Central University of Punjab, Bathinda

Ph.D Program in Botany

Academic Session - 2020

Department of Botany

School of Basic and Applied Sciences

Ph.D. Program in Botany will

1) Develop research aptitude and desired skills to undertake challenging and new opportunities in academia and industry with reference to basic and applied fields.
2) Generate human resource to cater academia and research in higher education and research institutions.

Course Structure

S.No	Paper Code	Course Title	L	T	P	Cr
1	BOT.701	Research Methodology and Computer Applications	4	0	0	4
2	BOT. 751	Research and Publication Ethics	2	0	0	2
Electives(Any two)						
2	BOT.703	Advanced Genomics	3	1	0	4
3	BOT.704	Advances in Stress Biology	3	1	0	4
4	BOT.705	Advanced Molecular Systematics	3	1	0	4

L: Lectures T: Tutorial P: Practical Cr: Credits
***Credits required : Minimum -14 are required to fulfill Ph.D course work requirement , student may opt for any two electives based on recommendations of the supervisor**
*** BOT.701 and BOT.702 are compulsory.**

Transaction Mode:

1) Lecture
2) Demonstration
3) Lecture cum demonstration
4) Seminar
5) Group discussion
6) Field visit
7) Tutorial
8) Problem solving
9) Self-learning

BOT.701, Research Methodology and Computer Applications

L	T	P	Cr
4	0	0	4

Objective and learning outcomes:

1. This course is designed in compliance to UGC and basic requirement for Ph.D.
2. The students shall be sensitized with general principles of research, scientific writing, good lab practices and fundamentals of computer applications and bioinformatics.
3. Learn the planning and preparing thesis
4. Learn the methods of Biostatistics and its application in biology
5. Know about the bioinformatic concepts, approaches and methods in study of behavior
6. Students will gain good knowledge on teaching skills

Unit. I **18 Lectures**

General Principles of Research: Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion.

Bibliographic index and research quality parameters: citation index, impact factor, *h* index, i10 index, etc. Research engines such as google scholar, Scopus, web of science, etc.

Scientific Writing; Reference Management using various softwares such as Endnote, reference manager, Refworks, etc. Communication skills – defining communication; type of communication; technicques of communication, etc.

Unit. II **18 Lectures**

Introduction and Principles of Good Lab Practices: Good laboratory practices, Biosafety for human health and environment. Biosafety issues for using cloned genes in medicine, agriculture, industry, and eco-protection, Biological containment and physical containment, CDC Biosafety levels, Biosafety in Clinical laboratories and biohazard management, Physical, Chemical & Biological hazards.

Research ethics: Ethical theories, Ethical considerations during research, data manipulations, subject consent, Plagiarism: definition, Search engines, regulations, policies and documents/thesis/manuscripts checking through softwares, Knowing and Avoiding Plagiarism.

Intellectual Property Rights: Intellectual Property, intellectual property protection (IPP) and intellectual property rights (IPR), Nuts and Bolts of Patenting, Technology Development/Transfer Commercialization Related Aspects, Ethics and Values in IP.

Unit. III **18 Lectures**

Fundamentals of computer: Parts of computer, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean Algebra. Application software: Spreadsheet applications, Word-processing applications, Presentation applications, Internet browsers, Reference Management, and Image processing applications. Computer language: Basic DOS commands, AutoHotKey scripting language, HTML and basic structure of a webpage, Designing websites. World wide web: Origin and concepts, Latency and bandwidth, Searching the internet, Advanced web-search using Boolean logic, Cloud computing.

Unit. IV **18 Lectures**

Bioinformatics: Organization, management and analysis of biological data, use of computers in data analysis, biological databases - DNA sequence databases and protein sequence databases, BLAST, FASTA, multiple sequence alignment, *in silico* approaches for drug designing, primers in biology (design and types of primers) genome projects (human, *Arabidopsis* and other genome projects), NCBI, UCSC and other database searches.

