from water. Estimation of MPN of coliforms from water.	12	CO3
IV	Determination of phosphate levels in clean and polluted waters. Determination of pH of soil. Determination of organic matter in soil. Determination of percent composition of soluble and insoluble components of community solid waste. Determination of percent	12	CO4

	composition of various components of community solid waste.		
V	Mini Project and Spotters: Bio gas production - Food toxicity tests - Field visit, Reflux condenser, BOD incubator, Spectrophotometer, Colorimeter, Atomic absorption spectroscopy, Ultracentrifuge, Incubator, HPLC. Visit to wastewater and drinking water treatment plants. Study of a vermicompost plant. Bio gas production - Visit to wastewater and drinking water treatment plants. Study of a vermicompost plant.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand the properties of toxicants, effects, origin and occurrence in the environment and explain the principle and procedure for quality evaluation, monitoring and remediation of contaminated environments.	PO1
CO2	Estimate the toxic chemicals in the environment. Apply tools and techniques for experimenting with environmental problems. Identify and implement solutions to the problems.	PO1, PO2
CO3	Analyse the consistent and inconsistent range of elements. Interpret the role of the elements in environmental pollution and the effects on organisms.	PO4, PO6
CO4	Relate the metabolic activity, diseases, ill health and death with reference to exposure to chemicals. Select the suitable experimental design to assess the toxic effects of pesticides and pollutants.	PO4, PO5, PO6
CO5	Discuss the applicability of chemical analysis and toxicity data, both individually and together, in risk assessment and environmental monitoring.	PO3, PO8

Text Books
(Latest Editions)

1.	Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
2.	DAS H.K.,2005. Text Book of Biotechnology. Wiley Dreamtech Pvt Ltd, New Delhi.
3.	Rastogi, S.C., 2005. Experimental physiology, New age International publishers, New Delhi.
4.	Ramesh, R and M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
5.	Micheal, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.
6.	Agarwal, A. State of India's Environment: A Citizens Report, Centre for Science and Environment, New Delhi.

7.	Goel, P.K. Water Pollution: Causes, Effects and Control. New Age International, Publishers, New Delhi (2006).	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Allan S. Cragg, 2010. Environmental Biotechnology, Oxford University Press. UK.	
2.	APHA, 1992. Standard Methods for the examination of water and waste water, American Public Health association,Washington D.C.	
3.	APHA, 2005. Standard Methods for the examination of water and waste water, 21st Ed., American Public Health association, Washington D.C.	
4.	Boyd C.E., 1992. Water Quality and Pond Soil Analysis for Aquaculture, C.E. Boyd, C.S. Tucker,Auburn University.	
5.	Csuros, M., 1994. Environmental Sampling and Analysis for Technicians, M. Lewis Publishers,Boca Raton.Florida.	
6.	Eugenia et al, 2008. Environmental Biotechnology and cleaner Bio Process, Taylor& Francis London, UK.	
7.	Francis, B.M., 1994. Toxic Substances in the Environment, John Wiley and Sons.	
8.	Hauser, B.A., 2001. Drinking Water Chemistry: A Laboratory Manual, Lewis Publishers,Boca Raton, Florida	
9.	Maier, R. M., Pepper I.L. and C. P. Gerba, 2009. Environmental Microbiology. 2nd ed. AcademicPress. USA	
10.	Rastogi, S.C., 2005. Experimental physiology, New age International Pvt. Ltd. New Delhi.	
11.	Rump, H.H., 1999. Laboratory Manual for the Examination of Water, Wastewater and Soil,3rd Ed., Wiley-VCH, New York.	
Web Resources		
1.	http://www.envexp.com/technical/method-downloads/cod-method-410	
2.	https://bit.ly/3u6o0Fb	
3.	https://bit.ly/3hX8Ux0	
4.	https://bit.ly/3EN2nz0	
5.	https://www.ncbi.nlm.nih.gov/pubmed/2170158	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	

Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course	**:**	**SEC- VI**
Course title	**:**	**LIFE SKILLS**
Credits	**:**	**2** **COURSE CODE: U23ZY4S6**

General Objectives:

1. To acquire skills and abilities for adaptive and positive behavior that helps to deal effectively with thedemands and challenges of everyday life.
2. To develop creative, communicative and critical thinking skills necessary for employability

UNIT I Basics of Communication skills & Effective Communication

Features of Communication – Process of Communication Verbal, nonverbal,Body Language – Postures& Etiquette –Listening& speaking Skills- Communication Barriers – Listening & speaking Skills.

Unit II Personal Effectiveness

Maslow's theory – Self-esteem- Role Conflict – Intra &Inter personal Skills – Efficiency Vs effectiveness – Team Building – Emotional Intelligence & Quotient

Unit III Interview Skills

Types of Interviews – Resume Formats & preparation - Cover letters – Simple rules to face interviews –Dos &Don'ts in a an Interview – Telephonic Interview and Etiquette - Group Discussions – Types –Methods – Ingredients and Tips for a Successful Group Discussion.

Unit IV

Test of Reasoning & Numerical Ability

A. Numerical Ability: Problems related to Average – Percentage – Profit /Loss – Simple & Compound InterestTime& Work – Boats & Streams etc.
B. Logical reasoning: Logical Detection – Nonverbal reasoning – Problems related to seating arrangements –Relationship model – Assertion & Reasoning etc.
C. Online Tests:Aptitude – Logical Reasoning – Problem Solving –Time management in Online tests- Onlinetests on Language skills- Aptitude and technical rounds

Unit V

Outbound Learning, Physical, Mental, and emotional exercises

Texts Books for Reference:

1. Barun.K.Mitra, Personality Development and Soft Skills, 6th edition, Oxford University pressNoida 2012.
2. M.Sarada, The complete Guide to Resume Writing, Sterling Publishers Pvt Ltd, New Delhi 2012.
3. Gloria J.Galances& Katherine Adams,Effective Group Disscussions,Theory& practice,12th Edition, Tata McGrawHillpvt Ltd 2012.
4. Francis Soundararaj, Basics of Communication in English, SoftSkills for Listening Speaking,Reading& Writing, Macmillan Publishers India Ltd. 2013.

Course	**:**	**SEC- VII**
Course title	**:**	**Integrated Farming System and management**
Credits	**:**	**2** **COURSE CODE: U23ZY4S7**

1. Course Outcomes (only five outcomes – unit wise)

CO No.	Course Outcomes	K - Level	Unit
CO1	To comprehend the key concepts of S-L and differentiate the community service and Service-Learning	K2	1
CO2	To discuss the importance of Integrated farming system	K2	2
CO3	To construct a model for sustainability and waste management concepts	K3	3
CO4	To apply the essential practices of IFS system in the model village/ community	K3	4
CO5	To analyze the quality of byproducts and improve the marketing strategies	K4	5

Unit 1

Service-Learning – Definition, difference between community service and service-learning, Principles; Whole Person Education. Identifying Community Needs, Community Partners, Reflection, Reciprocity. Public Dissemination; Understanding of community dynamics. Project Planning Stages and report preparation

Classroom Activity:

i. Group discussion about Civic/Social responsibility (Display of Video/Documentary film (Through this activity Students should recognize civic responsibility of the society)
ii. Conduct a role play/games/drawing to provide problem solving skill and ignites critical thinking.
iii. Group activity to frame questionnaire for identify community needs
iv. Reflection on identify the need of the community (Students go to the community for identify the community needs and reflect their experience)

