SIKKIM UNIVERSITY

(A Central University Established by an Act of Parliament of India, 2007)

LEARNING OUTCOME - BASED CURRICULUM

PH.D. COURSEWORK ZOOLOGY

(With effect from Academic Session 2023-24)

DEPARTMENT OF ZOOLOGY
SIKKIM UNIVERISTY
**6ᵀᴴ MILE, TADONG - 737102**
GANGTOK, SIKKIM, INDIA

PREAMBLE

The PhD course structure is envisaged as programme to train a student interested in a particular area of research. The PhD coursework covers one semester. The programme focusses on research methodology which is a common for all the Departments under School of Life Sciences. The departmental level paper focuses on preparation of research proposal and review which provides the opportunity to the students to get exposed to research during the period of the coursework. The programme structure at the department level offers flexibility to choose courses as per their interests between 'Recent advances in biodiversity and conservation biology' and 'Immunobiology and parasitology'.

Programme Learning Outcomes:

After completion of the programme scholars will be able to:

PLO 1: develop critical thinking, research aptitude and identify research problems.

PLO 2: demonstrate a thorough knowledge of the literature and a comprehensive understanding of methods and techniques applicable to their own research.

PLO 3: design own research protocol based on the available literature.

PLO 4: analyze data, interpret results, and write research articles.

PLO 5: demonstrate skill in the usage of software packages relevant to the field of study.

PLO 6: communicate effectively through written exams, presentations, preparation of scientific documents and participation in conference and workshops.
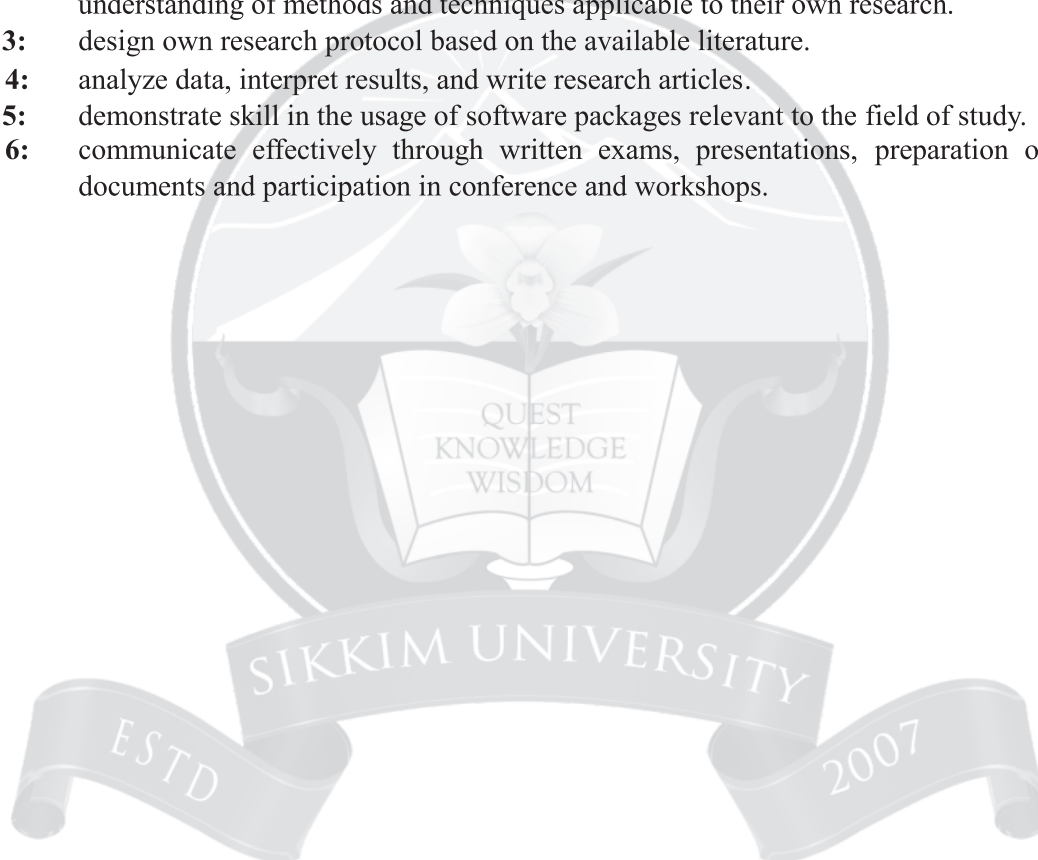
COURSE STRUCTURE SHOWING COURSE TITLE AND CODE