Suggested Reading:

1. Gupta, S. (2008). *Research Methodology and statistical techniques*. Deep & Deep Publications (P) Limited, New Delhi.
2. Kothari, C. R. (2014). *Research methodology (s).* New Age International (p) Limited. New Delhi.
3. Sahay, Vinaya and Pradumna Singh (2009). *Encyclopedia of Research Methodology in life sciences*. Anmol Publications. New Delhi.
4. Kauda J. (2012). *Research Methodology: A Project Guide for University Students*. Samfunds literature Publications.
5. Dharmapalan B. (2012). *Scientific Research Methodology*. Narosa Publishing
6. Rao, P. P., S. Sundar and Richard, J. (2009). *Introduction to Biostatistics and Research Methods.* PHI learning.
7. Christensen, L. (2007). *Experimental Methodology*. Boston: Allyn & Bacon.
8. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
9. Rockman, H. B. (2004). *Intellectual Property Law for Engineers and Scientists*.Wiley-IEEE Press, USA.
10. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
11. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases.* Oxford University Press, UK.
12. WHO (2005). *Laboratory Biosafety Manual*. World Health Organization. House ISBN: 978-81-8487-180-7.

Course Code: BOT.751 Research and Publication Ethics

L	T	P	Cr
2	0	0	2

Course Description: The course is focused on research Philosophy, scientific conduct, publication ethics, misconduct and about databases.

Unit I Philosophy and Ethics **3 Lectures**

Introduction to Philosophy : definition, nature and scope, content, branches
Ethics : definition, moral philosophy, nature of moral judgements and reactions

Unit II Scientific Conduct **5 Lectures**

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

Unit III: Publication ethics **7 Lectures**

Publication ethics : definition, introduction and importance
Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
Conflicts of interest
Publication misconduct : definition, concept, problems that lead to unethical behaviour and vice versa, types
Violation of publication ethics, authorship and contributor ship
Identification of publication misconduct, complaints and appeals
Predatory publishers and journals

Unit IV Open Access Publishing **4 Lectures**

Open access publications and initiatives
SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
Software tool to identify predatory publication developed by SPPU
Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Unit V Publication Misconduct **4 Lectures**

Group Discussions: Subject specific ethical issues, FFP, authorship; conflicts of interest; complaints and appeals: examples and fraud from India and abroad
Software tools: Use of plagiarism software like Turnitin Urkund and other open source software tools

Unit IV Databases and Research Metrics **7 Lectures**

Databases: Indexing databases; Citation database: 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, almetrics

BOT.703: Advanced Genomics

L	T	P	Cr
3	1	0	4

Course Description: The course is focused on the advancements in the area of genomics and its application in finding out the answers for complex traits and diseases. The course is divided into classroom lectures, Assignments and mutual discussions, experimental planning, presentation of recent research papers from international journals. The overall aim of the course is to develop research aptitude of the student in Genomics.

Scope of the course:

1. The students will be expected to gain knowledge in the frontier fields of high throughput DNA sequencing and applied aspects of genomics.
2. Understand the core concepts of plant biotechnology and genetic engineering.
3. Analyze the vectors for genetic manipulations, gene cloning, gene transfer and applications of transgenic technology.

Essential Background Knowledge: Advanced Genetics.

Unit. I **18 Lectures**

Gene expression Microarray technology, Methodology and data mining tools, Applications of microarray. Next Generation sequencing Technology, Methodology, Generation of Tissue specific data, Data mining tools, Applications of NGS.

Unit. II **18 Lectures**

cDNA library construction, Subtractive Library EST database generation, Transcriptomics analysis targeted via NGS, Unravelling the genetic regulatory circuits.

Unit. III **18 Lectures**

Molecular Markers, Generation of Molecular Markers, Molecular dissection of genetic relationships, Genetic basis of trait and trait dissection.

Unit. IV **18 Lectures**

Genomics and Comparative Genomics, Phenomics, Quantitative Trait Analysis and Marker assisted breeding, Molecular mapping, Genome sequencing.

Suggested Reading:

1. 1. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), Molecular Cell Biology. W.H. Freeman.
2. 2. Bruton E. Trop. (2008), Molecular Biotechnology: Genes to Protein. J&B Publishers.
3. David P. Clark. (2010), Molecular Biology. Elsevier.
4. Benjamin A. Pierce. (2008), Genetics: A conceptual approach. Palgrave Macmillan

BOT. 704: Advances in Stress Biology.

L	T	P	Cr
3	1	0	4

Course Description: The content of the course is based on the basic theoretical understanding of stresses, their occurrence and after effects, molecular mechanisms associated with tolerance to the advanced research based implications to counter and confer stress injuries.

Scope of the course:

1. The student/scholar shall be benefited with the focused course on recent advances in oxidative stress biology and its management.
2. A special section is kept to familiarise the scholar with methodology used in measurement and understanding the defence strategies to confer/ counter stress in general and at molecular level, which would be relevant to the future research.
3. The student/scholar shall be able to use acquired knowledge for scientific research, recognisable in national and international platform.
4. Explain different types of stress with examples, various physiological mechanisms that protect the plant from environmental stress i.e. adaptation, avoidance and tolerance.

Essential Background Knowledge: Biochemistry and metabolism; Advanced Plant Physiology.

Unit. I **18 Lectures**

Recent advances in Stress Biology: Types of stresses, Stress factors and occurrence, Avoidance, acclimation and tolerance, Molecular mechanisms of Drought, Temperature, salt and heavy metals tolerance.Climate change and sustainability Perspectives: Impact and adaptation of multiple stresses. Antagonism and synergism in multiple stress tolerance, Factors supporting sustainable development, CO2 enrichment.

Unit. II **18 Lectures**

Signal transduction during stress: Perception, Transduction and response trigger, Induction of specific gene expression, Convergence and divergence of signaling pathways, ROS signaling, Hydrogen peroxide; versatile molecule of the reactive oxygen species network. Management of stress:Secondary metabolites and stress, chemistry and functional genomics their biosynthesis and stress management.

Unit. III **18 Lectures**

Oxidative stress, antioxidants and stress tolerance: ROS/NOX and their production, DNA damage, Control mechanisms, Glutathion ascorbate pathway, Role of different antioxidantsin stress management. Metabolomics of stress.

Unit. IV **18 Lectures**

Gene regulation during stress: Transcription factors involved stress tolerance, Stress proteins; Heat shock (HSP's) and cold shock proteins (dehydrins), CFB, ABRE and DREB proteins etc. **RNA biology and stress:** Cellular stress and RNA Splicing, Si, RNAi, Micro RNA their implications in oxidative stress tolerance. Genome Editing and its scope.

Suggested Reading:

1. Ahmad, S. (1995). *Oxidative Stress and Antioxidant Defenses in Biology*. 1st Edition Springer.
2. Brown, T.A. (2010). *Gene Cloning and DNA analysis: An Introduction*. Blackwell PublishingProfessional. USA.
3. Buchanan, B.B. and Gruissem, W. (2005). *Biochemistry and molecular biology of plants*. IKInternational Pvt. Ltd. New Delhi, India.
4. Forman, H.J. and Cadenas E. (1997). *Oxidative Stress and Signal Transduction*. 1st EditionSpringer.
5. Hensley, K. and Robert, A.F. (2009). *Methods in Biological Oxidative Stress*. 1st editionAcademic Press.
6. Hopkins, W.G. (2007). *Plant Biotechnology*. Infobase Publications Inc.. USA.
7. Inze D. and Montagu M. V. (2001). *Oxidative Stress in Plants*, 1st Edition, CRC Press.
8. Nelson, D. and Cox, M.M. (2009). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company, New York.
9. Primrose, S.B and Twyman, R. (2011) *Principles of Gene Manipulation and Genomics*, 8thedn. Blackwell Publishing. Society of Plant Biologists, USA
10. Sunkar, R. 2012. MicroRNAs in Plant Development and Stress Responses (Signaling andCommunication in Plants). Springer Publications. New Delhi.

BOT.705: Advanced Molecular Systematics.

L	T	P	Cr
3	1	0	4

Course description: This PhD-level course is a comprehensive introduction to the theory and practice of molecular systematics, including concepts of molecular evolution, sequence analysis, computational phylogenetics, codes of taxonomy, rules of nomenclature, specimen and curation.

Scope of the course:

1. This graduate-level course is suitable to students working on taxonomy, molecular systematics, phylogenetic systematics, biodiversity, DNA barcoding and allied disciplines.
2. The student will be expected to have background knowledge on molecular biology, biosystematics, biodiversity, bioinformatics and computational biology.

Unit. I **18 Lectures**

General Introduction to Molecular Systematics: Evolutionary theory and Tree of Life, Tree thinking, Convergent Vs. Divergent evolution, Homologous and Analogous traits, Character states: Synapomorphy, Symplesiomorphy and Homoplasy, Types of Clades: Monophyly, Paraphyly and Polyphyly, Orthologous Vs. Paralogous Sequences, Phenetics Vs. Cladistics, DNA Barcoding, and Major Loci Used in Molecular Systematics.

Unit. II **18 Lectures**

Molecular Evolution: Neutral theory of molecular evolution, Models of nucleotide substitution, p-distance, poisson correction, Jukes-Cantor 69, Kimura-2-Parameter, Felsenstein 81, Hasegawa, Kishino and Yano 85, General Time Reversible (GTR), Rate heterogeneity (G), Rate Invariability (I), Model selection, Hierarchical Likelihood Ratio Test (hLRT), and locus selection.

Unit. III **18 Lectures**

DNA Sequence Analysis: Basics ofDNA Sequencing, Base calling, Sequence Assembly and Contig construction, Consensus Sequences, Multiple Sequence Alignment, Concatenation of datasets and construction of supermatrix, Sequence annotation and deposition in Genbank, DNA Flatfiles, rDNA Secondary structure construction, and *in-silico* translation. NCBI BLAST and its variants, Vienna RNA Package and RNAalifold, Primer design using primer BLAST, CodonCodeAligner, Geneious, and MEGA.

Unit. IV **18 Lectures**

Computational Phylogenetics: Theoretical framework of phylogenetics, Distance Vs. Discrete methods, Minimum Evolution, UPGMA, Neighbour Joining, Maximum Likelihood, Maximum Parsimony, Bayesian Inference, reconstruction of phylogeny from morphological data, Gene Tree Vs. Species

tree, and lineage sorting. Morphometry using ImageJ, Specimens and Curation, Herbarium Voucher preparation, Typification, Geographical sampling design, Taxonomic literature survey, Species description, Taxonomic publication and codes, Rules of nomenclature

Suggested readings:

1. Describing Species, Judith Winston, Columbia University Press,978-0231068253
1. Phylogenetic Analysis of Morphological Data (Smithsonian Series in Comparative Evolutionary Biology), John J. Wiens. Smithsonian Books, 978-1560988168
2. Phylogenetics: Theory and Practice of Phylogenetic Systematics, E. O. Wiley & Bruce S. Lieberman, Wiley-Blackwell, 978-0470905968
3. Phylogenetic Trees Made Easy: A How To Manual, Fourth Edition, Barry G. Hall, Sinauer Associates, Inc. 978-0878936069
4. Inferring Phylogenies, Joseph Felsenstein, Sinauer Associates, 978-0878931774
5. Phylogenetics (Oxford Lecture Series in Mathematics and Its Applications), Charles Semple & Mike Steel, Oxford University Press, 978-0198509424
6. Plant Systematics: A Phylogenetic Approach, Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellog, Peter F. Stevens & Michael J. Donoghue, Sinauer Associates, 978-0878934072
7. Bast, F (2013) Sequence Similarity Search, Multiple Sequence Alignment, Model Selection, Distance Matrix and Phylogeny Reconstruction. *Nature Protocol Exchange*. Nature Publishing Group. doi: 10.1038/protex.2013.065 Accessible at: http://www.nature.com/protocolexchange/protocols/2740
8. Bast, F (2015) Tutorial on Phylogenetic Inference Part-1. *Resonance* 20 (4) 360-367
9. Bast, F (2015) Tutorial on Phylogenetic Inference Part-2. *Resonance* 20 (5) 445-457
10. Tree Thinking 2015) An Introduction to Phylogenetic Biology. David Baum and Stacey Smith. Roberts and Company Publishers