Unit 2

Sustainable Agriculture: - Principles and concepts – cropping patterns; Integrated Farming Systems– Introduction, Scope and Economic Importance; Resource recycling in IFS - Evaluation indicators of integrated farming system Integrated Pest Management & Crop Management - Organic agriculture concepts

Classroom Activity:

i. Group discussion about sustainable agriculture
ii. Model preparation about IFS (Through this activity the students can develop their skills to build and ideal faming system in the adopted/ selected village/agricultural land).
iii. Group activity to frame questionnaire for identify community needs
iv. Reflection on identify the need of the community (Students go to the community for identify the community needs and reflect their experience)

Unit 3

Resource and Labour :- Management-Resource management under constraint situation - Cost reduction strategies in crop production - Nonmonetary inputs and low cost technologies - Labour management - farming system and environment

Classroom Activity:

i. Group discussion / chart presentation about Resource management
ii. Discussing the labour issues with government officials to meet the need of the people in the village
iii. Documentation (through audio or video models) about crop production & labour management
iv. Preparing journals regarding the Resource and Labour issues

Unit 4

Implementation of IFS Models:- Pisciculture, Apiculture, Vermiculture - Livestock management – Goat, Sheep & cattle .Agronomic approaches for increasing overall productivity and sustainability of IFS.

Field Activity

i. Conducting awareness programs on IFS
ii. Implementation of IFS models in the farm
iii. Monitoring the maintaining the IFS models (Frequent visits to collect datas)
iv. Visualization tools usage to increase the productivity

Unit 5
Byproduct & Marketing:-Production of Fish manure/fertilizer, Collection of Honey & honey associated products, preparation of vermicompost & by products from Livestock – Marketing the byproducts in the society **<u>Field Activity</u>** i. Implementation of by product production in farm ii. Sale of Farm products iii. Can create a platform in our college to improve the sales of by products iv. Compilation of collected data and presentation of project (PPT)

b. Text Books

- Shukla G.S and Upadhay, Economic Zoology, V.B. Rastogi Publications, 2004.
- Ravikiran Vasant Mane, Integrated Farming System, Scitus Academics,2015

c. References

- Srinivasaulu Reddy M, Sambasiva Rao, A Text Book of Aquaculture, KRS, DPH,1994
- Little D.C, Integrated Livestock fish farming systems, FAO Publishers,2003
- Dahama, A.K.2009. Organic farming for sustainable agriculture, Agrobros publishers.

SEMESTER- V

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY505	**EVOLUTIONARY BIOLOGY**	Core	Y	-	-	-	4	5	25	75	100

Learning Objectives	
CO1	Evolutionary biology is a branch of the biological sciences concerned with the origin of life and the diversification and adaptation of life forms over time.
CO2	This course helps to understand the important processes, principles, and concepts on evolution.
CO3	To provide adequate information on the Lamarckism - Neo Lamarckism – Darwinism, Neutral Theory of Molecular Evolution, and Human Genome Project.
CO4	To explain the importance of the fossil records in evolutionary studies, and the role of phylogenetic studies in the wider context of biodiversity and conservation.
CO5	In this course, we will apply the knowledge of human evolutionary history to simulate how genetic variation within and among human populations affects risk, diagnosis, and treatment of modern diseases.

UNIT	Details	No. of Hours	Course Objectives
I	Inorganic and organic evolution-History of evolutionary thought, Primordial earth and primeval atmosphere, Chemical origin of life: Synthesis of organic molecules, Urey-Miller experiment, Origin of prokaryotes and eukaryotes.	12	CO1
II	Lamarckism - Neo Lamarckism - Darwinism - Neo Darwinism and modern synthetic theory - DeVrie's Mutation theory – modern concepts of mutation - Mutation and their role in evolution - Animal colouration and Mimicry.	12	CO2
III	Isolating mechanisms - Modes of speciation- Hybridization is an evolutionary catalyst- Law of Adaptive Radiation- Adaptive radiation in reptiles and mammals - Convergence and parallelism - Evolutionary constancy.	12	CO3

IV	Morphological, physiological and biochemical, embryological, Taxonomical and geographical evidences -Palaeontological evidences – evolutionary genomics. Types of rocks - Geological time scale – Nature of fossils- Dating of fossils - Fossil records of man and fossil records of horse.	12	CO4
V	Natural selection in action in man- level of selection- Eugenics, Euphenics and Euthenics- Adaptation- Human Genome Project – Evolution and ethics.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To understand the Primordial earth and theories on origin of life	PO1	
CO2	To integrate and assess Lamarckism - Neo Lamarckism – Darwinism	PO1, PO2	
CO3	To analyse various fossil records of man and fossil records of horse, various types of rocks - Geological time scale.	PO4, PO6	
CO4	To explain the Nature of fossils- Dating of fossils, evidences of evolution, Adaptive radiation in reptiles and mammals,	PO4, PO5, PO6	
CO5	To construct and compile the role of Human Genome Project, Evolution in the diagnosis, and treatment of diseases.	PO3, PO8	
Text Books (Latest Editions)			
1.	Ridley, M., 2004. Evolution. III Edition. Blackwell Publishing.		
2.	Lull, R.S. 2010. Organic evolution, The Macmillan, New York.		
3.	Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company		
4.	Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.		
5.	Dr. Kishore R. Pawar, Dr. Ashok E. Desai, 2019. A text book of Organic Evolution, Nirali Prakashan,		
6.	Rastogi VB. 1991. Organic Evolution. Kedar Nath Ram Nath Publications, Meerut,Uttar Pradesh, India.		

7.	Stricberger, M.W., 1996. Evolution. Jones& Bartlett, USA	
8.	Colbert, E.H. Morales, M. and Minkoff, E.C. 2011. Colbert's Evolution of The Vertebrates: A History of the Backboned Animals Through Time, Wiley, India.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Burns GW. 1972. The Science of Genetics. An Introduction to Heredity. Mac Millan Publ. Co.Inc.	
2.	Gardner EF. 1975. Principles of Genetics. John Wiley & Sons, Inc. New York.	
3.	Harth and Jones EW. 1998. Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.	
4.	Levine L. 1969. Biology of the Gene. Toppan.	
5.	Pedder IJ. 1972. Genetics as a Basic Guide. W. Norton & Company, Inc.	
6.	Rastogi VB. 1991. A Text Book of Genetics. Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.	
7.	White MJD. 1973. Animal Cytology and Evolution. Cambridge Univ.Press.	
Web Resources		
1.	https://bit.ly/3nPD09m	
2.	https://bit.ly/3CHOdgL	
3.	https://bit.ly/2XvcCXl	
4.	https://bit.ly/2XAL1Vh	
5.	https://bit.ly/3zoU9Jl	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY506	ANIMALPHYSIOLOGY	Core	Y	-	-	-	4	5	25	75	100

Learning Objectives	
CO1	TofamiliarisestudentswiththeprinciplesandbasicfactsofAnimalPhysiology
CO2	Togivestudentsaninsightaboutthemolecularandcellularbasisofphysiologicalfunctionsin animals.
CO3	Togiveanideaabouttheregulationoforgansystemfunctionsinawholeanimalusingaconceptualmodel offeedback to explain homeostasis.
CO4	Tomakethe students awareabouthowthestructure-functionrelationships and its synchronisationwiththemolecularsignals.