COURSE CODE	COURSE TITLE
ZOO-C-701	Research Methodology
ZOO-C-702	Preparation of research proposal and review of literature
ZOO-E-703	Recent advances in biodiversity and conservation biology
ZOO-E-704	Applied immunobiology and parasitology
ZOO-C-705	Research & publication ethics

COURSE STRUCTURE SHOWING L+T+P, CREDITS, CREDIT HOURS AND MARKS

SEMESTER - I								
COURSE CODE	COURSE TITLE	L	T	P	Total Credits	Total Marks	IA	EA
ZOO-C-701	Research Methodology	3	1	0	4	100	50	50
ZOO-C-702	Preparation of research proposal and review of literature	0	4	0	4	100	0	100
ZOO-E-703	Recent advances in biodiversity and conservation biology	3	1	0	4	100	50	50
ZOO-E-704	Applied immunobiology and parasitology							
ZOO-C-705	Research & publication ethics	2	0	0	2	50	0	50
SEMESTER TOTAL					14	350	100	250

ZOO-C-701:
RESEARCH METHODOLOGY

First Semester: PhD coursework   Course Level: 700   Total Marks: 100
L+T+P: 3+1+0 = 4 Credits   Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After the completion of the course scholars will be able to:

CLO 1: recognize the field of research and different research methods.
CLO 2: comprehend the concepts of research problems, identification of research gap, framing
     research questions and develop research designs.
CLO 3: apply modern statistical tools to address research problems, research design and scientific
     document preparation.

UNIT I: Research design and data collection
Research methodology: different types of research design, Sampling methods- procedures of sampling, criteria of selecting a sample and different types of sampling designs. Primary and secondary data. Framing research questions and developing hypotheses.
Sample size estimation.

UNIT II: Processing of data and hypotheses testing
Processing operations: Elements/types of analysis, usefulness of statistics in research, dispersion, Preparation of data and visualization, summary items (figures, tables, images). Archiving of original lab/field data.
Introduction to computer-based programming in data analysis such as R.
Basic concepts of hypothesis testing.

UNIT III: Statistical techniques
Parametric and Non-parametric tests, Normality tests, F and t- tests, Mann- Whitney U-test, Chi square test, ANOVA (One Way and two way), MANOVA, ANCOVA, Kruskal-Wallis one way ANOVA.
Regression analysis: concepts of linear and higher order regression, regression models.
Ordination techniques: PCA, PCoA, CCA, NMDS.

UNIT IV: Scientific writing
Types of scientific documents, guidelines for preparation of scientific articles/documents, identification of journals, language practices of scientific writing, types of data and analysis, referencing and reference management tools.
Review articles: types of review (narrative, systematic and meta-analysis).
Literature search, advanced search in PubMed, DOI.

SUGGESTED TEACHING LEARNING STRATEGIES

1. Lecture-cum discussion, library readings, critical discussion.
2. Organizing philosophical debates and group discussions, case studies, projects.
3. Individual presentations by student on selected topic.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment.	Group Discussion, Quiz.	Presentation, Seminars.
Summative Marks: 50%	Semester examinations conducted by the university will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

Reading List:

1. CSIR (2019). *CSIR Guidelines for Ethics in Research and in Governance*. Council of Scientific and Industrial Research, New Delhi.
2. Kothari, C. R. & Garg, G. (2019). *Research Methodology*. New Delhi: New Age International Publishers. 1-480. ISBN-13: 978-9386649225
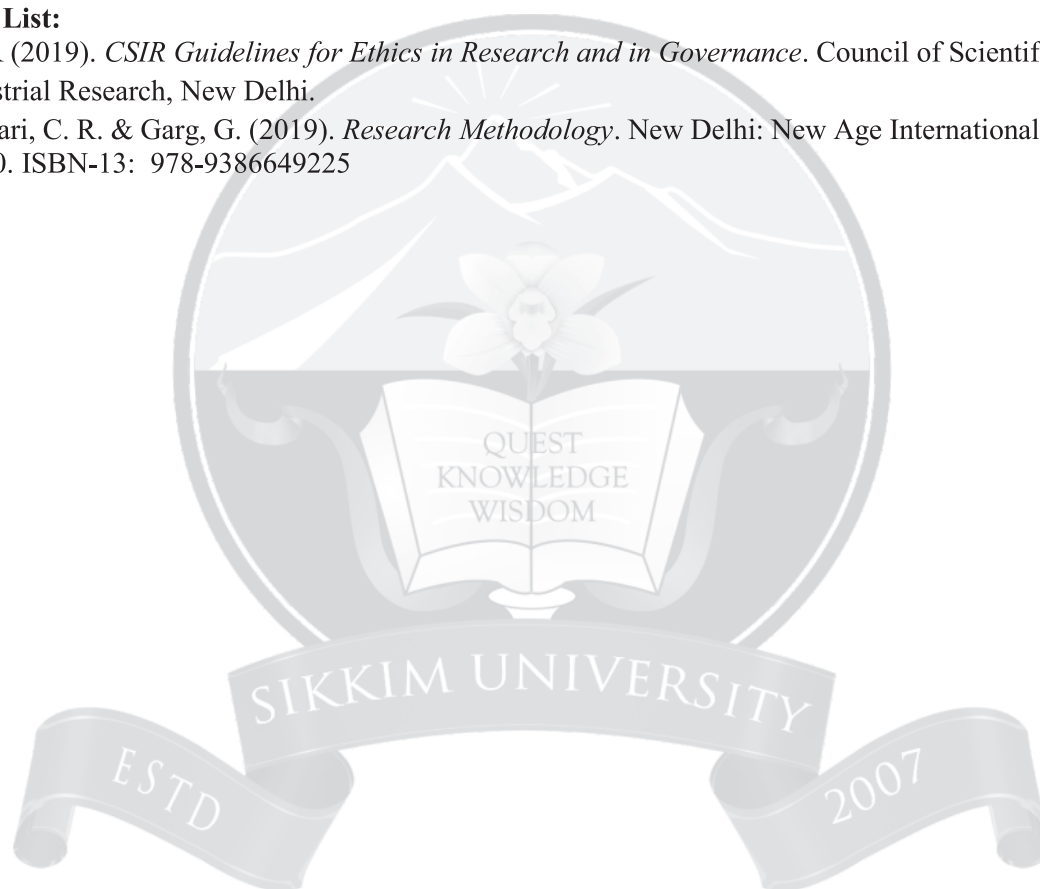
ZOO-C-702:
PREPARATION OF RESEARCH PROPOSAL AND REVIEW OF LITERATURE

First Semester: PhD coursework   Course Level: 700   Total Marks: 100
L+T+P: 0+4+0 = 4 Credits   Lecture: 0 Hrs + Tutorial: 60 Hrs + Practical: 0 Hrs

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Course Learning Outcome:

After the completion of the course scholars will be able to:

CLO 1: prepare a research proposal and formulate their own research plan.
CLO 2: put together the available literature on a topic and interpolate on the retrospective studies.
CLO 3: present the research proposal and summary of review work to the examiners and participate in discussion.

Preparation of research proposal

Students have to prepare Research Proposal in any standard format in the chosen field of research. The proposal should have clear objectives with identification of gaps in the knowledge, review of literatures, expected outcome, potential application, real time budget and timeline.

Review of Literature

An extensive review work is to be undertaken in the proposed area of research. It should have appropriate citation and well formatted references using any of the standard journal formats covered under scopus list, web of science, UGC care list, etc. The review work is also expected to cover meta-analysis in the chosen topic/research area.

