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SYLLABUS for

POST-GRADUATE Programme in

ZOOLOGY

Under the National Education Policy (NEP) 2020

(Semester Programme)

Vidyasagar University

Midnapore-721102,

West Bengal

DRAFT

(w.e.f. session 2025 -2026)

PREAMBLE

The course curriculum of the Department of Zoology has been systematically designed and developed with due emphasis on both the **classical foundations** of the subject and its **contemporary scientific advancements**, thereby aligning with global trends in higher education. The **classical components** of Zoology encompass essential areas such as **Anatomy, Biosystematics, Histology, Animal Physiology, Evolution, and Adaptation**. These provide students with a strong conceptual framework and a comprehensive understanding of structural–functional organization in animals. Complementing these, the curriculum integrates modern domains including **Molecular Biology, Genetics, Biotechnology, Bioinformatics, Biochemistry, Biostatistics, Histochemistry, Developmental Biology, Immunology, Parasitology, and Neurobiology**, which reflect current developments and applications in the biological sciences. This integrated approach has significantly contributed to the **academic performance and achievements** of both present and former students, many of whom have successfully qualified in **national and state-level competitive examinations**. The Department offers **four special papers**: Fishery, Ecology, Genetics & Molecular Biology, and Parasitology, which provide students, particularly those from rural backgrounds, with enhanced opportunities for **academic recognition and professional placement** in subject-related services. The Department also undertakes **outreach and extension programs**, wherein students are actively engaged as part of their practical curriculum. These initiatives have had a notable impact on the **livelihood generation of marginalized communities** in the region, thereby strengthening the social relevance of the curriculum. All courses are structured to prepare students for **competitive examinations (e.g., CSIR-UGC-DBT-NET, ICMR JRF Exam, GATE, SET) and to develop** capacity in **research proposal writing and grant acquisition**. During the curriculum development process, the guidelines of the National Education Policy (NEP) 2020 have been duly incorporated, with a particular emphasis on **employability, entrepreneurship, skill development, and digital literacy**. Additionally, the syllabus addresses cross-cutting issues, including **ethics, gender sensitization, human values, environmental awareness, and sustainability**, thereby ensuring holistic student development and alignment with national academic priorities.

PROGRAMME OUTLINES

1	Type of Program	This is a regular master's program, following the guidelines of NEP 2020.
2	Credit system	Each academic paper comprises four credits, including three credits dedicated to theoretical study and one credit allocated to practical work, thereby ensuring coherence in the learning process.
3	Duration and Eligibility Criteria	The department provides two types of Master of Science programs in Zoology. Students who have completed a three-year Honors degree in zoology are eligible for admission to the two-year M.Sc. program. In contrast, those who have completed a four-year Honors degree in zoology (with or without a research component) are eligible for admission to the one-year M.Sc. program.
4	Intake capacity	As per the Vidyasagar University admission rules.
5	Admission procedure	As per the Vidyasagar University admission rules.
6	Evaluation Process	<ul style="list-style-type: none"> • Continuous Evaluation (CE) has a 20% weight, while the End-of-Semester Examination accounts for 80% of the total marks. • Two CEs will be conducted for each paper/course, and the average of these two will determine the final CE marks. The CEs may be undertaken in various formats, such as multiple-choice questions (MCQs), short-answer questions, case studies, assignments, or small projects. • The end-semester examination will comprise short-answer, medium-answer, and long-answer type questions to evaluate the students' understanding and analytical skills comprehensively.
7	Teaching Methods	<ul style="list-style-type: none"> • To realize the desired learning outcomes, the subsequent teaching–learning strategies will be utilized: • Lecture-based Instruction – Systematic dissemination of fundamental concepts via classroom lectures. • Collaborative Learning – Engaging students in group discussions and activities to foster teamwork and exchange of ideas. • Autonomous Learning – Encouraging independent study and self-directed learning to enhance conceptual understanding. • Technology-Enhanced Learning – Incorporation of digital tools, software, and online resources to facilitate interactive and innovative learning experiences. • Peer Instruction – Students articulating concepts to their peers, thereby promoting active engagement and reinforcement of knowledge. • Problem-solving Methodology – Approaching learning through experimental, on-field problems, case studies, and practical exercises to cultivate analytical and critical thinking abilities.
8	Special Instructions	To align with NEP 2020, several general courses like Indian Knowledge System (IKS), IPR, Research Methodology and Ethics, Social Service, Internship/Industry visits, Field Visits, Research projects, and Vidyasagar's Life and Philosophy are compulsory. Core courses strengthen foundational knowledge in a subject, and electives offer flexibility. Semesters III and IV include four special papers, from which students must choose one.
9	Field Visits	Semester II offers a field visit; the place of visit is determined in the departmental committee meeting.
10	Research Projects	The mentor will distribute the research project to the students in the fourth semester.