UNIT	Details	No. of Hours	Course Objectives
I	**Nutrition & Respiration** Nutrition:Digestion and absorption of carbohydrates proteins and lipids. Minerals&Vitamins–theirdeficiency.Hormonalcontrolofdigestion. Types of Respiration, Respiratorypigments-structureofHaemoglobin,Transportationofgases-Bohreffect-Regulationofrespiration-bronchitis,asthma - Physiologicaleffects of smoking	12	CO1
II	**Circulation&Excretion** Blood- composition and functions, Mechanism of clotting. Types of Hearts – Heartbeat and its regulation -pace maker – Cardiac cycle – ECG - Pulse and blood pressure. Nephron structure &mechanismof urine formation, Regulation of acid base balance, Excretoryproducts, Osmoregulation infishes.	12	CO2
III	**Muscle&NervePhysiology** Types of muscles – Ultrast ructure of striated muscle, Muscle contraction & properties,Neurons–structure&types-Impulsepropagation,synaptictransmission,neurotransmitters - Reflex action, Nerve disorders – epilepsy,	12	CO3

	Alzheimer's disease, Parkinson'sdisease.		
IV	**SenseOrgans** Structure of eye, physiology of vision, visual elements and pigments, photo chemistry ofvision - Eye defects – myopia, hyperopia, presbyopia, astigmatism, cataract - Structureof ear and mechanism of hearing - Hearing impairments – deafness, labyrinthine disease - Olfactory,gustatoryandtactile sense organs	12	CO4
V	**ReproductivePhysiology** Endocrine glands in man - Hormones, action and disorders - Feed-back mechanism,Outlinesofmechanismofhormonalactivity. Puberty,adolescence,pregnancy,parturition,lactation andbirth control.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	beabletoexplainhowthevariousorgansystemsarecoordinatedand controlled.	PO1	
CO2	beabletolistthefunctionsofvariousorgansinrelationtophysiologicalprocess.	PO1, PO2	
CO3	be able todeveloptheideaofmultilevelcontrollingandfeedbackmechanisminrelationto various physiological functions.	PO4, PO6	
CO4	beabletounderstandthebasicphysiologicalprocessrelated toadaptation,metabolism and majorrequirements.	PO4, PO5, PO6	
CO5	be able to correlate and understand human physiology.	PO3, PO8	
Text Books (Latest Editions)			
1.	Agarwal R A., Anil K Srivastava., Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 pp.		
2.	Ambika Shanmugam, 2001. Fundamentals of Biochemistry for Medical students, Karthik Offset Printers, Chennai, 590pp		
3.	Berry A.K.1998. A text book of Animal Physiology and Biochemistry. Emkay Publications, New Delhi, 320 pp.		
4.	Parameswaran, Ananta krishnan and Ananta Subramanian, 1975. Outlines of Animal Physiology, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.		

5.	Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 pp.	
	Ganong, W.F., 2019. Review of Medical Physiology, McGraw Hill, New Delhi., 340 pp.	
	Hill, W.R., Wyse, G.A and Anderson, M. 2016. Animal Physiology (4thedn). Sinauer Associates is an imprint of Oxford University Press; USA, 828 pp.	
2.	Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi, 928 pp.	
3.	Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 pp.	
4.	Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., 2018. Text Book of Human Physiology, S. Chand & Co, New Delhi.	
5.	Singh, H.R and Kumar, N. 2017. Animal physiology and biochemistry, Vishal publishing company, Jalandhar, 864 pp.	
6.	Sreekumar, S. 2010. Basic physiology, PHI learning private ltd., New Delhi.210 pp	
7.	Tortora G.J. & Derrickson B., 2016. Principles of Anatomy and Physiology, John Sons, Inc. 1232 pp.	
	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London., 342 pp.	
Web Resources		
1.	https://microbenotes.com/category/biochemistry/	
2.	https://www.stem.org.uk/resources/collection/3931/animal-physiology	
3.	https://animalphys4e.sinauer.com	
4.	https://nptel.ac.in/courses/102/104/102104042/	
5.	https://biochem.oregonstate.edu	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		

Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY507	ENVIRONMENTAL BIOLOGY	Core	Y	-	-	-	4	5	25	75	100

Learning Objectives	
CO1	To understand the structure and functions of the ecosystem.
CO2	To explain the relationship between biotic and abiotic factors in an ecosystem.
CO3	To know the causes and effects of climate change and habitat loss.
CO4	To bring awareness about the impact of socio-economic development on the environment and the solutions put forward by the government to reduce environmental damage.

UNIT	Details	No. of Hours	Course Objectives
I	**Ecosystem** : Concept of an ecosystem-Structure and function of an ecosystem- Producers, consumers and decomposers-Energy flow in the ecosystem-Ecological succession-Food chains, food webs and ecological pyramids-Introduction, types, characteristic features, structure and function of the following ecosystem : Forest ecosystem-Grassland ecosystem-Desert ecosystem-Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).	12	CO1
II	**Population And Biological Cycles :** Structure and distribution – Growth curves - Groups, natality, Mortality -Density indices, Life study tables - factors affecting population growth -Carrying capacity. Population regulation and human population control. Complete and incomplete biogeochemical cycles - Sedimentary cycle.	12	CO2
III	**Environmental Stresses And Management** :Global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition. Uptake, biotransformation, elimination and accumulation of toxicants. Factors	12	CO3

	influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals.		
IV	**Environmental Pollution**: Definition- cause, effects and control measures of: -Air pollution - Water pollution - Soil pollution -Marine pollution - Noise pollution - Thermal pollution -Nuclear hazards.	12	CO4
V	**BiodiversityConservation**: Biodiversity crisis – habitat degradation, poaching of wild life. - Socio economic and political causes of loss of biodiversity. - In situ and ex situ conservation of biodiversity -Hot spots of Biodiversity. Green peace movement - Chipko Movement - Role of government agencies: Central and State Pollution Control Boards - Ministry of Environment and Forests- National Biodiversity Authority. Awareness, Programme, NGOs, Natural Disaster Management, Legislations for environmental Protection, Bio villages – sustainable utilization and development, Environmental ethics.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	Understand the fundamental structure and functions of the ecosystem.	PO1	
CO2	Assess the inter-relationship between organisms and between biotic and abiotic factors in an ecosystem.	PO1, PO2	
CO3	Analyze the factors that cause pollution, climate change, loss of biodiversity and depletion of resources.	PO4, PO6	
CO4	Evaluate the impact of human population growth and socio-economic development on the structure and function of the ecosystem.	PO4, PO5, PO6	
CO5	Design plans to scientifically solve environmental problems using biological tools, technologies and government policies.	PO3, PO8	
Text Books			

(Latest Editions)		
1.	Matthew R. Fisher, 2018. Environmental Biology.Open Oregon Educational Resources. James Madison University.	
2.	Asthana, D.K. and Meera, A. 2009. A text book of environmental studies, S. Chand, New Delhi.	
3.	Sanyal, K. Kundu, M. and Rana, s. 2009. Ecology and environment, Books and allied, Kolkata.	
4.	Grant, W.E. and Swannack, T.M., 2008, Ecological Modelling, Blackwell.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Odum E.P.1983. Basic Ecology, Saunders, New York	
2.	Wilkinson, D.M., 2007, Fundamental Processes in Ecology: An Earth system Approach, Oxford University Press, UK.	
3.	Saha, T.K. 2010. Ecology and Environmental biology, Books and Allied, Kolkata.	
Web Resources		
1.	https://bit.ly/2VYWOM5	
2.	https://bit.ly/2VZQFiT	
3.	https://bit.ly/3kqdXYA	
4.	https://bit.ly/39rvvgt	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY5P5	**ECO- PHYSIOLOGY LAB COURSE**	Core	Y	-	-	-	5	4	25	75	100

Learning Objectives	
CO1	To demonstrate an understanding of core ecological principles, and define scientific principles and concepts as related to environmental studies and sustainability.
CO2	To understand the physiological processes that regulate body functions.
CO3	To strive to demonstrate the role of experimentation in developing our understanding of living animals.
CO4	To attain knowledge of important biomolecules such as carbohydrates, lipids, amino acids, proteins and enzymes.
CO5	Measure and interpret experimental data and demonstrate laboratory skills in animal physiology and ecology.

