NORTH-EASTERN HILL UNIVERSITY
DEPARTMENT OF BOTANY
SHILLONG – 793022

Syllabus for Ph.D. Course Work -2022
Duration of the Course: One Semester

Paper	Course Code	Name of Paper	Credits
1	SLS-PhD-700	Research Methodology	4
2	SLS-PhD-701	Research and Publication Ethics	2
3	BOT-PhD-702	Plant Sciences	4
4	BOT-PhD-703	Review of Literature	4

Programme Objectives (POs):

Ph.D. Course Work programme in Botany aims to:

- Equip students with a strong foundation covering wide topics essential for understanding plant biology and its interdisciplinary applications.

- Provide comprehensive knowledge of advanced topics in plant biology, including molecular biology, plant biotechnology, plant physiology, ecology, and microbiology.

- Acquaint students with various research methodologies, experimental designs, and analytical techniques relevant to plant research.

- Develop the ability of students to analyze critically scientific literature and assess the research findings related to Plant Sciences.

Programme Specific Outcomes (PSOs):

- **PSO1**. Students completing the course will be able to understand advanced technologies that are currently in use in the study of plant life forms, and their interactions with the ecosystem.

- **PSO2**. Students will be trained in various analytical techniques of Life Sciences, use of technologies for research in plants and analyze critically scientific literature, evaluating methodologies and conclusions in the field of Plant Sciences.

- **PSO3.** Students completing the course will be able to enhance skills in writing and presenting scientific research effectively. Students will be also familiarized with the use of bioinformatics tools and application of statistics to biological data.

- **PSO4**. To instil a strong understanding of ethical considerations in research, including issues related to biodiversity conservation and sustainable practices.

Syllabus for Ph.D. Course Work -2022
Duration of the Course: One Semester

SCHOOL LEVEL COURSE

1. SLS-PhD-700: RESEARCH METHODOLOGY CREDITS-4

Course Objectives (CO): The course aims to equip students with the skills necessary to design and conduct experiments in life sciences, including bioinformatics and laboratory techniques.

Learning Outcomes (LO): The course will help the students to attain:

1. Knowledge in the research methodologies to be followed in life sciences.
2. Proficiency in the design and execution of scientific experiments related to life sciences, utilizing appropriate methodologies and techniques.
3. Expertise in applying statistical and bioinformatics tools to analyze, interpret, and present data effectively.

Unit-1: Microscopy: Fluorescent and Confocal; Electron microscopy: SEM and TEM; In-situ hybridization techniques: FISH, GISH and MCFISH; Chromosome painting.

Unit-2: Microarray; RNA-Seq; Chromatography: Ion-exchange, Gel filtration, Affinity, HPLC and GC; Spectroscopy: Fluorescent, MS and AAS; Electrophoresis and Isoelectric focusing.

Unit-3: DNA and RNA extraction; Preparation of cDNA; RT-PCR; Designing of primers; Real Time PCR; DNA sequencing; Tissue culture and its applications; Cryopreservation techniques; Techniques in soil Microbiology (Fungi and bacteria).

Unit-4: Bio-computing: Biological database (protein, nucleotide and natural products); BLAST; FASTA; Sequence comparison and alignment techniques; Phylogentic analysis-tree building methods and its evaluation-Bootstrapping; Bibliographic resources: PubMed and PIoS; Use of statistical packages for ANOVA and Multiple regression.

Suggested Readings:

1. Dubey, R.C. and Maheshwari, D.K. (1999). A text book of Microbiology, S. Chand & Company Ltd., New Delhi, India.
2. Harris R (ed.) (1991). Biological Microscopy for Biology: A Practical Approach, Oxford, IRL Press
3. Letovsky, S. I (1999). Bioinformatics. Kluver Academic Publishers.
4. Lesk, A. M (2002). Introduction to Bioinformatics, Oxford University Press.
5. Prescot, L.M., Harley, J.P. and Klein, D.A. (2005). Microbiology. 6th Edition Mc Graw – Hill International Edition. USA.
6. Maniatis, T. et.al. (1982). Molecular Cloning: A laboratory Manual, Cold Spring
7. Murad, H and Atique, M. V. A (1991). Biological Techniques in Electron Microscopy, CBS Publication
8. Nelson, D. L and Cox, M. M (2009). Principles of Biochemistry. 5th Edition
9. Plummer, D. T (1987). An Introduction to Practical Biochemistry, 3rd Edition, Tata Mc Graw Hill
10. Stiles et al (1991). Basic and Clinical Immunology, Prentice Hall International Inc.
11. Switzer, R. L., and Garry L. F. (1999). Experimental Biochemistry, 3rd Edition, W. H. Freeman Company.

12. Tate, R.L. (2000). Soil Microbiology. 2nd edition. John Wiley and Sons, Inc. New York, USA.
13. Tortora, G.J., Funke, B.R. and Case. C.L (2008). Microbiology– An Introduction. 9th edition. Dorling Kindersley (India), New Delhi, India.
14. Van Elsas, J.D., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker Inc. USA.
15. Wilson, K and Walker, J (1994). Principles and Techniques of Practical biochemistry, Cambridge University Press.
16. Setubal, J. and Meidanis, J. (1996). Introduction to computational molecular Biology, PWS Publishing Co., Boston
17. Zar, R (1974). Biostatistic Analysis, Prentice Hall Inc.
18. SPSS -2010, SPSS Inc., USA.
19. Dubey, R.C. and Maheshwari, D.K. (1999). A text book of Microbiology, S. Chand & CompanyLtd., New Delhi, India.
20. Prescot, L.M., Harley, J.P. and Klein, D.A. (2005). Microbiology. 6th Edition McGraw – Hill International Edition. USA.
21. Tate, R.L. (2000). Soil Microbiology. 2nd edition. John Wiley and Sons, Inc. New York, USA.
22. Tortora, G.J., Funke, B.R. and Case. C.L (2008). Microbiology– An Introduction. 9th edition. Dorling Kindersley (India), New Delhi, India.
23. Van Elsas, J.D., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker Inc. USA.

SCHOOL LEVEL COURSE

2. SLS-PhD-701: RESEARCH AND PUBLICATION ETHICS CREDITS-2

Course Objectives (CO): The course aims to demonstrate an awareness of ethical issues related to publication in life sciences, including plagiarism, publication ethics, and research metrics

Learning Outcomes (LO): The course will help the students to accomplish:

1. Plagiarism prevention through proper citation to original sources for ideas, text, data, and images used in research and publications.
2. Adherence to ethical guidelines for research involving human participants and animals, including obtaining informed consent and ensuring humane treatment.
3. Participation in training sessions and workshops on research ethics to stay informed about best practices and emerging issues.

Unit-1: Research integrity, scientific misconduct, manipulation, selective presentation, and falsification ofdata, plagiarism, self-plagiarism, image plagiarism, publication ethics, predatory publications (publishers and journals), Complaints and appeals, biosafety guidelines and regulatory bodies.

Unit-2: Open access publications, indexing and citation databases, research metrics (impact factor of journal as per JCR, SNIP, SJR, citations, h-index, i10 index,), conflict of interests, Use of plagiarism Software tools like Turnitin, Urkund and iThenticate.