Program Outcomes (POs)

On successful completion of the M.Sc. in Zoology program, the students will develop following skills: -

- PO1. Comprehensive Knowledge: Demonstrate a deep understanding of animal structure, function, diversity, evolution, genetics, molecular biology, and physiology.
- PO2. Practical Competence: Apply laboratory and field techniques to investigate animal biology, analyze data, and interpret scientific observations.
- PO3. Research and Inquiry: Design, conduct, and report scientific research in zoology, integrating modern methodologies and ethical practices.
- PO4. Critical and Analytical Thinking: Analyze complex biological data, discuss contemporary issues in biodiversity, and solve zoological problems scientifically.
- PO5. Technological Application: Utilize bioinformatics, biostatistics, remote sensing, and microscopy as tools for animal research and management.
- PO6. Communication and Teamwork: Present scientific ideas and research findings effectively; collaborate in academic, research, and professional settings.
- PO7. Ethics and Responsible Practice: Demonstrate ethical responsibility towards animals and promote sustainable practices in animal biology and conservation.
- PO8. Interdisciplinary Skills: Integrate zoological knowledge with related fields such as biotechnology, botany, physiology, environmental science, and public health.
- PO9. Career Readiness and Entrepreneurship: Prepare for teaching, research, conservation, and industry roles, and pursue professional development through entrepreneurship.

Programme Specific Outcomes (PSOs)

After the successful completion of M.Sc. in Zoology program, the students are expected to:

- PSO1. Improve their biological knowledge: Gain in-depth understanding of animal diversity, physiology, ecology, genetics, and evolution.
- PSO2. Gain research & technical skills: Apply modern laboratory, field, and analytical techniques for studying animals and ecological systems.
- PSO3. Apply critical thinking: Analyze biological data and address issues in conservation and wildlife management.
- PSO4. Expertise in technological applications: Use tools like Microscopy, instrumentation, GIS, remote sensing, and bioinformatics in animal research.
- PSO5. Follow ethics & sustainability: Practice ethical and sustainable approaches in zoology and conservation.
- PSO3. Communication & Professionalism: Effectively present scientific findings and work collaboratively in academic and research settings.

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Semester	Code	Details	Course Details	Credit	Marks
<i>Sem-I</i>	ZOO-C101	T	Functional anatomy and Physiological process	3	50
		P	Lab exercise based on course ZOO-C101T	1	
	ZOO-C102	T	Cytogenetics and Evolutionary process	3	50
		P	Lab exercise based on course ZOO-C102T	1	
	ZOO-C103	T	Research Methodology and Ethics	4	50
	ZOO-E104	T	Bioinformatics & Biostatistics / Applied Zoology	3	50
		P	Lab exercise based on course ZOO-E104T	1	
	ZOO-E105	T	Biotechnology & Public Health/ Insect Vector and Management	3	50
		P	Lab exercise based on courses ZOO-E105T	1	
	IKS	Indian Knowledge System		2	25
	Vidyasagar Life and Philosophy			Compulsory non-credit course	
<i>Sem-I</i>	Total			22	275
<i>Sem-II</i>	ZOO-C201	T	Advanced Parasitology & Clinical Immunology	3	50
		P	Lab exercise based on the course ZOO-C201T	1	
	ZOO-C202	T	Cell and Molecular Biochemistry	3	50
		P	Lab exercise based on the course ZOO-C202T	1	
	ZOO-E203	T	Embryology/ Human Genetics	3	50
		P	Lab exercise based on the course ZOO-E203T	1	
	ZOO-E204	T	Biophysics and Microscopy / Biosystematics & Applied Entomology	3	50
		P	Lab exercise based on the course ZOO-E204T	1	
	ZOO-E205	T	Wildlife Ecology / Environmental Issues & Management	3	50
		P	Lab exercise based on the course ZOO-E205T	1	
	ZOO-C206	Field Visit		2	25
<i>Sem-II</i>	Total			22	275
Total: 1st Year of PG				44	550

Semester	Code	Details	Course Details	Credit	Marks	
<i>Sem-III</i>	ZOOC301	T	Molecular Biology & Environmental Microbiology	3	50	
		T	Lab exercise based on the course DSC6	1		
	ZOOC302	T	Histochemistry and Neurobiology	3	50	
		T	Lab exercise based on the course DSC7	1		
	ZOOC303	T	Special Paper -I: Fishery / Ecology/ Genetics & Molecular Biology/ Parasitology Theory	3	50	
		P	Lab exercise based on the course DSC8	1		
	ZOOC304	T	Special Paper -II: Fishery / Ecology/ Genetics & Molecular Biology/ Parasitology Theory	3	50	
		P	Lab exercise based on the course DSC9	1		
	MOOC	T	MOOC	4	50	
		Social Service / Community Engagement		2	25	
Total				22	275	
<i>Sem-IV</i>	ZOOC401	P	Special Paper -III: Fishery / Ecology/ Genetics & Molecular Biology/ Parasitology Theory	3	50	
		T	Lab exercise based on the course DSC10	1		
	ZOOC402	P	Special Paper -IV: Fishery / Ecology/ Genetics & Molecular Biology/ Parasitology Theory	3	50	
		T	Lab exercise based on the course DSC11	1		
	ZOOC403		Research Project/ Dissertation		8	100
	ZOOC404		Internship / Capstone Project/ Applied Field or Industry Project / Innovation & Incubation / Entrepreneurship / Start-up Proposal or Practice		4	50
ZOOC405		Intellectual Property Rights (IPR) / Skill-Enhanced Course		2	25	
		Total		22	275	
Total: 2nd Year of PG				44	550	

DETAILS OF THE COURSE

Paper-ZOO-C101: Functional Anatomy and Physiological Process

Credit – 04

About the Course

This course examines evolutionary milestones from Precambrian life to the Cambrian explosion and subsequent terrestrial colonization. It highlights patterns of early biodiversification and the distribution of modern animal species across zoogeographical realms. Functional adaptations such as fish swimming and bird flight are analyzed through anatomical and biomechanical perspectives. The course introduces systems biology, integrating computational tools, high-throughput techniques, and biological networks. Physiological processes, stress responses, and thermoregulation are studied to understand animal survival and adaptation in varied environments.