UNIT	Details	No. of Hours	Course Objectives
I	**Estimation of Abiotic Factors**: Estimation of dissolved Oxygen, Dissolved carbon-di-oxide, Determination of alkalinity in water samples, Determination of salinity of water samples, Determination of bicarbonate and carbonates.	12	CO1
II	**Digestive Enzymes**: Survey of digestive enzymes in Cockroach, counting of cockroach haemocytes using haemocytometer. Ptyalin activity in relation to temperature and pH in human saliva. Ecological Methods: Estimation of oxygen consumption in an aquatic and a terrestrial animal.	12	CO2
III	**Biochemical Tests**: Use of pH meter for estimation of pH in water and soil samples, Study of micro arthropods of water and soil samples (Tullgren's funnel method and Ladell's Floating Method). Collection, isolation, identification and mounting of marine and freshwater	12	CO3

	plankton.Study of sandy shore fauna- Study of rocky shore fauna - Study of animal Association.		
IV	**Qualitative Detection of Biomolecules**: Qualitative tests for identification of carbohydrates, proteins and lipids. Amino acid in haemolymph of any insect by chromatographic technique. Estimation of Haemoglobin by Cyanmethemoglobin method, Blood grouping - total and differential counts. Determination of plasma hemoglobin, Total erythrocyte count by hemocytometer.	12	CO4
V	**Field Work**: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site- Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.	12	CO5
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	List and recall the basic equipment used in physiology and ecology lab and develop skill about quantitative determination of biomolecules and quantitative analysis of blood.	PO1	
CO2	Demonstrate the instruments, discuss the clinical importance and its applications, and explain the principle of bioinstruments.	PO1, PO2	
CO3	Understand and identify the chemical composition of major and minor nutrients and analyse Physio - chemical parameters that regulate metabolism.	PO4, PO6	
CO4	Evaluate and Examine the various parameters of haematology and biochemistry and Identify the nitrogenous waste products of animals.	PO4, PO5, PO6	
CO5	Summarise the effect of various physical and chemical factors on enzyme activity/. Compile the changes in various physiological parameters in man and other animals using various tools and techniques.	PO3, PO8	
Text Books			

(Latest Editions)	
1.	Widmaier, E.P., Raff, H. and Strang, K.T. 2008. Vander's Human Physiology, XI Edition., McGraw Hill., 770 PP.
2.	Bishop, ML.,Fody, E.P., Schoeff, LE. 2010. Clinical Chemistry: Principles, Procedure, correlations. Wolters Kluwer, Inida, 298 PP.
3.	Burtis, C.A. and Ashwood, E.R. 2008. Tietztext book of Fundamentals of clinical chemistry and molecular diagnostics, Elsevier, Philadelphia.
4.	Tortora G.J.&Derrickson B.., 2016. Principles of Anatomy and Physiology, John Wiley and Sons, Inc. 1232 PP.
5.	Agarwal R A., Anil K Srivastava.,Kaushal Kumar.,1978. Animal Physiology and Biochemistry, S. Chand & Co. Ltd., New Delhi Publishing., 377 PP.
6.	Abhijit Dutta, 2009. Experimental biology: A Laboratory Science, Narosa, New Delhi.
7.	Michael, P, 1984. Ecological Methods for field visit and laboratory investigation. Tata McGraw Hill, New Delhi.
8.	APHA, 1992. Standard Methods for the examination of water and waste water, American Public Health association, Washington D.C.
References Books (Latest editions, and the style as given below must be strictly adhered to)	
1.	Hoar, W.S. 1983. General and Comparative Physiology. Prentice Hall of India, New Delhi., 928 PP.
2.	Prosser C.L., 1985. Comparative Animal Physiology, Satish Book Enterprise, Agra - 282 003, 966 PP.
3.	Wood, D.W., 1968. Principles of Animal Physiology, Edward Arnold Ltd, London.,342 PP.
4.	Guyton, A.C. and Hall, J.B., 2011. Text Book of Medical Physiology, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore., 1064 PP.
5.	Wilson, J.A. 1984, Principles of Animal Physiology, Macmillan Publishing., 426 PP.
6.	Eugenia, 2008. Environmental Biotechnology and cleavers Bioprocesses, London.
7.	Ramesh, R & M, Anbu 1996. Chemical methods for environmental Analysis of water and sediment. Macmillan India Limited, Chennai.
Web Resources	
1.	https://bit.ly/3hNyeFN
2.	https://www.medicinenet.com/alp_test/article.htm
3.	https://vlab.amrita.edu/?sub=3&brch=63

4.	https://www.asbmb.org/education/online-teaching/online-lab-work	
5.	https://open.umn.edu/opentextbooks/textbooks/687	
	https://bit.ly/3lO29yP	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY5PJ	**CORE PROJECT WITH VIVA-VOCE**	Core	Y	-	-	-	3	4	40	60	100

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY5:A	ELECTIVE I -ANIMAL BEHAVIOUR	Elective I	Y	-	-	-	3	4	25	75	100

Learning Objectives

1. To learn the origin and development of animal behaviour and to understand the influence of genetics, environment on animal behaviours.
2. To understand the biological properties of animal behavior, with an evolutionary and ecological emphasis.
3. To Compare innate and learned behavior and differentiate between various mating system.
4. To impart the knowledge about visual and auditory communication; courtship, mate choice, and mating systems; social behavior and social systems; and animal personality.
5. To discuss how movement and migration behaviors are a result of natural selection.

Unit I: Genetics and Behaviour : Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.

Unit II: Evolution and Social Behaviour : Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.

Unit III: Animal and the Environment: Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.

Unit IV: Understanding Complex Behaviour : Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of hobey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals : Languages and mental representation, non-verbal communication in human, mental images,Intelligence, tool use and culture, Animal awareness and Emotion.

Unit V: Chronobiology : Organization of circadian system in multicellularanimals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction; The physiological clock and measurement of day length; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases - Chronopharmacology, chronomedicine, chronotherapy.

Text Books

1. David McFarland, 1985.Animal Behaviour, Longman Scientific & Technical, UK.576pp.
2. HarjindraSingh,1990.ATextBookofAnimalBehaviour,AnomolPublication,293pp.
3. HoshangS.GundeviaandHareGovingSingh,1996.AnimalBehaviour,S.Chand&Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. BiologicalRhythms. NarosaPublishingHouse, Delhi.

