Sophia College for Women (Autonomous)

Affiliated to

UNIVERSITY OF MUMBAI

Programme: Zoology

Programme Code: SPSZOO

Ph. D. Course Work in Zoology

(Choice Based Credit System with effect from the year 2020-21)

Programme Outline: Ph. D. Course Work in Zoology

Course Code	Unit No	Name of the Unit	Credits
SPSZOO101		RESEARCH METHODOLOGY	4
	1	Introduction to Research Methods and Methodology	
	2	Biostatistics	
	3		
SPSZOO102		Advances in Biochemistry & Toxicology	4
	1	Basic Toxicology	
	2	Regulatory Toxicology	
		Practical Course	
SPSZOO103		Other Research related Academic Activities	4

Preamble:

Ph. D. Course work is mandatory for the students enrolled in the Ph.D. program as per the University of Mumbai Circular No. Exam/ Thesis/Univ./VCD/947 of 2018. Based on the guidelines mentioned in this circular, this syllabus has been designed in order to bring about an in-depth knowledge of research methods and methodology as well as the core subject of the research discipline offered at the zoology research centre of our institution.

Research methodology curriculum is developed such that it would encompass the various areas of the very process of research in science. The research students would be oriented to the ethics in research and publication and also to the good laboratory practices which must serve as a foundation for quality research. ICT skills for research analysis and presentation are also included that would help students at all levels of their research endeavor. This background knowledge gained could be demonstrated by the students through their publications in science journals and/or popular science communications.

The course work for the core discipline of research would focus on the essentials of Advanced Biochemistry and Toxicology along with the hands-on training through the practical course. Information regarding the various categories of industries assigned by CPCB namely red, orange and green as per the level of toxicity of pollutants that they may produce could also be imparted while dealing with the toxicity guidelines. Students should be made aware of the various alternative methods in toxicology such as in vitro tests, the use of pesudovirus as an easier and a useful alternative for cell-based assays which could be carried out even in a laboratory with limited infrastructure as against the Class-3 or Class -4 viruses that require highly specific research institutions. Students could also get to understand the significance of pharmacokinetics, how specific models are selected depending on the experimental studies, importance of phased clinical trials and such important aspects involved in the toxicological research.

Research students could also contribute to the department activities as an added dimension to their research career while they are affiliated to our institution. This would give them an opportunity to get involved by participating as well as organizing certain teaching as well as research related activities within the institution. They could also attend workshops, lecture series, conference that are related to or are parallel to their research study which could update their knowledge further. This could also provide them a platform to present their research work to the others in the scientific community.

The performance of the students for this course work will be evaluated through the continuous assessment as well as course end examination; both being of equal weightage.

PROGRAMME OBJECTIVES

PO 1	To impart an in-depth knowledge of research methods and research methodology that would equip the researchers to undertake challenging research problems for societal benefits.
PO 2	To gain expertise in core subject of the research discipline to bridge the gaps in specific research skills
PO 3	To orient the researchers to the ethics in research and publication and also to the good laboratory practices that serve as a foundation for quality research.
PO 4	To enhance ICT skills for research analysis and presentation
PO 5	To provide opportunity to get involved in the research related activities within the institution

PROGRAMME SPECIFIC OUTCOMES

PSO 1	Apply the research methodology in the given research problem
PSO 2	Analyze and evaluate the research data obtained from the research study for its significance
PSO 3	Draw inferences from research results in the context of toxicology studies
PSO 4	Get career opportunities in research field

NAME OF THE COURSE	RESEARCH METHODOLOGY	
CLASS	Ph. D. ZOOLOGY	
COURSE CODE	SPSZOO101	
NUMBER OF CREDITS	4	
EVALUATION METHOD	INTERNAL ASSESSMENT	COURSE END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	To understand the concept of research methods and methodology
CO 2.	To learn about the various research data bases
CO 3.	To gain knowledge about research communication
CO 4.	To know about the importance of ethics in research and publication

COURSE LEARNING OUTCOMES:

CLO 1.	Design the experiment and the protocols of the research study by following the good laboratory practices
CLO 2.	Compile the extensive literature review pertaining to the research problem
CLO 3.	Prepare the manuscript for paper publication as well as presentation at research conferences incorporating ICT skills
CLO 4.	Apply the biostatistical tools for analyzing the research data

UNIT 1	**INTRODUCTION TO RESEARCH METHODS AND METHODOLOGY (2 Credits)**
1.1	Basics of Research Methodology: Definition of research, Characteristics of research, Types of research- Conceptual vs. Empirical, Applied vs. Fundamental, Descriptive vs. Analytical, Quantitative vs. Qualitative, Overview of research methodology in various areas, Basic research terminology such as research problem hypothesis, proof, experimental design etc.

1.2	Good laboratory practices: Recording and storage/ retention of recorded materials Introduction to EHS (Environment, Health and Safety) guidelines Maintenance of equipment, proper storage and disposal of hazardous materials (chemical & biological) Management and user responsibilities in proper utilization of the facilities
1.3	Literature review, Internet and its application in research: Literature survey through NCBI -PubMed, Google Scholar, ResearchGate, etc., Defining the research question, Approaches and Methodology, Documentation and, Analysis and interpretation of data, manuscript preparation, presentation of data, Computer application: Plotting of graphs, Statistical analysis of data.
1.4	Scientific writing: Preparation of manuscript for publication of research / reviewpaper: Structure and components of a research / review paper, Peer reviewed, UGC – CARE listed and Indexed journals, Citation index and Role of citations, impact factor of a journal. Use of free open sources such as Mendeley Reference Manager, LaTeX as writing software, Storage through Google Drive/ DropBox
1.5	ICT and soft skills: Software tools in the structure and design and preparation of thesis, layout of Illustrations – labeling of photomicrographs, figure legends, scale bar, Layout of tables, Oral presentation: planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication. Effective poster presentation with the help of appropriate software tools
1.6	Ethics in Publication & Research: Ethics in publication: citation and acknowledgement, conflict of interest, plagiarism, Plagiarism checking tools, introduction to ORCID iD Ethics in research: Overview of Legislation and regulations/ethical guidelines in animal research, clinical research and wildlife research IPR: intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights, Incubation and Innovations as a future prospect of research
UNIT 2	**BIOSTATISTICS (2 Credits)**
2.1	Basics of Biostatistics: Measures of Central tendencies of a statistical data: Mean, mode, median and their calculations Measures of Variation: Variance, standard deviation (SD), standard error of means (SEM) Graphical representation with the help of computer, significance of Y-error bars Use of appropriate software for computation of statistical data

2.2	Correlation and Regression: Interpolation and extrapolation Nonlinear data fitting Probit analysis Use of appropriate software
2.3	Concept of Probability: Conditional probability and Random variables Probability mass function, and Probability density function Expectation, Variance and Covariance Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, p-value
2.4	Test of Hypothesis: Basic concepts, types of hypotheses: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis Parametric test: z test, t test (1 tailed and 2 tailed Test of Hypothesis, p-value) Different kinds of ANOVA tests Post ANOVA tests Non-parametric test: Chi-square test and its applications, Mann-Whitney U test, Kolmogorov Smirnov, Kruskal Wallis, Friedman analysis, Spearman correlation Use of appropriate software

REFERENCES:

1. Aliotta M. (2018). *Mastering Academic Writing in the Sciences: A Step-by-Step Guide*. CRC Press.
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3. CSIR. (2019). *Guidelines for Ethics in Research and in Governance.* CSIR, New Delhi.
4. Day, R.A. (1998). How to Write and Publish a Scientific Paper. (5th ed.). Oryx Press.
5. Harikrishna, M., Pillai, M. and Dass, S.H. (2020). *Ed. In: Means to a Beginning: Funding opportunities for PhD students and Postdocs in India*. IndiaBioscience, Bangalore.
6. Kothari, C.R. (2023). *Research Methodology*: Methods and Techniques. (5th ed.), New Age International.
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NAME OF THE COURSE	ADVANCES IN BIOCHEMISTRY & TOXICOLOGY	
CLASS	Ph. D. ZOOLOGY	
COURSE CODE	SPSZOO102	
NUMBER OF CREDITS	4	
EVALUATION METHOD	INTERNAL ASSESSMENT	COURSE END EXAMINATION
TOTAL MARKS	50	50
PASSING MARKS	20	20

COURSE OBJECTIVES:

CO 1.	Understand the fundamental principles of toxicology and its scope
CO 2.	Analyze the different types and aspects of toxicity
CO 3.	Explore biochemical assays and their significance in toxicology
CO 4.	Understand regulatory frameworks and guidelines for chemical testing and using animal models

COURSE LEARNING OUTCOMES:

CLO 1.	Describe the historical development of toxicology, identify different areas within toxicology, and explain the principles governing toxicological studies.
CLO 2.	Differentiate between acute, sub-acute, sub-chronic, and chronic toxicity, and explain how factors such as duration, frequency, site, and route of exposure influence toxicity.
CLO 3.	Understand the importance of biochemical assays in toxicological studies, including assays for biochemical parameters, various enzymes including oxidative stress markers
CLO 4.	Gain knowledge of the OECD guidelines for testing chemicals and using animal models including principles, methodologies, and regulatory requirements for safety assessment and CCSEA guidelines

	THEORY COURSE (2 Credits)
UNIT 1	**BASIC TOXICOLOGY**
1.1	Introduction to toxicology – brief history, different areas of toxicology, principles and scope of toxicology

1.2	Toxins and Toxicants – Phytotoxins, Mycotoxins Zootoxins, Xenobiotics
1.3	Types of Toxicity – Acute toxicity, Sub-acute toxicity, Sub-chronic toxicity and Chronic toxicity, Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure, Concept of LD50, LC50, ED50
1.4	Dose Response relationship – Individual / Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety
1.5	Dose translation from animals to human – Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)
1.6	Target organ toxicity: Hepatotoxicity: susceptibility of the liver, types of liver injury, histopathological changes Neurotoxicity: vulnerability of nervous system, histopathological changes examples of neurotoxicants Nephrotoxicity: susceptibility of kidney, histopathological changes, examples of nephrotoxicants Reproductive toxicity: histopathological changes seen in male and female reproductive organs
1.7	Biochemical Assays: Importance of various biochemical assays of parameters such as glucose, glycogen, total lipids, cholesterol and enzymes- ACP, ALP, SGOT, SGPT, GGT, SOD, GSH, lipid peroxidase, catalase
UNIT 2	**REGULATORY TOXICOLOGY**
2.1	Overview of OECD guidelines for testing of chemicals
2.2	Animal models used in regulatory toxicology studies
2.3	Alternative methods in toxicology (*in vitro* tests)
	PRACTICAL COURSE (2 Credits)
1	Familiarization with research microscope and stereo-binocular microscope, phase contrast, fluorescence microscopes
2	Preparation of tissue homogenization and technique of ultra centrifugation
3	Tissue fixation, paraffin block preparation, sectioning and staining
4	Quantitative estimation of proteins and lipids, carbohydrates
5	Enzyme Assays: ACP, ALP, SGOT, SGPT, GGT, SOD, GSH, lipid peroxidase, catalase
6	Extraction and quantitative estimation of nucleic acids
7	Breeding of zebrafish and study of its normal developmental stages
8	Study of adult and embryonic behavior of zebrafish
9	Culturing of *Caenorhabditis elegans*
10	Observation of *Caenorhabditis elegans* adult and larvae behavior

REFERENCES:

1. Plummer, D. T. (2017). *Introduction to Practical Biochemistry*. (3rd ed.). Tata McGraw Hill Publishing Co. Ltd.

2. Sawhney, S.K. and Singh R. (2007). *Introductory Practical Biochemistry*. (2nd ed.). Narosa Publishing House.

3. Veerakumari, L. (2011). *Bioinstrumentation* (1st ed.). M.J.P. Publishers.

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NAME OF THE COURSE	OTHER RESEARCH RELATED ACADEMIC ACTIVITIES
CLASS	Ph.D. ZOOLOGY
COURSE CODE	SPSZOO103
NUMBER OF CREDITS	4
EVALUATION METHOD	GRADED INTERNAL ASSESSMENT

COURSE OBJECTIVES:

CO 1.	To enhance the scholar's ability to present and communicate their research findings effectively through literature reviews, seminar presentations, and research proposals.
CO 2.	To cultivate critical analysis skills by reviewing and critiquing research papers, thereby understanding the current research trends and methodologies related to research problem
CO 3.	To encourage active engagement and contribution to the academic community by participating in seminars, conferences, and organizing departmental academic activities, thus building a collaborative and professional network.

COURSE LEARNING OUTCOMES:

CLO 1.	Demonstrate improved skills in preparing comprehensive literature reviews and research proposal for topic approval
CLO 2.	Exhibit the ability to critically evaluate and present research papers by participating and presenting the research work and publishing research papers
CLO 3.	Actively participate in academic events, contribute to organizing workshops and seminars, and produce science communication articles, reflecting their commitment to the academic and scientific community.

1	Literature Review Presentation: based on the topic of research area
2	Seminar Presentations: based on the critical review of a research paper published in the related area
3	Preparation and Presentation of the research proposal before RAC
4	Participation in research seminar / lecture series / conference [certificate to be submitted]
5	Paper / poster presentation in a research conference or research meet (including in-house)
6	Writing a popular science article / science communication in any print media (including in-house)
7	Active participation and contribution in organizing the academic activities in the department like training workshops for UG / PG students, National Science Day, short lecture video or screen recording of PPT based on any study topic of UG / PG level.

ASSESSMENT DETAILS:

I) The Course work of SPSZOO101 will be of 100 marks.
This will have two components as follows:

(a) Continuous assessment of total of Fifty (50) marks shall be conducted through various modes such as tests, descriptive assignments, exercise solving, computer skills, presentations etc.
(b) Course End Examination: Theory examination out of Fifty (50) marks shall be conducted at the end of the course work.

II) The Course work of SPSZOO102 will be of 100 marks
This will have three components as follows:

(a) Theory Course: Continuous assessment of Twenty-five (25) marks shall be conducted through various modes such as tests, assignments, presentations etc.
(b) Practical Course: Continuous assessment of Twenty-five (25) marks based on the laboratory

work completed and a certified journal.

(c) Course End Examination: Theory examination out of Fifty (50) marks shall be conducted at the end of the course work.

III) **The Course work of SPSZOO103** will be based on internal and/or external evaluation as applicable, where students will be graded for each of the activities mentioned in the syllabus. The average grade will then be taken as an overall grade for this course. It is mandatory to complete all the activities**.**

PASSING STANDARD:

The students to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Continuous Assessment & Course End Examination. The students shall obtain minimum of 40% marks (i.e. 20 out of 50 or 10 out of 25) in the Continuous Assessment and 40% marks in Course End Examination (i.e. 20 out of 50) separately, to pass the course. A student will be said to have passed the course if the learner passes the Continuous Assessment & Course End Examination together; wherever applicable.

PERFROMANCE GRADING:

The Performance Grading of the learners shall be on the UGC 7- Point Scale as under:

Grade	Marks	Grade Points
O	70 & above	7
A	60 to 69.99	6
B	55 to 59.99	5
C	50 to 54.99	4
D	45 to 49.99	3
E	40 to 44.99	2
F(Fail)	39.99 & below	Taken as 0 while calculating GPA

The performance grading shall be based on the aggregate performance of Continuous Assessment and Course End Examination wherever both the types of assessments are applicable.

PAPER PATTERN OF COURSE END EXAMINATION

All Questions are compulsory
Figures to the right indicate full marks

Time: 2 hrs. **Total marks: 50**

Q.1.	Long Answers: Any 2 out of 3 [10 marks each]	20 marks
Q.2.	Short Notes: Any 4 out of 6 [5 marks each]	20 marks
Q.3.	Short Answers: Any 5 out of 7 [2 marks each]	10 marks