Course Outcomes

The students at the completion of the course will be able to-

CO1. Explain key evolutionary events, including the Cambrian explosion, animal colonization on land, and patterns of biodiversification.

CO2. Functional adaptations like fish swimming and bird flight using anatomy and vector-based approaches.

CO3. Apply systems biology tools such as high-throughput methods, computation, and network analysis to biological problems.

CO4. Evaluate physiological and stress responses, including circulation, respiration, thermoregulation, and acclimatization to extreme environments.

Paper: ZOO-C101-T: (Theory)

Credit- 03

	Course Contents	Lectures / Hours
Unit 1:	Cambrian explosion and terrestrial animal species: Key Cambrian explosion events: Precambrian life Small shelly fauna Uniqueness of the early Cambrian biodiversification Terrestrial Life Post-Cambrian Explosion (Later Colonization, Arthropod invasions, Environmental factors)	4
Unit 2:	Animals of the 21st century and their distribution in zoogeographical realms:	4

	Bumpy Snailfish; <i>Labeo chekida</i> ; Sumatran Cascade Frog; Miniature Frogs; Caribbean lizards; <i>Theioderma khoii</i> (Khoi's mossy frog); Peleng leaf warbler; Pygmy three-toed sloth; Vangunu giant rat	
Unit 3:	Morpho-functional coordination and Bioengineering: Swimming Mechanism in Fish (Anatomical structure & vector analysis) Flight mechanism of Birds (Anatomical structure & vector analysis)	3
Unit 4:	System Biology and its components: Biological Problems High-Throughput Technologies Computation and Mathematics Data Integration Biological Networks	3
Unit 5:	Punctuated equilibrium and Darwin's thoughts: Stasis and Spurts Speciation Fossil record evidence Criticisms of Darwinian thoughts	4
Unit 6:	Stress-Response mechanisms: Homeostasis, feedback control systems Oxidative stress; Cellular response; Free radicals and antioxidants Acclimatization to extreme conditions like hypoxia & diving	4
Unit 7:	Blood, Circulatory, and Respiratory processes: Haemopoiesis & haemostasis Regulation of blood volume and blood pressure Body oxygen stores: Haemoglobin, Oxyhaemoglobin, and Myoglobin; Oxygen dissociation curve	5
Unit 8:	Cardiovascular System: Regulation of heart pumping; gap junction Cardiac cycle & Cardiac output Neural and chemical regulation of excitation & conduction in the heart ECG – principles and interpretations	5
Unit 9:	Thermoregulatory processes: Body temperature and determinants of body heat production and loss Physical, chemical, and neural regulation of body temperature; Counter current heating & cooling mechanisms	4
	Total	36

Paper- ZOO-C101-P: (Practical)

Credit- 01

Functional Anatomy

- i) Identification of Invertebrate species collected from the local area.
- ii) Model demonstration of selected vertebrate species (Culturable animals).

Physiological process

- i) Demonstration of haemoglobin from blood in an animal model or visualization in a structural database
- ii) Bioassay of any aquatic organism using chemicals or physical factors (pH).

- iii) Observation of gut movement in an animal under hypoxia using Dale's apparatus and preparing a kymograph.
- iv) Comparing Blood Pressure and Heart Rate during rest and exercise
- v) Determination of Breath-Holding Time (BHT)

Recommended Readings

1. "The Cambrian Explosion: Evolution's Big Bang? Or Darwin's Dilemma", by Walter L. Starkey, Last edition [2011].
2. "The geographical distribution of animals" By Alfred Russel Wallace, Macmillan and Co., Harvard University Press, London [1876].
3. "Vertebrates Comparative Anatomy, Function, Evolution" Eighth edition, Kenneth V. Kardong, Ph.D. Washington State University, McGraw-Hill Education, [2018].
4. "Systems Biology Principle, Methods and concept" Edited by A. K. Konopka, CRC Press, Taylor and Francis Group [2007].
5. "One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought" by Ernst Mayr, Harvard University Press, Cambridge, Massachusetts [1991].
6. Ganong's Review of Medical Physiology; McGraw-Hill.
7. Gunstream SE. 2010. Anatomy and Physiology with an integrated study guide. McGraw-Hill.
8. Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. Hercourt Asia P Ltd.
9. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Asso.
10. Kesar, S. and Vashisht, N.; 2007. Experimental Physiology, Heritage Publishers.
11. Prosser C. L. and F. A. Brown – Comparative Animal Physiology; Saunders.
12. Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman. Refinetti R. 2000. Circadian Physiology. CRC Press, Boca Raton.
13. Schmidt-Neilson K – Animal Physiology – Adaptation & Environment, Cambridge University Press.
14. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole Tortora, G.J. and Derrickson, B.H.; 2009. Principles of Anatomy and Physiology, XII Ed, Wiley and Sons, Inc.

About the Course

This course provides an in-depth understanding of the cytogenetic basis of heredity and its role in evolutionary processes. It covers the genetics of prokaryotes, mechanisms of population genetics, and the principles of genetic equilibrium and genetic variation that drive evolutionary changes. Emphasis is placed on how genetic alterations at the cellular and molecular levels contribute to the process of adaptation, natural selection, and speciation. Students will gain both theoretical knowledge and practical skills relevant to the fields of genetics, cytogenetics, and evolutionary biology.