Suggested Readings

1. Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2. Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3. Davis E.Davis, 1970. Integral Animal Behaviour, Mac Millan Company,London, 118pp.
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.

Web Resources

1. https://www.ncbs.res.in/content/animal-behaviour
2. https://bit.ly/3i6wUxR
3. https://www.behaviour.univie.ac.at/
4. https://www.ru.nl/bsi/

Course Outcomes (COs)

1. Recall and record genetic basis and evolutionary history of behaviour.
2. Classify movement and migration behaviors and explain environmental influence upon behaviour.
3. Analyze and identify innate, learned and cognitive behavior and differentiate between various mating systems.
4. Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction.
5. Discuss the rhythmicity of behavioural expressions and the scientific concepts in behavior and behavioral ecology.

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY5I1	**INTERNSHIP/INDUSTRIAL TRAINING**	Core	Y	-	-	-	3	4	100		100

SEMESTER - VI

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY608	**BIOTECHNOLOGY**	Core	Y	-	-	-	4	6	25	75	100

Learning Objectives	
CO1	To impart the skills required to explain the protocols for genetically manipulating cells and produce transgenic animals.
CO2	To encourage the use of the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and employ methods for easy taxonomical identification and classification for biodiversity and environmental studies.
CO3	To study methods of transgenesis and to consider their use in improving animal husbandry and animal health.
CO4	To motivate students to review the ethics and speculate on the environmental implications of animal biotechnological methods

UNIT	Details	No. of Hours	Course Objectives
I	**Fundamentals of Biotechnology** : Animal cell culture: Basic requirements and techniques of cell culture, natural and synthetic culture media, primary culture and cell lines; Stem cells: types, culture and applications; r-DNA technology: Enzymes; Vectors – pBR322, Phage lambda, Cosmid, HAC, BAC, YAC; Host cells; Gene cloning: steps in cloning, selection of clones – chromogenic substrate, antibiotics.	12	CO1
II	**Techniques in Animal Biotechnology** : Isolation and purification: DNA and mRNA; Blotting techniques: Methods of different types of blotting; DNA sequencing: Sanger method, DNA chips, microarray; PCR: principle, types and application; Gene library: screening with probes; Site directed mutagenesis: principle and	12	CO2

	application; Gene transfer in animal cells: transfection, liposomal, viral mediated, electroporation, biolistic, direct DNA injection.		
III	**Transgenic Animal Technology** : Transgenesis: Concept, transgenes, transgenic animal models - knock out mice, sheep; Applications of transgenesis : Molecular farming, Transgenic fishes, transgenic live stocks, and animals as bioreactors.	12	CO3
IV	**Animal Biotech and Health Care** : Medical biotechnology: Monoclonal antibodies, recombinant vaccines –hepatitis B, hormones – insulin. DNA diagnostic systems: tuberculosis, AIDS, genetic diseases; Gene therapy: Ex vivo and in vivo, role in cancer treatment; CRISPR gene editing. Molecular markers: RFLP, RAPD, DNA fingerprinting and application.	12	CO4
V	**Applications and Ethics** : Human genome project: Mapping of human genome, applications, ethics; Industrial biotechnology: Bioreactors - Basic concepts of fermentation, bioreactor design, production of ethanol and streptomycin; Ethics: Socio ethical problem, recent trends in animal biotechnology, ethical implications.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To describe the methodologies for handling animal cells based on their diverse characteristics and identify the correct biotechnological tools to obtain the desired products from the cells.	PO1
CO2	To develop and explain the protocols for genetically manipulating cells and produce transgenic animals	PO1, PO2
CO3	To select the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and devise methods for easy taxonomical identification and classification for biodiversity and environmental studies.	PO4, PO6
CO4	To choose the correct methods of transgenesis and to consider their use in improving animal husbandry	PO4, PO5, PO6

	nationally and globally	
CO5	To speculate on the environmental implications of animal biotechnological methods and design responsible, ethical solutions to livestock production and health issues.	PO3, PO8
Text Books (Latest Editions)		
1.	Singh B. D., 2015. Biotechnology: Expanding horizon, Kalyani publishers.	
2.	Sasidhara, R., 2015. Animal biotechnology, MJP publishers.	
3.	Dubey R. C., 2014. A text Book of Biotechnology, S. Chand & Co Ltd, Ram Nagar, New Delhi.	
4.	Dubey S. K., Bandana Ghosh, 2012. Fish biotechnology, Wisdom Press.	
5.	Dubey R.C., 2014. Advanced Biotechnology, S. Chand Publication.	
6.	Ruby, R.C., 2012. A text book of biotechnology, S. Chand Company, New Delhi.	
7.	Sambamurthy K., Ashutosh Kar., 2009. Pharmaceutical Biotechnology, New Age International (P) Ltd.	
8.	Ramdoss P.,2009. AnimalBiotechnology- Recent concepts and developments, MJP publishers.	
9.	Sathyanarayran U., 2008. Biotechnology, Books and Allied, Kolkata.	
10.	Ignacimuthu, S., 2008. Basic Biotechnology, Tata McGraw hill, New Delhi.	
11.	Rastogi S. C., 2007. Biotechnology: Principles and applications, Alpha Science publishers. Ranga, M.M., 2003. Animal biotechnology, Agrobios, New Delhi.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Veer Bala Rastogi, 2016. Principles of Molecular biology, Medtech, Maine, USA.	
2.	Michael Crichton, 2014. Essentials of Biotechnology, Medtech, Maine, USA.	
3.	Godbey W.T., 2014. An Introduction to Biotechnology, Academic press, New York, USA.	
4.	Peters, P., 2009. Biotechnology – A guide to genetic engineering, WMC brown publisher, UK.	
5.	Ramawat, K.G and Shailey Goyal, 2009. Comprehensive biotechnology, S.Chand company, New Delhi, India.	
6.	Primrose S.B., R. M. Twyman and R. W. Old, 2001. Principles of gene manipulation, Wiley- Blackwell, UK.	
7.	Primrose S. B., 2001. Molecular Biotechnology, Panima Publishing Corporation, New Delhi, India.	

8.	Hames B.D. and Higgins S.J. 1995. Gene Probes: A Practical Approach, Oxford University Press, UK.
Web Resources	
1.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3612824/
2.	https://www.isaaa.org/resources/publications/pocketk/40/default.asp
3.	https://www.ncbi.nlm.nih.gov/books/NBK207574/
4.	https://iopscience.iop.org/article/10.1088/1755-1315/492/1/012035/pdf
5.	https://go.nature.com/3zAZmO9

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY609	MICROBIOLOGY	Core	Y	-	-	-	4	6	25	75	100

Learning Objectives	
CO1	To become familiar with the foundation concepts of history of Microbiology
CO2	To understand the structure and functions of a typical prokaryotic cell
CO3	To gain the knowledge of microscopy and staining concepts
CO4	To understand and implement disposal and safety measures