SUGGESTED TEACHING LEARNING STRATEGIES

1. Discussion with faculties, library readings, critical discussion.
2. Preparation of research proposal.
3. Preparation of a one-page summary of review of literature for non-specialist science readers.
4. Seminar, conference, workshops.
5. Guided readings and discussions.
6. Presentations by students on selected themes.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Follow-up on review, Proposal Writing.	Discussion, seminar.	Presentation.
Summative Marks: 50%	Assessment of submission and presentation followed by viva voce. Assessment would be made based on scientific content, writing and communication skill, presentation, analysis and interpretation.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO.

ZOO-E-703:
RECENT ADVANCES IN BIODIVERSITY AND CONSERVATION BIOLOGY

First Semester: PhD coursework	Course Level: 700	Total Marks: 100
L+T+P: 3+1+0 = 4 Credits	Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs	

Course Learning Outcome:

After completion of the course scholars will be able to:

CLO 1: apply various sampling methodology involved in faunal studies.
CLO 2: enumerate both morphological and molecular traits for species delimitation.
CLO 3: comprehend methods of animal taxonomy and systematics and link it to conservation.
CLO 4: recognize the value of socio-cultural landscapes and urban spaces in biodiversity conservation.
CLO 5: recognize the importance and use of online databases of animals.
CLO 6: utilize methods of data downloading and processing from key online databases.
CLO 7: familiarize latest tools and techniques used in biodiversity and conservation biology.
CLO 8: comprehend the concept of phylogeography in the context of speciation with reference to Himalaya.

Unit I: Sampling methodology

Sampling technique of major faunal groups: aquatic and terrestrial; Population estimation: distance sampling, occupancy studies,enumeration of morphometric and meristic traits of lepidoptera, herpetofauna, birds and small mammals; Enumeration of habitat and micro-habitat parameters; Reproductive ecology of select faunal groups; Feeding ecology: feeding guild, feeding rate, maneuver; Functional diversity: indices, traits; Ecosystem services: assessment methods, economic and socio-ecological dimensions.

Unit II: Taxonomy and biodiversity

Taxonomy and systematics: principles of evolutionary systematics and integrative taxonomy; Species concept: conventional and advanced approach; Description of new species, cataloguing and submission of specimens to museums; Life history traits and taxonomy; Role of taxonomy in biodiversity conservation; Introduction to important animal databases (e.g., ifoundbutterflies, avonet, vertlife, amphibians of the world, GBIF, herpnet, etc.).

Unit III: Biodiversity management approach

Management of protected areas; Man, and biosphere reserve, Community reserves, Important bird areas; Conservation outside protected areas; Socio-cultural dimensions of biodiversity conservation; Urban biodiversity: importance, trends, management, urban green spaces and human wellbeing; Citizen science: roles of community in conservation, citizen science projects (e.g., biodiversity atlas-India, ebird, inaturalist, indiabiodiversity portal, etc.).

Unit IV: Recent techniques in systematics, biogeography and biodiversity

Designing of primers, gene amplification and PCR, DNA and protein sequencing, DNA barcoding: process, application, barcode of life data systems, metabarcoding; Phylogenetic analysis: construction of phylogenetic trees, species divergence rate, estimation of genetic distance, species delimitation, phylogeography; species distribution modelling: tools and techniques; Remote sensing and geographical information system: concept, process of GIS, data sources, global positioning system.