Course Outcomes:

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

- CO1. Perform transcriptional analysis using in situ hybridization techniques to visualize gene expression at the chromosomal level, thereby understanding the regulation of genetic activity.
- CO2. Carry out gene mapping studies in *Escherichia coli* and other model organisms to determine gene location, linkage, and recombination frequencies, thereby gaining insights into microbial genetics.
- CO3. Analyse evolutionary changes through population genetics approaches, including the study of genetic drift, mutation, migration, and selection, and explain their role in the emergence of new species (speciation).
- CO4. Interpret the relationship between chromosomal variations and evolutionary processes, with special reference to polyploidy, chromosomal aberrations, and molecular cytogenetics.
- CO5. Develop problem-solving skills by applying the principles of cytogenetics and evolutionary biology to experimental data and case studies relevant to biodiversity, conservation, and human genetics.

Paper-ZOO-C102T: (Theory)

Credits 03

Course Contents	Hours
Unit 1: The structure and function of the eukaryotic chromosome: Polytene chromosome structure and sequence organization.	2 hrs
Unit 2: Regulation of gene expression in <i>E. coli</i>: Constitutive, Inducible, and repressible gene expression, Positive and negative control of gene expression, Lactose and Tryptophan Operon in bacteria.	5 hrs
Unit 3: Genetic fine structure: The rII fine structure, complementation, and deletion mapping	5 hrs
Unit 4: Genetic transfer and mapping in Bacteria and bacteriophages: Conjugation mapping, Transduction mapping	4 hrs
Unit 5: Medical genetics and cancer: Genetic analysis of human diseases, the genetic basis of cancer	4

<p>Unit 6: Genetic analysis of population: Theory of allele frequencies, Genetic equilibrium, estimation of equilibrium frequencies in natural populations. Changes in gene frequencies through natural selection, mutation, migration, and genetic drift.</p> <p>Unit 7: Molecular Evolution: Molecules as documents of evolutionary history, molecular phylogenetics, and rates of molecular evolution</p>	<p>hrs</p> <p>10 hrs</p> <p>6 hrs</p>
Total	36 hrs

Paper-ZOO-C102P: (Practical)

Credits 01

1. Studies on the life history of *Drosophila melanogaster*, identification of larval stages and adults.
2. Dissection of salivary gland, preparation of polytene chromosome from 3rd instar larva, studies on band, inter-band, and puffs.
3. Analytical studies on the Genetic cross of different mutants of *Drosophila*.
4. Making a molecular phylogenetic tree by gene sequences and amino acid sequences

Recommended Readings

1. Griffiths, A. J. F., Doebley, J., Peichel, C., & Wassarman, D. A. (2025). *Introduction to Genetic Analysis* (12th ed., Digital Update). W. H. Freeman & Company. ISBN: 978-1319337797.
2. Lewin, B. (2019/2020). *Lewin's GENES XII* (12th ed.). Jones & Bartlett Learning. ISBN: 978-1284104493.
3. Brooker, R. J. (2023). *Genetics: Analysis and Principles* (8th ed., International Student Edition). McGraw-Hill Education. ISBN: 978-1265350796.
4. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (1999). *An Introduction to Genetic Analysis* (7th ed.). W. H. Freeman.
5. Pierce, B. A. (2020). *Genetics: A Conceptual Approach* (7th ed.). W. H. Freeman & Company. ISBN: 978-1319216801.
6. Russell, P. J. (2010). *iGenetics: A Molecular Approach* (3rd ed.). Benjamin Cummings (Pearson). ISBN: 978-0321569769.
7. Snustad, D. P., & Simmons, M. J. (2015). *Principles of Genetics* (7th ed.). Wiley. ISBN: 978-1119142287.
8. Hartl, Daniel L., & Ruvolo, Maryellen. *Genetics: Analysis of Genes and Genomes* (8th Edition). Jones & Bartlett Publishers, 2012. ISBN 978-1449626105.

Paper- ZOO-C103: Research Methodology and Ethics

Credit – 04

About the Course

The course is designed to provide postgraduate students with a comprehensive understanding of the fundamental principles and practical aspects of research processes while emphasizing the importance of ethical conduct in scholarly inquiry. Covering key topics such as research design, literature review, data collection and analysis, and scientific writing, the curriculum also addresses essential ethical issues, including intellectual honesty, plagiarism, research integrity, authorship, and responsible publication practices. Through a blend of conceptual frameworks, case studies, and applied exercises, the course equips students to engage critically with methodological challenges and ethical dilemmas, fostering both academic rigor and social responsibility in research.

Course Outcomes

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

- CO1. Develop an understanding of different types of research problems and the different steps of formulation of research problems according to their roles in real life.
- CO2. Generate research questions associated with research problems.
- CO3. List various sources of information for literature review and data collection
- CO4. Apply different research techniques and methodologies for implementation so that the research problem can be solved.