UNIT	Details	No. of Hours	Course Objectives
I	**Introduction to microbiology** History, scope, branches of microbiology. Contribution of Leeuwanhoek, Jenner, Pasteur, Koch, Fleming, Iwanowsky, Waksman, Luria, M. J. Thirumalachar, Subba Rao, Sambhu Nath De. Evolution of Microbial diversity. Systematic position: 5 kingdom classification of Whittaker and 3 kingdom classification of Carl Woese. Comparison of Bacteria, Archaea, Eukarya (tabular and diagrammatic). Controlling microbes.	12	CO1
II	**Microscopy** Principles of microscopy ii. Compound microscope (Monocular and Binocular microscopes) – construction and function of parts, ray diagram of path of light, objectives, oculars, condensers, sources of illumination and uses iii. Dark field, Phase contrast and Fluorescence microscopes, Confocal microscopes, Atomic Force Microscope - principle, construction, ray diagram and applications iv. Electron microscopy – TEM and SEM – principle, construction, ray diagram and uses.	12	CO2
III	**Introductory Mycology** General characteristics and outline classification of fungi, Morphology of some common fungi - Mucor, Rhizopus,	12	CO3

	Aspergillus, Penicillium and Fusarium. Yeasts: General characteristics and outline classi fication of yeasts 3. General characteristics of Lichens and Mycorrhiza.		
IV	**Introductory Bacteriology** Classification of bacteria. Anoxygenic photosynthetic bacteria: general characteristics of purple bacteria and green bacteria. Oxygenic photosynthetic bacteria: General characteristics of Cyanobacteria – external and internal features, physiology and ecology. Magnetotactic bacteria- General characteristics, Magnetosomes, Enrichment and isolation of Magnetotactic bacteria. Types of staining.	12	CO4
V	**Introductory Virology** Virus Structure and Classification. Virus Entry and Viral Pathogenesis. Positive-strand RNA viruses: Picornaviruses, Flaviviruses, Togaviruses, Coronaviruses. Negative-strand and double-strand RNA viruses: Paramyxoviruses, Rhabdoviruses, Filoviruses, Bunyaviruses, Orthomyxoviruses and Reoviruses. DNA viruses: Parvoviruses, Polyomaviruses, Papillomaviruses, Adenoviruses and Baculoviruses, Herpes viruses and Poxviruses.	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	To understand history, relevance of microbiology and classification of bacteria	PO1
CO2	To understand the working of various microscopes and their application	PO1, PO2
CO3	To gain knowledge of various (physical and chemical) methods of control of microorganisms and safety measures to be followed while handling microbes	PO4, PO6
CO4	To understand the structure of bacterial cells, its organelles, physiology and behaviour.	PO4, PO5, PO6

CO5	To learn different methods of staining bacteria and demonstrate proficiency in handling aseptic bacteriological specimen.	PO3, PO8
Text Books (Latest Editions)		
1.	Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation , New Age International, New Delhi.	
2.	Atlas R.M., Microbiology – fundamentals and applications, Macmillan Publishing Company, New York.	
3.	Ravindra Nath, Fundamentals of Biology Courses for Biotechnology, - Vol.1, Special Bangalore University edition, Kalayani Publishers.	
4.	Greenwood D, Richard CD, John S and Peuther F (1992). Medical Microbiology, 16th edition. ELBS, Churchill living stone.	
References Books (Latest editions, and the style as given below must be strictly adhered to)		
1.	Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.	
2.	Thomas M. Bell, 1965. An Introduction to General Virology, William Heinemann Medical books, London.	
3.	Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.	
4.	Salle A.J., Fundamental Principles of Bacteriology, Tata McGraw – Hill Publishing Company Limited, New Delhi.	
5.	Pelczar .J. Chan E.C.S. and Krieg N.R., Microbiology, McGraw Hill Book Company, New York.	
6.	Benson Harold J, Microbiological Applications, WCB McGraw – Hill, New York.	
7.	Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.	
8.	Collins CH, Patricia M, and Lyne JM (1995). Collins and Lynes Microbiological Methods 7th edition. Grange, Butter Worth, Oxford.	
9.	Cappucino JG and Sherman N (1996). Microbiology, A Laboratory Manual 4th edition. Benjamin Cumings Inc. California.	
10.	Pelczar MJ, Chan ECS and Krieg NR (1993). Microbiology 5th edition, Tata McGraw Hill.	
11.	Madigan MT, Martinko JM and Parker J (2012). Brock Biology of Microorganism, 11th edition Prentice Hall International Inc. London.	
Web Resources		

1.	https://vlab.amrita.edu/?sub=3&brch=73
2.	https://learn.chm.msu.edu/vibl/
3.	https://mvi-au.vlabs.ac.in/
4.	https://virtuallab.tlc.ontariotechu.ca/intro.php
5.	https://www.merlot.org/merlot/viewMaterial.htm?id=79694

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY6P6	**BIOTECHNOLGY LAB**	Core	Y	-	-	-	3	5	40	60	100

Learning Objectives	
CO1	To encourage students to interpret the organization of genomic material and to research theories of genetic inheritance.
CO2	To impart the skills required to prepare samples of genetic molecules and to determine their purity, structure and characteristics and to analyze genomic preparations.
CO3	To study the changes in genetic material and to predict and consider the consequences of those changes.
CO4	To encourage students to report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.

UNIT	Details	No. of Hours	Course Objectives
I	**Isolation of genetic molecules:** Isolation of DNA from spleen. Total RNA isolation from plant/animal cells	12	CO1
II	Qualitative and quantitative analysis of genetic molecules: Determination of the purity of isolated DNA and RNA samples by UV spectrophotometry. Quantitative estimation of DNA by spectrophotometry	12	CO2
III	**Molecular analysis**: Agarose gel electrophoresis of DNA. Restriction fragment length polymorphism study. Eliza, Western Blot.	12	CO3
IV	Blood Grouping. Total WBC and RBC. Estimation of Haemoglobin. Preparation of Serum components. Radial Immunodiffusion test. Double Immunodiffusion test. Restriction Digestion of plasmid DNA. Ligation of restricted fragments.	12	CO4
V	Basic animal cell culture technique and transgenesis: Trypsinization of liver cells. Determination of the viability of trypsinized cells by Trypan Blue method. Creation of transgenic flies through virtual lab activity	12	CO5

	(https://media.hhmi.org/biointeractive/vlabs/transgenic_ fly/index.ht ml)		
	Total	**60**	
Course Outcomes			
Course Outcomes	On completion of this course, students will;		
CO1	To describe, examine and interpret the organization of genomic material and to research theories of genetic inheritance.	PO1	
CO2	To prepare samples of genetic molecules and to determine their purity, structure and characteristics.	PO1, PO2	
CO3	To experiment with genomic preparations and devise techniques to distinguish genetic material in different organisms to survey biodiversity.	PO4, PO6	
CO4	To assess the changes in genetic material and to predict and consider the consequences of those changes.	PO4, PO5, PO6	
CO5	To report and justify the results of molecular and genetic experiments in an accurate and meaningful manner.	PO3, PO8	
Text Books (Latest Editions)			
1.	Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.		
2.	Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.		
3.	Saxena J., Baunthiyal M., Ravi I., 2015. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology, Scientific Publishers, India.		
4.	Bansal M.P., 2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.		
5.	Chaitanya K.V., 2013. Cell and molecular biology: A Lab Manual, Phi Learning Pvt. Ltd., New Delhi, India.		
References Books (Latest editions, and the style as given below must be strictly adhered to)			
1.	Andreas Hofmann, Samuel Clokie, 2018. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, UK.		
2.	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, 2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.		