Suggested Readings:

1. Chaddah, P., (2018) Ethics in competitive research: Do not get scooped; do not get plagiarized, ISBN:9789387480865.
2. 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.
3. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019). ISBN: 9788193948217.
4. UGC-CARE Reference List of Quality Journals (https://ugccare.unipune.ac.in/apps1/home/index).
5. Lakhotia, S. C., (2015) Predatory journals and academic pollution. Curr. Sci., 108: 1407–1408.
6. Priyadarshini, S., (2017) India tops submissions in predatory journals. Nature India, 8/doi:1038/nindia.2017.115.
7. Pulla, P., (2016) Predatory publishers gain foothold in Indian academia's upper echelon. Science News, doi:10.1126/science.aal0526.
8. Patwardhan, B., (2017) Indian science and predatory journals. J. Ayurveda Integr. Med., 8(1): 1-2

DEPARTMENTAL LEVEL COURSE

3. BOT-PHD-702: PLANT SCIENCES 4 CREDITS

Course Objectives (CO): The course aims to increase the comprehensive understanding of the students with understanding of plant biology, including ecology, taxonomy, plant biotechnology and physiology, molecular biology, genetics, microbiology and bio fertilizers.

Learning Outcomes (LO): The course will help the students to achieve:

1. Knowledge in understanding plants, including concepts in ecosystems, emphasizing their interactions with other organisms and their importance in environmental sustainability.
2. Sustainable methods for agricultural practices and their impact on plant health, biodiversity, and ecosystem services.
3. Biotechnology applications in plant sciences, including genetic modifications, tissue culture, and molecular breeding.
4. Understanding of plant conservation strategies and the importance of preserving plant diversity in the face of environmental changes.

Unit-1: Quantitative ecology: quantitative community characteristics, application of multivariate analysis in community studies, population growth and competition models, monitoring plant diversity and diversity indices; plant diversity and strategies for management; Concepts of systematic botany, taxonomic literature; floras, taxonomic accounts, revisionary studies, plant diversity of vascular plants with emphasis on angiosperms.

Unit-2: Biotechnological approaches in plant improvement and conservation in vitro technologies of propagation; molecular marker, diagnostic, cryopreservation, Plant growth reproduction: growth in secondary plant body, sexual reproduction and its application; Physiology of seed ageing.

Unit-3: Regulation of metabolic pathways; Macromolecular interactions: protein-protein, protein-nucleic acids, protein-carbohydrates; DNA based molecular markers and marker assisted selection.

Unit-4: Microbial culture techniques: Sterilization, culture media, types of cultures-batch and continuous, culture preservation; Application of microbes in agriculture and forestry; Industrial production of alcohol and organic acids; Biofertilizers: Definition and types, importance of biofertilizers in agriculture; Biologicalcontrol of plant diseases; Fungal bioremediation.

Suggested Readings:

1. Agrios, G.N. (2008). Plant Pathology (5th edition). Academic Press, Reed Elsevier India Private Ltd.,New Delhi, India.
2. Alberts, B. et al. (2002). Molecular Biology of the cell. Gerland
3. Buvat, R. (1988). Ontogeny, Cell differentiation and structure of vascular plants. Springer-verlag,Germany.
4. Bewley, J.D and Black, M (1994). Seeds: Physiology of Development and Germnation. Plenum Press.
5. Bhojwani, S.S and Bhatnagar, S. P (2000). The embryology of angiosperms. Vikas Publishing House.
6. Chawla, H. S. (2009). Introduction to plant biotechnology (3rd ed.), Science Publishers, USA
7. Clark, M. S. and Wall, W. J. (1996). Chromosomes. Chapman & Hall Dekker Inc.
8. Cronquist (1968). The evolution and classification of flowering plants. Nelson.
9. Dubey, R.C and Maheshwari, D. K. (1999). A text book of Microbiology, S. Chand & Company.
10. Eisenthal, R and Danson, M.J (2006). Enzyme assays, Oxford University Press.
11. Elrod, S and Stanfield, W. (2004). Genetics, Tata MCGraw-Hill.
12. Greig-Smith, P. (1983). Quantitative plant Ecology, (3rd ed.), Blackwell Scientific Publications.
13. Gupta, P. K. (2004). Biotechnology and genomics. Rastogi & Co.
14. Heldt, H (1997). Plant iochemistry and molecular biology. Oxford University Press.
15. Henry, A. A. and Chandrabose, M (1979). An aid to international code of botanical nomenclature.
16. Horton, H. R., Moran, L. A., Scrimgeour, K. G., Perry, M. D. and Rawn, J. D. (2006). Principles of biochemistry, (4th ed.) Pearson-Prentice Hall.
17. Hutchinson, J (1973). The families of flowering plants (3rd ed.), Clarendon Press Oxford.
18. Iqbal, M. (1994). Growth patterns in vascular plants, Timber Press, Germany.
19. Jain, S. K. (ed.) (1981). Glimpses of Indian ethnobotany. Oxford
20. Jain, S. K. and Rao, R. R. (1977). A handbook of field and herbarium methods. Today & Tomorrow,New Delhi.
21. Khattar, J. (2009). Biology and biotechnology. I. K. International Pvt. Ltd.
22. Kiri-Marja O., Wolfgang, B. (Eds.) (2002). Plant biotechnology and transgenic plants, Marcel Dekker.
23. Lewin, B. (2004). Genes VIII, Pearson-Prentice Hall Ltd., New Delhi
24. Michael, J., Carlile, S., Watkinson, C. and Gooday, G.W. (1994). The fungi (2nd edition). Academic Press. USA.
25. Mishra, R. R. (1996). Soil microbiology, CBS Publ.
26. Misra, R. (1968). Ecology work book. Oxford and IBH Co. Ltd.
27. Poole, R. W. (1974) An Introduction to Quantitative Ecology, McGraw-Hill Inc.
28. Prescot, L. M, Harley, J. P., Klein, D. A. (2005). Microbiology (6th eds.) Mc Graw-Hill Press.
29. Radford, A. R. (1986). Fundamentals of plant systematic, Harper Row.
30. Raghavan, V. (1999). Development biology of flowering plants. Springer-Verlag
31. Sporne, K. R. (1974). The morphology of angiosperms. Hutchinson University Press.
32. Stohlgren, T. J. (2007). Measuring plant diversity, Lessons from the field, Oxford University.
33. Strickberger, M. W. (1985). Genetics, Maxmillan
34. Susan, A. L., Douglas, E. and Ravan, J. A. (2004). Photosynthesis in algae, Kluwer Acad. Pub, Netherlands.

35. Sybenga, J. (1972). General Cytogenetics, North Holland
36. Taktajan, A. (1997). Diversity and classification of flowering plants, Columbia Univ. Press
37. Tate, R.L. (2000). Soil Microbiology. 2nd edition. John Wiley and Sons, Inc. New York, USA.
38. Tamarin, R. H. (2002). Principles of Genetics. Tata McGraw-Hill.
39. UNEP (1995). Global biodiversity assessment. Cambridge University Press
40. Van Laar, A and Akca, A. (2007. Forest mensuration (Managing Forest Ecosystems), vol. 13, Springer
41. Watson, J. D. et al. (2004). Molecular biology of the gene, Pearson Education.
42. Wulf, C. and Anneliese, C. (2000). Biotechnology: A textbook of industrial microbiology. Panima Publishing Corporation, New Delhi, India.

4. BOT-PHD-703: REVIEW OF LITERATURE 4 CREDITS

Course Objectives (CO): The review of literature aims to summarize and evaluate the existing research on a particular topic. It will serve to identify gaps in research, establish a theoretical framework, or justify the topic of research to be undertaken.

Learning Outcomes (LO): The course will help the students to:

1. Highlight the main contributions of the source, including methodologies, findings, and conclusions.
2. Discuss how each work relates to the research in question and the larger body of knowledge.
3. Evaluate the strengths and weaknesses of the research studies reviewed, identifying the gaps in the literature or areas where further research is needed.
4. Discuss how the existing literature connects to the proposed research, identifying patterns, contradictions, or trends.
5. Highlight how the proposed research will contribute to or challenge the existing knowledge and future research directions.