Paper: ZOO-C103T: Research Methodology and Ethics (Theory)

Credit- 04

	Course Contents	Lectures / Hours
Unit 1:	Facets of Research Design: Importance and features of research; Research prototype; phenomenological and positivistic research; inductive and deductive reasoning	4
Unit 2:	Research problems and processes: Identification and formulation of research problem; research questions and objectives; Hypothesis – meaning, role, and types - <i>a priori</i> and <i>a posteriori</i> hypotheses testing Research design – meaning, significance, and types (exploratory, descriptive, analytical, and experimental). Experimental design- informal and formal; concept of replicates and its application in biology	5

Unit 3:	Data Collection Types of data – primary and secondary; sources of data; methods of data collection – observation, interview, questionnaire, case study, experiment, content analysis; distinction between method and methodology	4
Unit 4:	Sampling Methods Concept of sampling; probability sampling – simple, random, stratified, cluster, systematic; non-probability sampling – purposive, convenience, quota, snowball.	3
Unit 5:	Basics of drafting scientific papers Writing scientific research papers, concept of IMRAD, types of research articles, literature review, style and formats for references, and graphical presentations. Empirical, case study, methodology, and theoretical papers	4
Unit 6:	Research Ethics and Integrity Nature and scope of ethical practice in research and academia; Responsibilities of researchers - honesty, transparency, and accountability; Academic integrity and scientific misconduct: plagiarism, data fabrication, falsification, selective reporting, redundancy and overlapping publications; Concepts of privacy, autonomy, confidentiality, and anonymity in research; ethical handling of sensitive data.	10
Unit 7:	Publication Ethics and Professional Conduct Definition and importance of publication ethics; publication misconduct; conflict of interest; authorship issues; responsibilities of editors, reviewers, and publishers; Peer review ethics and transparency	4
Unit 8:	Research Metrics Impact Factor, h-index, g-index, i10-index; altmetrics and their role in evaluating research impact.	4
Unit 9:	Exercise: Submission of Review of Literature or Project Proposal	10
	Total	48

Recommended Readings

1. Baran E., Warry F. 2008 Simple data analysis for biologists. World Fish Center and the Fisheries Administration. Phnom Penh, Cambodia. 67 pages.
2. Grafen A, Hailes R. 2002. Modern Statistics for Life Sciences. Oxford University Press, New York, USA.351.
3. Holmes D, Moody P, Dine D, Trueman L 2010. Research Methods for the Biosciences. 2nd ed. Oxford University Press, New York, USA. 460p
4. Mangel M. 2006. The theoretical Biologist's toolbox. Quantitative Methods for Ecology and Evolutionary Biology. Cambridge University Press, New York, USA. 390p.
5. Hurlbert SH. 1984. Pseudoreplication and the design of ecological field experiments.

- Ecological Monographs, 54(2); 187 – 211.
6. Kothari, C. R., and Garg, G., *Research Methodology: Methods and Techniques*, New Age International Publishers; 4th edition, 2019.
 7. Quinn GP, Keough MJ. 2002. *Experimental Design and Data Analysis for Biologists*. Cambridge University Press, Cambridge UK 537p.
 8. Zar JH. 1999. *Biostatistical Analysis*. IV ed. Pearson Education Pte Ltd. Singapore (Indian Branch) New Delhi, India. 663 pages
 9. Davis, M.: *Scientific Papers and Presentations*. Academic Press, San Diego (1997)
 10. Day, R.A.: *How to Write and Publish a Scientific Paper*. Second edn. ISI Press, Philadelphia (1983)
 11. Council of Biology Editors: Proposed definition of a primary publication. Newsletter,
 12. Council of Biology Editors (1968)
 13. Booth, W.C., Colomb, G.G., Williams, J.M.: *The Craft of Research*. Univ. of Chicago Press, Chicago (1995)
 14. Stock, W.G.: Was ist eine Publikation? Zum Problem der Einheitenbildung in der Wissenschaftsforschung. In Fuchs-Kittowski, K., Laitko, H., Parthey, H., Umstätter, W., eds.: *Wissenschaftsforschung Jahrbuch 1998*. Verlag für Wissenschaftsforschung, Berlin (2000) 239- 282
 15. O'Connor, M.: *Writing Successfully in Science*. Chapman & Hall, London (1995)
 16. Peat, J., Elliott, E., Baur, L., Keena, V.: *Scientific Writing - Easy when you knowhow*. BMJ Books, London (2002)
 17. Swales, J.M.: *Genre analysis: English in academic and research settings*. Cambridge Univ. Press, Cambridge (1993)
 18. Berry, R.: *How to Write a Research Paper*. Second edn. Pergamon Press, Oxford (1986)
 19. Dees, R.: *Writing the Modern Research Paper*. Second edn. Allyn & Bacon, Boston (1997)

Paper-ZOO-E104: Bioinformatics & Biostatistics

Credits 04

About the Course

This course provides a comprehensive introduction to the principles and applications of biostatistics and bioinformatics in modern biological research. The biostatistics component focuses on methods for data collection, summarization, visualization, and statistical inference, enabling evidence-based decision-making in the presence of uncertainty. The bioinformatics component introduces computational approaches for analysing biological data, with emphasis on sequence alignment, database searching, molecular phylogenetics, and the use of online tools and software for genomic and proteomic studies. Together, these components equip students with quantitative and computational skills essential for contemporary life sciences.

Course Outcome:

On successful completion of this course, students will be able to:

- CO1. Explain the theoretical foundations of parametric and nonparametric statistics and apply them to biological datasets.
- CO2. Perform and interpret standard statistical analyses, including t-tests, Chi-square tests, correlation, regression, and ANOVA.
- CO3. Utilize biostatistical and bioinformatics software tools for data visualization, hypothesis testing, and biological interpretation.
- CO4. Apply bioinformatics approaches such as sequence alignment, database mining, molecular phylogeny construction, and gene/protein annotation.
- CO5. Integrate biostatistical reasoning and bioinformatics tools to solve complex problems in genomics, proteomics, molecular biology, and biomedical sciences.
- CO6. Develop analytical, computational, and critical thinking skills necessary for research, data-driven decision making, and preparation for competitive examinations.