3.	Leonard Davis, Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science Pubilshing Co., NY, USA.	
4.	Robert F. Schleif, Pieter C. Wensink, 2012. Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.	
5.	Ian Freshney R., 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley & Sons, USA.	
Web Resources		
1.	https://www.jove.com/	
2.	https://vlab.amrita.edu/?sub=3&brch=77	
3.	http://cbii-au.vlabs.ac.in/	
4.	https://media.hhmi.org/biointeractive/vlabs/transgenic_fly/index.html	
5.	https://www.ibiology.org/biology-techniques/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze (K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge	
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons	
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations	

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	S							
CO 2	M	S						
CO 3				S		S		
CO 4				S	S	M		
CO 5			S					S

S-Strong(3) **M-Medium (2)** **L-Low (1)**

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY6:A	ELECTIVE II-WILDLIFE CONSERVATION AND MANAGEMENT	Elective II	Y	-	-	-	3	5	25	75	100

Learning Objectives

1. To understand and discuss the importance of wildlife, its values, modern concepts in wildlife management, and relevant conservation policies.
2. To assess and instil strong foundations on wildlife policies and be familiar with a variety of laws and regulations.
3. To analyse and design appropriate approaches to turn conflict into tolerance and coexistence, with an emphasis on the human dimensions of human-wildlife interactions.
4. To evaluate and integrate all the related areas like Fundamentals in Ecology, Forestry, Natural Resource Conservation approachesand develop the role PVA models for protection of Endangered species.
5. To explain the advanced scientific basis for wildlife management and discuss National and International Efforts for successful wildlife conservation.

Unit I :Biodiversity Extinction and Conservation Approaches :

Perspectives and Expressions. Identification and prioritization of Ecologically sensitive area (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.

Unit II: Theory and Analysis of Conservation of Populations :

Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity.Population viability analysis-conceptual foundation, uses of PVA models. Management Decisions for small populations using PVA models. Minimum viable populations & recovery strategies for threatened species.

Unit III: National and International Efforts for Conservation :

International agreements for conserving marine life, Convention on wetlands of International Importance (Ramsar convention), Conservation of Natural Resources.Overview of conservation of Forest &Grassland resources. CITES, IUCN, CBD National Forest Policy,

1988, National Wildlife Action Plan 2017-2031, Wildlife Protection Act 1972, National and State Biodiversity Action Plans and other Forests and Environmental Acts.

Unit IV: Wildlife in India : Wildlife wealth of India & threatened wildlife, Reasons for wildlife depletion in India, Wildlife conservation approaches and limitations. Wild life Habitat: Characteristic, Fauna and Adaptation with special reference to Tropical forest. Protected Area concept: National Parks, Sanctuaries and Biosphere Reserves, cores and Buffers, Nodes and corridors.Community Reserve and conservation Reserves.

Unit V: Management of Wildlife : Distribution, status. Habitat utilization pattern, threats to survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle. Wild life Trade & legislation, Assessment, documentation, Prevention of trade, Wild life laws and ethics.

Text Books:

1. Robinson W L and Eric G Bolen, 1984. Wildlife Ecology and Management, Maxmillan Publishing Company, New York, p 478.
2. Aaron, N.M.1973 Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A.
3. Dasmann R F, 1964. Wildlife Biology, John Wiley & Sons, New York, p 231.
4. Justice Kuldip Singh 1998. Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj Publishers, Dehradun.
5. Hosetti, B.B. 1997 Concepts in Wildlife Management, Daya Publishing House, Delhi.
6. Sutherland, W.J 2000. The conservation handbook: Research, Management and Policy. Blackwell Science.
7. Caughley.G and Sinclaire, A.R.E 1994 Wildlife ecology and management. Blackwell Science.
8. Woodroffe R, Thirgood, S. and Rabinowitz A. 2005.People and Wildlife, Conflict or Co exsistence? Cambridge University.
9. Sinha, P.C. 1998. Wildlife and Forest Conservation, Anmol Publishing Pvt. Ltd., New Delhi.
10. Singh, S.K, 2005. Text Book of Wildlife Management. IBDC, Lucknow.

Suggested Readings

1. Gilas R H Jr.(ed.), 1984. Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington D.C., Nataraj Publishers, Dehra Dun, p 547.

2. Rodgers W A, 1991. Techniques for Wildlife Census in India - A Field Manual: Technical Manual - T M - 2. WII.
3. Saharia V B, 1982. Wildlife of India, Natraj Publishers, Dehra Dun.
4. Goutam Kumar Saha and SubhenduMazumdar, 2017. Wildlife Biology: An Indian Prospective, PHI Publisher, Delhi.
5. Katwal/Banerjee, 2002. Biodiversity conservation in managed and protected areas, Agrobios, India.
6. Gopal, Rajesh,1992. Fundamentals of Wildlife Management, Justice Home, Allahabad, India.
7. Sharma, B.D, 1999. Indian Wildlife Resources Ecology and Development, Daya Publishing House, Delhi.
8. Stephen, H.B. and V.B. Saharia,1995. Wildlife research and management. Asian and American Approaches, Oxford University Press, Delhi.
9. Negi, S.S. 1993. Biodiversity and its conservation in India, Indus Publishing Co., New Delhi.
10. Moulton, M. P. & J. Sanderson, 1997. Wildlife Issues in a Changing World. St. Lucie Press.

Web resources

1. https://bit.ly/39oPj44
2. https://bit.ly/3lHdEYJ
3. https://bit.ly/3CwBCfY
4. https://bit.ly/3EDYr3a
5. https://bit.ly/3tVtG4U

Course outcomes (COs)

1. To understand and recall the importance of wildlife, extinction and Conservation Approaches of wildlife.
2. To integrate and assess the National, international approaches for biodiversity conservation.
3. To analyse and differentiate threats to wildlife, various action plans, conservation strategies on wildlife of India to turn conflict into tolerance and coexistence.
4. To explain the role PVA models, Wildlife conservation approaches, and limitations.
5. To construct and simulate National and International strategies for Conservation, Wild life laws and ethics.

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ZY6:B	ELECTIVE III-NANOBIOLOGY	Elective III	Y	-	-	-	4	6	25	75	100

Learning Objectives:

This course provides knowledge about the basic concepts of nanobiology. The learners will be able to acquire skills in the assembly, design and types of nanomaterials and nanoparticles, They will be able to appreciate the applications of nanobiology in diverse fields.

Unit-I: Nanobiology- Definition-concepts and scope. History of nanotechnology and nanoscience in Nature; Structure and Properties ofnanomaterials: size, surface charge, conductivity, optical properties and biocompatibility.

Unit-II: Synthesis and characterization of nanomaterials, Fabrication of nanostructures, Metallic nanoparticles, semiconductor, biopolymericnano-structures and nanoparticles.

Unit-III: Composition and functional properties of nanostructures: Protein and peptide-based nanostructures, carbohydrate and nucleic acid based nanomaterials; Use of gold, silver and other metallic nanoparticles.

Unit-IV: Strategies to design biologically active nanostructure-based biomaterials. Interaction of nanoparticles with biomolecules to study their conformational and functional properties.

Unit-V: Biological Applications of Nanomaterials and nanoparticles – therapeutics – biomaterials - Immobilized enzymes - drug delivery systems – Biosensors - Cellular imaging tools and diagnostics.

