SYLLABUS FOR
Ph.D. COURSE WORK IN ZOOLOGY
(w.e.f. the academic session 2022-2023)

DEPARTMENT OF ZOOLOGY
SIKSHA-BAHVANA
VISVA-BHARATI
SANTINIKETAN

Department of Zoology
Siksha Bhavana, Visva-Bharati

Syllabus for Ph.D. course work in Zoology

Course structure

Course Code	Course Title	Credits	Marks
ZCW-101	Research Methodology A. Computer Application B. Analytical Techniques in Research	1+3=4	100
ZCW -102	Research and Publication Ethics	2	50
ZCW-103	Advanced Zoology	4	100
ZCW-104	Review of Literatures	4	100
	Total	14	350

Details Ordinance of the Course

Ph.D course work in Zoology will be of 14 credits (350 Marks) and one (1) credit is equivalent to 25 (twenty five) marks. 1 credit = 4 hours theory classes per week /8 hours hands on training or review work per week. Candidates shall have to take 14 credits and have to secured 5 OGPA in a 10-point scale (50% marks) in final aggregate and also 50% marks or 5 OGPA in each course to pass the course. Conversion formula: OGPA= Percentage of marks/10.

There shall be no provision of reevaluation/ review of answer scripts. However, if a candidate fails to qualify/pass in any of the course (s) in his/her regular chance, **one** additional chance in the immediately succeeding academic session shall be given and that shall be the final chance.

Duration of the course is **one** semester i.e **6 months**

Courses: ZCW-101 Research Methodology (A. Computer Application; B. Analytical Techniques in Research); ZCW-102 (Research and Publication Ethics); ZCW-103 (Advanced Zoology) and ZCW-104 (Review of Literatures).

Assessment: Continual Internal assessment on 20% of total marks (Continual assessment should be at least two tests per paper/course in the form of written test/ viva/assignment/ presentation).

Final examination on 80% of total marks. Written examination duration 4 hours for the courses of 80 marks and 3 hours for the courses of 40 marks.

Question pattern: ZCW-101 Part B (Analytical Techniques in Research): Four questions (out of Six) of 5marks each and Four questions (out of Six) of 10 marks each are to be answered.

ZCW-102: Five questions (out of 8) of 2 marks each and Two questions (out of Three) of 5 marks and Two questions (out of Three) of 10 marks each are to be answered.

ZCW-103: Eight questions (out of 10) of 10 marks each are to be answered.

ZCW-104: Review of literatures: submission 40 marks; seminar presentation and interaction 40 marks (30+10).

Course: ZCW-101
(Research Methodology)

Full marks: 100 **Credits: 4** **No. of lectures: 72**

A. Computer applications

Marks: 25 **Credits: 1** **Total lectures: 18**

(To be framed by the Department of Computer Systems & Science)

B. Analytical techniques in Research

Marks: 75 **Credits: 3** **Total lectures: 54**

1. **Microscopy and its application:** Applications of light and fluorescence microscopy, confocal microscopy, electron microscopy (SEM/TEM) and super resolution microscopy. (6L)
2. **Separation techniques:** Centrifugation: analytical centrifugation, differential centrifugation; density gradient centrifugation; Chromatography: column chromatography; affinity chromatography, Ion exchange chromatography; gel permeation, high-pressure liquid chromatography. (6L)
3. **Analysis and quantification of biomolecules**: spectrophotometric; gravimetric and titrimetric estimation. (3L)
4. **Methods to study properties of proteins and purification:** Protein sequencing: Edman degradation, mass spectrometry; Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF); protein interaction studies: SPR; evaluating protein secondary structure: CD spectra (6L)
5. **Microbiological technique:** Molecular techniques in microbial identification, metagenomics. (3L)
6. **Histochemical analysis of animal tissues:** Preparation of animal tissues for microscopic studies, biological staining of tissues; immunohistochemistry and *in situ* hybridization (4L)
7. **Immunological techniques:** Immunoelectrophorosis; Immunoprecipitation; ELISA, Flow cytometry and FACS; raising of antibodies against a protein/ peptide in rabbit/mouse /rat, Monoclonal antibody. (4L)

8. **Cell culture**: Aseptic handling procedures; types of media used in animal cell culture; preparation of primary and secondary culture system; maintenance of cell culture and sub culture; Cell viability assays. (4L)
9. **Bioinformatics:** Data analytic resources: NCBI, EBI, ExPASy, Sequence and structure databases, Sequence analysis, Sequence-based database searches, Pair wise sequence alignments & Multiple sequence alignments, Taxonomy and phylogeny, Protein secondary structure prediction and classification of protein folds; Primer designing, Big data analysis. (8L)
10. **Biostatistics**: Data type (continuous, discrete, proportion, count). Population and samples. Probability (Def- inition of probability), Research planning, Research design, Experimental design, Sampling methods and data collection, Hypothesis testing, , Error-I type, Error-II type. Homogeneity of variance, Test for Normality, **Parametric test** versus **Non-Parametric tests** Statistical packages and their applications (Excel, R, Graphpad, Prism, SPSS). (10L)

Suggested readings:

- David W. Mount (2004). Bioinformatics: Sequence and Genome Analysis. Cold spring Harbor laboratory press.
- Gebhardt, N. (2010). Fluorescence in Situ Hybridization (fish): Application Guide. Springer.
- Pevsner, J. (2015). Bioinformatics and functional genomics. John Wiley & Sons.
- Presnell, J. K., Schreibman, M. P., & Humason, G. L. (1997). Humason's animal tissue techniques. Johns Hopkins University Press.
- Rastogi, V. B. (2015). Biostatistics. Scientific International Pvt.Ltd.
- Ronald, N. F., Eun, S. E. & Michael, H. (2007). Biostatistics. A guide to Design, Analysis, and Discovery. Academic Press.
- Glass, D.J. (2014). Experimental design for Biologists (Second Edition). Cold Spring Harbor Laboratory Press, New York.
- Kothari, C.R. (2011). Research Methodology: Methods and Techniques (Second Edition). New Age International Publication, New Delhi.
- Quinn, G and Keough, M.J. (2002). Experimental Design and Data Analysis for Biologists. Cambridge University Press, New York.
- Tenenbaum, A. S & Wetherhall, D. J. (2013). Computer Networks. Pearson
- Towner, K. J., & Cockayne, A. (1993). Molecular methods for microbial identification and typing (No. 04; QR65, T6.). London: Chapman & Hall.
- Wang, F. (2006). Culture of animal cells: a manual of basic technique. In Vitro Cellular & Developmental Biology-Animal, 42(5), 169-169.
- Zar, J. H. (1999). Biostatistical analysis. Pearson Education Inc., New Delhi, India

(Research and Publication Ethics)

Full Marks: 50 **Credits: 2** **Total lectures: 36**

1. **Philosophy and Ethics:** Introduction to Philosophy: Definition, nature and scope, concept, branches. Ethics: Definition, moral philosophy, (8L)
2. **Scientific Conduct**: Ethics with respect to science and research; Intellectual honesty and research integrity; scientific misconducts: falsification, fabrication and plagiarism (FFP); redundant publications: duplicate and overlapping publications, salami slicing; selective reporting and misrepresentation of data**.** (6L)
3. **Publication ethics:** Definition, introduction and importance; Best Practices/standard settings initiatives and guidelines: COPE, WAME etc; Conflicts of interest; Publication misconduct: definitions, concept, problems that lead to unethical behavior and vice versa, types; violation of publication ethics, authorship and contributorship; identification of publication misconduct, complaints and appeals; predatory publishers and Journals**.** (6L)
4. **Open Access Publishing:** Open access publications and initiatives; SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies; Software tools to identify predatory publications developed by SPPU; Journal finder/ journal suggestion tools viz JANE, Elsevier Journal Finder, Springer, Journal Suggester etc. (4L)
5. **Publication Misconduct: (**A) Group Discussion: Subject ethical issues, FFP, authorship, conflicts of interest; complaints and appeals, examples and fraud from India and Abroad. (B) Software tools: Use of Plagiarism software like Urkund and other open-source software tools. (6L)
6. **Database and research matrix: (**A) Database: Indexing databases, citation databases, web of science, Scopus etc. (B) Research metrics: Impact factor of journal as per journal citation report, SNIP, SJR, IPP, Cite score; Metrics: h- index, g index, i10 index, altimetric (6L)

Suggested readings:

- P.Chaddah, (2018) Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN:978-9387480865
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to responsible conduct in Research: Third Edition, National Academies Press.
- Resnik, D.B. (2011) What is ethics in research & why is it important. National institute of Environmental
- Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. htt://www.insaindia.res.in/pdf/Ethics_Book.pd

Course: ZCW-103
(Advanced Zoology)

Full marks: 100 **Credits: 4** **Total lectures: 72**

1. **Model organisms for research**: Animal handling and ethics; maintenance oflaboratory animal; CPCSEA guidelines; Institutional ethics committees; Ethical considera- tion in research on human beings. mice (Knock in; Knock out, knockdown, nude mice), rats, zebrafish; *Drosophila melanogaster*; *Caenorhabditis elegans.* (6L)
2. **Biology of Parasitism:** Parasite surface coat; Host interaction; Immune response and self defense mechanisms, immune evasion and biochemical adaptations of parasites; Drug target, mechanism of drug resistance, vaccine strategies. (8L)
3. **Developmental Biology:** Stem cell Biology and regenerative medicine; Cell fate and pattern formation. (8L)
4. **Genetic biomarkers:** Toxicological biomarker genes, genes involved in Nrf2-ARE pathway. Apoptotic biomarker genes. (8L)
5. **Molecular endocrinology and reproduction**: (A) Molecular mechanisms of hormone action: Transduction of endocrine signals: receptor-ligand interaction, GPCR (G_s & G_i), RTKs, role of second messengers (cAMP, cGMP), kinases. (B) Gonadal steroids and autocrine/paracrine factors. (10L)
6. **Ecology:** Population dynamics, Diversity measures (Models for S: N relationship, Non- parametric Indices), Metadata in Ecology. (8L)
7. **Fish Biology and Aquaculture:** Propagation and stock improvement; Fish nutrition; Nutritional requirements; Feed formulation and probiotics in fish nutrition. (8L)
8. **Molecular biology:** Genomic DNA and RNA isolation; PCR and qRT-PCR; Microarray technology; molecular cloning; Recombinant protein expression and purification, gene silencing by siRNA/shRNA; Gene knockout technology; Genome-Editing Technologies: Principles and Applications. Genome sequencing techniques. Next generation sequencing. (16L)

Suggested readings:

- Compendium of CPCSEA (2018). Ministry of environment, Forest and Climate Change, Government of India
- Bentley, P. J., & Bentley, P. J. (1998). Comparative vertebrate endocrinology. Cambridge University Press.

- Berryman, A. A. (2020). *Principles of population dynamics and their application*. Garland Science.
- Carson, S., Miller, H. B., Srougi, M. C., & Witherow, D. S. (2019). Molecular biology techniques: a classroom laboratory manual. Academic Press.
- Currie, S., & Evans, D. H. (Eds.). (2020). *The physiology of fishes*. CRC Press.
- Chemotherapeutic Targets in Parasites Contemporary strategies, 2002 Tag E. Mansour. Cambridge University Press Published
- Davis, R. H. (2004). The age of model organisms. Nature Reviews Genetics, 5(1), 69-76.
- De Silva, S. S., & Anderson, T. A. (1994). *Fish nutrition in aquaculture* (Vol. 1). Springer Science & Business Media.
- Evans,D.H., (2006).The Physiology of Fishes, CRC Press.
- Fields, S., & Johnston, M. (2005). Whither model organism research? Science, 307(5717), 1885-1886.
- Gilbert, S. F. (2000). An introduction to early developmental processes. In Developmental Biology. 6th edition. Sinauer Associates.
- Gotelli, N. J. (2008). *A primer of ecology* (Vol. 494). Sunderland, MA: Sinauer Associates.
- Gupta S.K. and Gupta, P.C. (2006). General and Applied Ichthyology (Fish and Fisheries), S. Chand & Co., New Delhi
- Hayat, M. A. (ed.) (1978). Principles and Techniques of Electron Microscopy: Biological Applications. 2nd edition. Van Nostrand Reinhold, New York.
- Wilson, K., & Walker, J. (eds.) (2001). Principles & Techniques of Practical Biochemistry.5 th ed. Cambridge University Press.
- Indian Council of Agricultural Research (2015) Handbook of Fisheries and Aquaculture
- Kiernan, J. A. (1999). Histology and Histochemical Methods: Theory & Practice. 3 rd ed, Butterwork Heinemann
- Leonelli, S., & Ankeny, R. A. (2013). What makes a model organism? Endeavour, 37(4), 209-212.
- Joseph Marr, Timothy W Nilsen and Richard W. Komunieck (2003). Molecular Medical Parasitology, Elsevier Science Ltd, Academic Press
- Moody SA (1998) Cell lineage and fate determination. 1st ed. Academic Press.
- Namboodiri, K. (1996). *A primer of population dynamics*. Springer Science & Business Media.
- Norris, D. O., & Carr, J. A. (2020). Vertebrate endocrinology. Academic Press.
  Sharma, V. K. (1991). Techniques in Microscopy and Cell Biology. Tata-McGraw Hill.
- Spencer, M., Spencer, M., & Michael Spencer, F. I. F. (1982). Fundamentals of light microscopy (Vol. 6). CUP Archive.
- Spitsbergen, J. M., & Kent, M. L. (2003). The state of the art of the zebrafish model for toxicology and toxicologic pathology research—advantages and current limitations. Toxicologic pathology, 31(1_suppl), 62-87.
- Twyman, R. (2018). *Advanced molecular biology: a concise reference*. Garland Science.
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Course-ZCW-104
(Review of Literatures)

Full marks: 100 **Total Credits: 4**

A review of literatures to be conducted and submitted by the candidate based on research area of his/her interest followed by presentation and viva-voce in presence of subject expert and Departmental research committee.