Paper-ZOO-E104 T (Theory)

Credits 03

Course Contents	Hours
Unit 1: Basics of Bioinformatics Introduction and scope of bioinformatics: concept of digital laboratory; Basics of information technology, computer, operating systems, network; Introduction to data archiving systems (FASTA format and Accession Number); Applications of bioinformatics.	5hrs
Unit 2: Database Management: Software, Packages, and Tools Basic features and management systems of Nucleic acid sequence databases, genome databases, protein sequence, structures, and interacting proteins databases, literature databases; Introduction to data retrieval systems, Search engines, Entrez, sequence	5hrs

retrieval system (SRS), and protein identification resource (PIR); Sequence alignments (BLAST and Clustal W) and phylogenetic trees (PHYLIP).	
<p>Unit 3: Data Collection, Distribution, Presentation, Authentication, and Analysis</p> <p>Collection and classification of data; Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot; Probability theory: Binomial distribution, Poisson distributions; Measures of central tendency: Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation, and Standard error; Concept of Coefficient of variation.</p>	13hrs
<p>Unit 4: Statistical Tests</p> <p>Correlation: Types of correlation, calculation of correlation, Partial and multiple correlation; Regression: Linear regression, regression coefficient;</p> <p>Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, & F-test)</p> <p>Analysis of variance (ANOVA): One-way, post-hoc tests;</p> <p>Non-parametric tests (Rank Correlation, Chi-square test, Mann-Whitney U-test).</p>	13hrs

Paper-ZOO-E104P (Practical)

Credits 01

1. Perform Chi-square test, t-test, z-test, F test, ANOVA, and Mann-Whitney U-test analysis from the provided data.
2. Solve the problems related to correlation and regression from the supplied data.
3. Graphically represent the supplied data (Pie chart, Bar diagram, Histogram, Frequency polygon, Cumulative frequency curve).
4. Introduction to Biological Databases: NCBI, EMBL, DDBJ, UniProt, PDB. Retrieval and management of nucleotide and protein sequence data.
5. Sequence Alignment: Pairwise alignment using BLAST and FASTA; Multiple sequence alignment (MSA) using CLUSTAL Omega; Interpretation of alignment scores and significance.
6. Phylogenetic Analysis: Construction of phylogenetic trees from aligned sequences; Interpretation of evolutionary relationships.
7. Genomics and Proteomics Tools: Gene prediction tools and annotation methods; Analysis of protein domains and motifs (Pfam, PROSITE, InterPro); Secondary and tertiary structure prediction (SWISS-MODEL, Phyre2).
8. Molecular Visualization: Structural visualization using tools such as PyMOL or RasMol.

Recommended Readings

1. Daniel, W.W. (2012). Biostatistics: A Foundation for Analysis in Health Sciences (10th edition). John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition), McGraw-Hill.
3. Zar, J.H. (2013). Biostatistical Analysis (5th edition). Pearson.

4. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.

5. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS.

Paper-ZOO-E104: Applied Zoology

Credits 04

About the Course

The study of the Applied Zoology program focuses on developing theoretical and practical knowledge in sericulture, lac culture, apiculture, fishery, dairy and poultry farming, vermiculture, and pearl culture, among others. Based on the acquired experience, students will be encouraged to take up a small-scale business as a career.

Course Outcomes

Applied Zoology deals with the application of Zoological knowledge for the welfare of mankind. At the end of the course, the student will be able to:

CO1. To understand the different breeds in poultry and dairy farming, along with their management

CO2. Gain knowledge about silkworm rearing and their products.

CO3. Acquire knowledge about the culture techniques of oyster and prawn.

CO4. Acquire knowledge about the basic procedure and methodology of vermiculture.

CO5. Learn various aspects of beekeeping & lac culture.

CO6. Know the concepts of induced breeding techniques and post-harvesting techniques of fish.

Paper-ZOO-E104 T (Theory)

Credits 03

Course Contents	Hours
Unit 1: Poultry & Dairy Farming Types of poultry breeds, poultry housing, farm, and farm Management. Egg grading, handling, and marketing management of poultry diseases. Composition of Milk, Dairy products, National Dairy Development Board, and Operation Flood Program.	6 hrs
Unit 2: Economic Zoology 2.1 Sericulture: Definition, Types of silkworms and their host plants; Life cycle of Bombyx mori; Structure of silk gland; Silk: composition, characteristics, and uses; Diseases and pests of silkworms and their control measures; Genetic improvement of silk breed in India; Prospects of sericulture in India.	6 hrs
2.2: Apiculture: Definition, Status and Scope, Products of Apiculture and their uses, Life Cycle of the Honey Bee	6 hrs
2.3: Prawn culture: Types of cultivable prawn species; Different categories of	

modern prawn culture; Culture of prawn in brackish water and fresh water and their advantages; Hazards of brackish water and fresh water prawn culture and their control; Prawn breeding; Preservation and processing of prawn; Prospects of prawn culture in India.	6 hrs
2.4: Pearl Culture: Definition: Chemical composition and uses of pearl; Pearl-producing oysters; Process of pearl formation; Biology of pearl oyster; Pearl oyster farming. Recent development leading to the quality of pearl and prospects of pearl culture in India.	6 hrs
Unit 3: Vermitechnology: Definition of vermiculture, vermicomposting, and vermi-bed; Suitable and non-suitable breeds for vermiculture; Vermiculture process; Advantages and disadvantages of vermicomposting; Prospects of vermiculture.	6 hrs
Total	36 hrs

Paper-ZOO-E104P (Practical)

Credits 01

1. Finding out the significance and identification of economically significant animals such as *Antheraea* sp., *Bombyx mori*, *Penaeus* sp., *Macrobrachium* sp., *Pinctada* sp., *Eisenia* sp, and *Apis dorsata*
2. Identification and application of different rearing tools and equipment used in sericulture and lac culture.
3. Study of the morphology of different stages of the silk moth and the lac insect (through photographs).
4. Identification and uses of the products of sericulture and lac culture.
5. Identification of penaeid and non-penaeid groups from the supplied prawn specimens.
6. Identification of different species of earthworm used for vermicomposting, Estimation of pH of vermicompost.
7. Visit to Sericulture farm /Lac culture farm/Prawn processing farm/ Pearl culture center and submission of the report.

Suggested Readings

1. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
2. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan.
3. Dunham, R.A. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
4. Sharma P.L. and Singh, S.H. Book of Bee Keeping
5. Khanna and H.R. Singh, A textbook of Fish Biology and Fisheries, Narendra Publishing House.
6. Ghorai, N. Lac culture in India. International Books and Periodicals, New Delhi.
7. Pillay, T.V.R. Aquaculture Principles and Practices, Fishing News Books, Blackwell Science Ltd.
8. Banerjee, G.C. A Text Book of Animal Husbandry. Oxford and IBH Pub. Co. Pvt. Ltd, New Delhi.
9. Singh, H. and Moore, E.N. Livestock and Poultry Production. Prentice-Hall of India Pvt. Ltd, New Delhi.

PAPER CODE: ZOO-E105 (Biotechnology and Public Health)

Credits: 04

About the Course:

The course is designed to enlighten the students on both the basic principles and practical applications of Biotechnology in the progress of industrial, medical, agricultural, and aquacultural sectors of modern civilization. The course also highlights the role of Biotechnology in managing environmental pollution.

Moreover, the course focuses on the fundamental aspects of public health issues, as well as the causes and control of various vector-borne and food- or water-borne diseases. Further, the course highlights the role of vaccination in promoting public health.

Course Outcomes:

Upon completing the course, the students will be able to understand:

CO1. The basic principles of gene cloning and cDNA technology,

CO2. The application of Biotechnology in the production of biofuels, clinically useful substances, improved varieties of crops, and pest-resistant plants.

CO3. The use of Biotechnology in the management of environmental pollution.

CO4. The cause and control of different vector-borne and food-borne diseases.

CO5. The role of vaccination in promoting public health.

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PAPER CODE: ZOO-E105T (Theory)

Credits: 03

Course Contents	Hours
Unit 1: Key Aspects of Biotechnology Meaning and advantages of Biotechnology; Purview of Biotechnology: white, red, green, blue, and environmental biotechnology; Restriction and modifying enzyme, Recombinant DNA: Production of recombinant DNA molecule, Cloning vectors ; Gene cloning vs. cDNA technology; Biotechnology sector (Sunrise sector) of India and National Biotechnology Development Strategy (NBDS).	5 hrs
Unit 2: White (Industrial) Biotechnology Need and advantage of biofuel production; Principles of bio-ethanol and bio-diesel	2 hrs

production.	
Unit 3: Red (Medical) Biotechnology Production of human insulin by genetic engineering	2 hrs
Unit 4: Green (Agricultural) Biotechnology Production and utility of golden rice; Controversies over genetically modified crops (GMC).	2 hrs
Unit 5: Blue (Aquacultural) Biotechnology Production of transgenic fish and its application	2 hrs
Unit 6: Environmental Biotechnology Bioremediation; Production of 'superbug'; Vermicomposting and its utility	3 hrs
Unit 7: Biotechnology-related laboratory techniques Agarose gel electrophoresis; Southern blotting hybridization, Western blotting hybridization, Polymerase chain reaction (PCR), Cell fractionation	4 hrs
Unit 8: Introduction to Public Health Issues Zoonotic and vector-borne diseases; Endemic, epidemic and pandemic diseases; Mechanical and biological vectors of diseases; Propagative, cyclo-propagative, and cyclo-developmental transmission of diseases, virus-associated human cancer	3 hrs
Unit 9: Vector-borne diseases Life cycle of <i>Plasmodium vivax</i> and <i>Leishmania donovani</i> ; Mode of transmission, pathogenicity and symptoms, diagnosis and treatment/control, and prophylaxis of Cerebral malaria, Kala-azar, and Dengue. Mosquito control measures: chemical, environmental, and biological measures	6 hrs
Unit 10: Food and water-borne diseases Mode of transmission, pathogenicity and symptoms, diagnosis and treatment/control, and prophylaxis of Amoebiasis and Shigellosis.	3 hrs
Unit 11: Vaccination to promote public health Utility of vaccination; Formulation and efficacy of BCG vaccine, oral polio vaccine;	4 hrs

National Immunization Schedule in India.	
Total	36 hrs

PAPER CODE: ZOO-E105P (Practical)