References

1. Pradeep, T. (2017) The Essentials: Understanding Nanoscience and Nanotechnology: McGraw-Hill Education.

2. Phoenix, D.A. and Ahmad, W (2014) Nanobiotechnology. One Central Press Ltd.

Course outcomes (Cos)

Students will be able to:

- Understand basics of Nano-science and Nano-biology.
- Gain knowledge on nanomaterials and nanoparticles.
- Know the biological applications of nanomaterials and nanoparticles.
- Apply their knowledge in their career development in higher education, research and development.

Course	**:**	**PCS**
Course title	**:**	**Zoology for Competitive Examinations**
Credits	**:**	**2** **COURSE CODE: U23ZY6G1**

Learning Objectives:

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 behavior of different forms of life.

UNIT I:

Taxonomy-Pro-and eukaryotic organisms -digestion and absorption- detoxifying mechanisms; respiration- regulation of body fluids and excretory mechanisms-animal hormones and their action Mendelian genetics and heredity- populations and communities- evolution- genesis and diversity of organisms- animal behaviour

UNIT II:

Buffers; trace elements in biological systems- Carbohydrates; Proteins; Lipids; Nucleic acids; Enzymes; Vitamins. Metabolism: Glycolysis, TCA cycle and Oxidative Phosphorylation. Nitrogen Fixation, Fertilization and Osmoregulation;

UNIT III:

Cell Biology: Cytoskeletal elements; Cellular organelles and its function - nature of the gene and its function, Genetic code, synthesis of nucleic acids and proteins. Structure of biomolecules; intra and intermolecular forces; thermodynamics and kinetics of biological systems

UNIT IV:

Classes of microorganisms and their characterization, nutrient requirement for growth; laboratory techniques in microbiology, pathogenic microorganisms and diseases; Microbial genetics. Innate and adaptive immunity, antigen and antibodies. cell division; types of chromosome structure; Inborn errors of metabolisms; viruses and fungi: Processof development.

UNIT V:

Tissue culture - Antigen-antibody interaction; Antibody production; Diagnostic aids, Molecular Biology: DNA; RNA; Replication; Protein synthesis; Operon model; Gene transfer, Cloning of animals through somatic cell nuclear transfer; Applications of recombinant DNA technology in medicine, agriculture and forensic science.

References:

1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734
3. Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp-928.
4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.
5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.
6. Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.
7. Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740.
8. Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York, pp-670
9. Dubey R.C., 2014. Advanced Biotechnology, S. Chand Publication.
10. Sathyanarayran U., 2008. Biotechnology, Books and Allied, Kolkata.

Course Outcomes

- Exams improve IQ, rational and analytical thought, and lay the groundwork for a successful career.
- Competitive examinations also aid in career selection
- Students begin to recognise their areas of interest while gaining a deeper understanding of subjects.

Course Code	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
U23ESZY2	ENVIRONMENTAL ZOOLOGY	Allied Zoology II for Env. Sciences	Y	-	-	-	3	4	25	75	100

COURSE OUTCOMES:

On Completion of this course, the students will be able to

CO.No	COURSE OUTCOME	LEVEL	UNIT
CO1	Explain the salient features of Kingdom Animalia and the levels of organization at cellular, tissue and organ grade level of organization	**K6**	**I**
CO2	Classify the major Phylum Invertebrata and Chordata with its distinctive characters and suitable examples	**K3**	**II**
CO3	Compare the major process of mechanism of migration and flight adaptations in animals.	**K4**	**III**
CO4	Explain the types of animal behaviour and distinguishing between stereotyped and Acquired behaviour in animals	**K4**	**IV**
CO5	Discuss the process of communication in birds and mammals	**K6**	**V**
CO6	Compare the external morphology of invertebrates and chordates	**K4**	**II**

Unit I : INVERTEBRATA (12 Hrs)

Kingdom Animalia: Salient features - levels of organization: cellular, tissue, organ and organ system; General characters and Classification of major Invertebrata up to classes with suitable examples.

Unit II: BENEFICIAL INSECTS AND VERMICULTURE (12 Hrs)

Economic importance of beneficial insects - Social life of honey bees and Life cycle of Silk worm. Ecological Classification of Earthworm, Brief study of Vermiculture, vermicomposting and its applications.

Unit III : PHYLUM CHORDATA, MIGRATORY ANIMALS AND ADAPTIVE RADIATION IN CHORDATES (12 Hrs)

General characters and Classification of Phylum Chordata upto classes with suitable examples. Biological significance of Migratory animals: Fish, Birds and Mammals. Flight adaptations in vertebrates - Aquatic adaptations in birds and mammals. Adaptive radiations in chordates: Aquatic, terrestrial and arboreal. Bio indicators.

Unit IV ANIMAL BEHAVIOUR AND PHEROMONES (12 Hrs)

Animal Behaviour: Stereotyped behaviour- instincts and motivation; Acquired behaviour: Pavlovian learning, trial and error learning. Pheromones and behaviour: types, significance – Pheromones with reference to insects and rodents.

Unit V: SOCIAL BEHAVIOUR, BIOLOGICAL RHYTHM AND COMMUNICATION IN ANIMALS (12 Hrs)

Social behaviour: Birds, primates. Biological rhythms: circadian, tidal, lunar, circannual rhythms. Types of communication in animals: visual, olfactory, tactile, verbal and non-verbal-Communication in bees and birds. mimicry and animal colorations.

Text Book

1.Jordan E.L. and Verma P.S., Invertebrate Zoology,12thedn. Schand& Co. 1995.
2. Kotpal R.L., Agarwal, R.P.R., Khertarpa,Modern **Text Book** of Zoology-I –Rastogi Publications.1989.

References:

1. Ayyar E.K. Ananthakrishnan, T.N., **Outlines of Zoology**: **Invertebrata**, Vol-I and Vol-II Viswanathan Pvt. Ltd.1993.
2. Hoshang. S, Gundevia and Hare Govind Singh, **A textbook of Animal Behaviour**, Chand & Co., 1997.
3. Shukla G.S and Upadhay V.B., **Economic Zoology**, Rastogi Publications, 2004.
4. Jordan, E.L. and Verma P.S., **Invertebrate Zoology,** 12thedn. S.Chand& Co., 1995.
5. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I., **Modern Text Book of Zoology,** Rastogi Publications, 1989.
6. Dhami, D.S and Dhami, J.K.R., **Chordate Zoology,** Chand & Co., 1978.
7. Ismail,S.A., **Vermicology: The Biology of Earthworm**, Orient Longman, London,1970.

Web-links:

1.https://www.who.int/news-room/fact-sheets/detail/zoonoses
2.https://www.acs.edu.au/courses/invertebrate-animals-730.aspx
3.https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-course-biology-science/v/crash-course-biology-123
4. https://courses.lumenlearning.com/suny-biology2xmaster/chapter/chordates/

MAPPING (CO, PO, PSO)

U20ESZY2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	L	H	H	L	M	-	-	H	H	-	H
CO2	H	H	L	H	H	L	M	-	-	H	H	-	H
CO3	H	H	L	H	H	L	M	M	-	H	H	-	M
CO4	H	H	L	H	H	L	M	-	-	H	H	-	M
CO5	H	H	L	H	H	L	H	-	-	H	H	-	H
CO6	H	H	-	H	H	-	M	-	-	H	H	-	H

L-Low M-Moderate H- High

COURSE ASSESSMENT METHODS

DIRECT
4. Continuous Assessment Test I,II **5. AssignmentGroup Presentation, Poster preparation,** **6. End SemesterExamination**
INDIRECT
1. Course-end survey