SUGGESTED TEACHING LEARNING STRATEGIES

1. Lecture-cum discussion, library readings, critical discussion.
2. Organizing philosophical debates and group discussions, case studies, projects.
3. Hands on training on database downloads, analysis pipelines.
4. Guided readings and discussions of classical texts written by famous philosophers.
5. Individual presentations by student on selected topic.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment.	Group Discussion, Quiz.	Presentation, Seminars.
Summative Marks: 50%	Semester examinations conducted by the university will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

Suggested Readings

1. Allendorf, F. W., Luikart, G. H. & Aitken, S. N. (2012). Conservation and the Genetics of Populations 2e. Willey-Blackwell.
2. Avise, J. C. (2000). Phylogeography: The History and Formation of Species. Harvard University Press.
3. Bhatta, B. (2011). Remote sensing and GIS, Oxford University Press.
4. Bibby, C. J., Burgess, N. D., Hill, D. A. & Mustoe, S. H. (2000). Bird census techniques. Academic Press, London.
5. Frankham, R., Ballou, J. D. & Briscoe, D. A. (2010). Introduction to Conservation Genetics. Cambridge University press.
6. Heyer, W. R., Donnelly, M. A., Mcdiarmid, R. W., Hayek, L. C. & Foster, M. S. (1994). Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution Press. Washington.
7. Kothari, C. (2017). Research methodology methods and techniques by CR Kothari. Published by New Age International (P) Ltd., Publishers.
8. Magurran, A. E. & McGill, B. J. (2011). Biological Diversity: frontiers in measurement and assessment. Oxford University Press.
9. Primack, P. B. (2014). Essentials of Conservation Biology. Sinauer Associates Inc.
10. Southwood, T. R. E. & Henderson, P. A. (2000). Ecological methods. Blackwell Science, London.
11. Watson, M. F., Lyal, C. & Collin, P. (2015). Descriptive Taxonomy: The foundation for biodiversity Research.Cambridge University Press.

ZOO-E-704:

APPLIED IMMUNOBIOLOGY AND PARASITOLOGY

Semester: PhD coursework   Course Level: 700   Total Marks: 100
L+T+P: 3+1+0 = 4 Credits   Lecture: 45 Hrs + Tutorial: 15 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After completion of the course scholars will be able to:

> **CLO 1:** comprehend the advanced immunological and parasitological techniques.
> **CLO 2:** develop the research protocol based on the studied techniques.

Unit I: Molecular techniques in immunology

Cell culture systems: types and forms of cell culture, methods and strategies for human WBC and macrophage cell line culture, examination of cells of suspension cultures, application of cell culture.

Epigenetic changes and its importance, Types of epigenetic changes, Profiling of DNA methylation through pyrosequencing.

Gene expression assays.

Unit II: Immunogenetics, gene cloning and genome editing, neuroimmune interactions

Evolution of MHC; Determination of HLA allele frequency, haplotype estimation, linkage disequilibrium, Relative Risk; Role of HLA in autoimmune and infectious diseases.

Gene Cloning, Genome editing: Zinc finger nuclease, Transcription activator-like effector nuclease, Engineered homing endonuclease, CRISPER/Cas9.

Brain immune system interactions.

Unit III: Parasitic protozoa and helminths

Neglected tropical diseases; Zoonosis; Food and vector borne parasitic diseases; Infection chain; parasite-host interactions; parasite control strategies: drugs and vaccines; drug resistance in parasites.

Unit IV: Parasitology techniques

Parasite diagnostics; Parasite culture; Recombinant DNA technology; Application of omics technologies in identification of drug targets, diagnosis and vaccine candidates; Biological tools and databases (nucleotide, protein, natural products, barcode of life data systems, molecular phylogenetics, in silico drug designing).

SUGGESTED TEACHING LEARNING STRATEGIES
1. Lecture-cum discussion, library readings, critical discussion.
2. Organizing philosophical debates and group discussions, case studies, projects.
3. Guided readings and discussions of classical texts written by famous philosophers.
4. Individual presentations by student on selected topic.

ASSESSMENT FRAMEWORK

Assessment	Written Modes	Oral Modes	Integrated Modes
Formative Marks: 50%	Class Test, Article Writing, Assignment.	Group Discussion, Quiz.	Presentation, Seminars.
Summative Marks: 50%	Semester examinations conducted by the university will be considered the mode of summative assessment.		