Credits: 01

1. Agarose gel electrophoresis
2. Tissue homogenization
3. Demonstration of PCR
4. Microscopic identification with reasons: Signet ring of malaria parasite, Microfilaria larva, *Entamoeba histolytica* (trophozoite), some important vectors, Head of female *Anopheles* and *Culex* mosquitoes.
5. Observation of people's awareness on any health issue in any locality (E.g., Source of drinking water used by villagers; Measures taken by villagers to avoid mosquito-borne diseases; Use of sanitary napkin by village women; Practice of Yoga and physical exercise by school children; Awareness of villagers on any other health issue), University USIC visit

Recommended Readings:

1. Chatterjee, K. D. (2009). Parasitology (Protozoology and Helminthology), 13th edition, CBS Publishers & Distributors, Kolkata.
2. Dubey, R. C. (2022). A Textbook of Biotechnology, S. Chand and Co. Ltd., New Delhi
3. Mullen, G. R. and Durden, L. A. (2018). Medical and Veterinary Entomology, 3rd edition, Academic Press, London.
4. Singh, B. D. (2025). Biotechnology (Expanding Horizons), 6th edition, Kalyani Publishers, New Delhi.
5. Thieman, W. J. and Palladino, M. A. (2014). Introduction to Biotechnology, 3rd edition, Pearson, London.
6. Hati A.K. (2001) Medical Parsitology, Allied Book Agency, Kolkata
7. Eiteman, D. K., Moffett, M. H., Stonehill, A. I., Thieman, W. J., & Palladino, M. A. (2020). Introduction to Biotechnology (4th Ed.). Pearson.
8. Clark, D. P., & Pazdernik, N. J. (2015). Biotechnology (2nd Ed.). Academic Cell (Elsevier).
9. Park, K. (2021). Park's Textbook of Preventive and Social Medicine (26th Ed.). Banarsidas Bhanot.
10. Tuttle, T. D. (2020). Principles of Public Health: A Simple Textbook on Hygiene Presenting the Principles Fundamental to the Conservation of Individual and Community Health. Lector House.
11. Lal, S., & Vikas. (2025). Public Health Management: Principles and Practice (4th Ed.). CBS Publishers & Distributors Pvt. Ltd.
12. Roberts, L. S., Janovy, J. and Nadler S. (2013) *Gerald D. Schmidt & Lary S. Roberts' Foundation of Parasitology*. 9th ed. McGraw-Hill International.
13. Lynne Shore Garcia (2007) Diagnostic Medical Parsitology (5thEdn) ASM press Washington D.C.
14. T.A. Brown (2010) Gene cloning an DNA analysis- An introduction (6thEdn) Willey Blackwell
15. iGenetics: A Molecular Approach by Peter J. Russell 3rd Edn. (2010)

PAPER CODE: ZOO-E105 (Insect Vector and Management)

Credits: 04

About the Course:

The course provides insight into common vector-borne diseases, their etiology, the role of vectors in their spread, the host-parasite relationship, and strategies to manage these diseases.

Course Outcomes:

After completing this course, the students will be able to:

- CO1. Develop awareness about the causative agents and control measures of many commonly occurring diseases.
- CO2. Develop an understanding of the favorable breeding conditions for the vectors.
- CO3. Devise strategies to manage the vector population below threshold levels, with public health importance.
- CO4. Undertake measures or start an awareness program for the maintenance of hygienic conditions, avoidance of contact with vectors, and destruction of breeding spots in the vicinity of houses and cattle sheds by a public health education campaign.

PAPER CODE: ZOO-E105T (Theory)

Credits: 03

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Course Contents	Hours
Unit 1: Introduction to Insects General Features of Insects; Morphological features- Head & Eyes; Types of antennae: Mouth Parts.	4 hrs
Unit 2: Vector and Vector Bionomics Brief introduction; Types of vectors; Morphological peculiarities of different vectors; Host-vector relationship; Adaptations of vectors; Host specificity; Vectorial capacity.	4hrs
Unit 3: Insects as Vectors Detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata & Hemiptera.	4hrs
Unit 4: Dipteran as Disease Vectors Dipterans as important insect vectors – Mosquitoes, Sand flies, and Houseflies. Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes. Study of sand fly-borne diseases –Leishmaniasis; Control of Sand flies.	7 hrs

Unit 5: Siphonaptera as Disease Vectors Fleas are important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas.	4hrs
Unit 6: Siphunculata as Disease Vectors The human louse (Head, Body, and Pubic louse) is an important insect vector; control of human lice.	4 hrs
Unit 7: Hemiptera as Disease Vectors Bugs as insect vectors; Blood-sucking bugs; Chagas disease; Bed bugs as mechanical vectors; Control and prevention measures.	4hrs
Unit 8: Vector management: Control of vectors through screening, traps, electrocution, poison baits, outdoor residual sprays, biological control, chemical control, sterile insect technique, and pheromones /allelochemicals.	4 hrs

PAPER CODE: ZOO-E105P (Practical)

Credits: 01

1. Study of the mouth parts of different insects.
2. Study of the following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus humanus capitis*, *Phthirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica* through permanent slides/ photographs.
3. Study of different diseases transmitted by the above insect vectors.
4. Submission of a project report on any one of the insect vectors and diseases transmitted.

Recommended Readings:

1. Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
2. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
3. Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
4. Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell
5. Medical Entomology, Hati A. K Allied Book Agency, Kolkata

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