Note: Teachers can choose any mode of formative assessment as per nature of the CLO

Suggested Readings
1. Abbas, A. K., Lichtman, A. H. & Pillai, S. (2006). Cellular and molecular Immunology. W.B. Saunders.
2. Boothroyd, J. C. & Komuniecki, R. (1995) Molecular approaches to Parasitology. Wiley-Liss, New York.
3. English, L. S. (1994). Technological Applications of Immunochemicals *(BIOTOL)*. Butterworth-Heinemann,Oxford Freeman & Co.
4. Freshney, R. I. (2015). Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons.
5. Green, M. R. & Sambrook, J. (2012). Molecular cloning: a laboratory manual. Cold Spring Harbor Laboratory Press, New York.
6. Janeway Jr, C. A., Travers, P., Walport, M. & Shlomchik, M. J. (2005). Immunobiology – The immune system in health and disease, 6th ed, Garland Science Publishing, New York, USA.
7. Miligan, T. (2015). Animal ethics: The basics. Routledge.
8. Ministry of Environment & Forests (Animal Welfare Division) (2007). Guidelines on the regulation of scientific experiments on animals. Government of India
9. Roitt, I. M. & Brostoff, J. (2006). Immunology, 7th ed., Mosby & Elsevier Publishing, Canada, USA.
10. Sandøe, P., Corr, S. & Palmer, C. (2015). *Companion animal ethics*. John Wiley & Sons.
11. Schmidt, G. D. & Roberts, L. S. (2001). Foundation of Parasitology. McGraw Hill Publishers.
12. Smyth, J. D. (1994). Animal Parasitology. Cambridge University Press.
13. Vasbinder, M. A., & Locke, P. (2017). Introduction: Global laws, regulations, and standards for animals in research. ILAR journal, 57(3), 261-265.

ZOO-C-705:
RESEARCH & PUBLICATION ETHICS

Semester: PhD coursework   Course Level: 700   Total Marks: 50

L+T+P: 2+0+0 = 2 Credits   Lecture: 30 Hrs + Tutorial: 0 Hrs + Practical: 0 Hrs

Course Learning Outcome:

After completion of the course scholars will be able to:

CLO 1:   determine the ethics involved in research and be informed on moral values and standards in research.

CLO 2:   record the details of publication ethics and scientific writing.

CLO 3:   determine and follow ethical guidelines in human and animal experimentation.

CLO 4:   recognize and use open access publishing, databases, and learn research metrics.

Unit I: Scientific conduct and publication ethics

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.

Best practices /Standards setting initiatives and guidelines: COPE, WAME, etc.

Conflicts of interest.

Violation of publication ethics, authorship and contributorship.

Identification of publication misconduct, complaints and appeals.

Predatory publishers and journals.

Welfare of animals used in research, ethics in research involving human experimentation.

National and international guidelines and regulation in research involving animals and humans, participant information document and informed consent.

Institutional ethical committee, Institutional animal ethics committee and Biosafety committee: roles and responsibilities.

Unit II: Open access publishing, databases and research metrics

Concept of Open Educational Resources (OER), concept of open license, open access publishing, open access content management.

Databases: Indexing databases, Citation databases: Web of Science, Scopus, etc.

Research Metrics: Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP,

Cite Score: Metrics: h-index, g index, i10 index, altmetrics, ISBN, ISSN.

UGC CARE list journals, latest UGC regulations on academic integrity.

SUGGESTED TEACHING LEARNING STRATEGIES

As per MOOCS, COPE guidelines.

ASSESSMENT FRAMEWORK

Average assignment score = 25% of average of best 6 assignments out of the total 8 assignments given in the course.
Exam score = 75% of the proctored certification exam score out of 100
Final score = Average assignment score + Exam score

Reading List:
1. Alasdair, (1967). A Short History of Ethics. London.
2. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a.
3. Bird, A. (2006). Philosophy of Science. Routledge MacIntyre.
4. Chaddah, P. (2018). Ethics in Competitive Research: Do not get Scooped; do not get Plagiarized, ISBN :978-9387480865.
5. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. https://www.insaindia.res.in/pdf/Ethics_Book.pdf.
6. 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.
7. Resnik, D. B. (2011). What is ethics in research & why is it important. National institute of Environmental Health Science, 1-10 Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm.