Ph.D. Program in Life Sciences (2016)

School of Basic and Applied Sciences

Semester-1						
S.No	Paper Code	Course Title	L	T	P	Cr
1	LSS.701	Research Methodology and Computer applications	4	-	-	4
2	LPS.702	Advanced Genomics	4	-	-	4
3	LPS.703	Advances in Stress Biology	4	-	-	4
4	LPS.704	Advanced Molecular Systematics	4	-	-	4
5	LBM.702	Advanced Biochemistry	4			4
		Total Sem-1	20	0	0	20

L: Lectures T: Tutorial P: Practical Cr: Credits

LSS.701. Research Methodology and Computer applications. Credits: 4

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. **Technical Writing:** Scientific writing, Writing synopsis, Research paper, Poster preparation, oral presentations and Dissertations.

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, Animal testing. Animal rights, Perspectives and methodology & Ethical issues of the human genome project, Plagiarism

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. Norman, G. and Streiner, D. (2008). *Biostatistics:* The Bare Essentials.3/e (with SPSS). Decker Inc. USA.
7. Rao, P. P., S. Sundar and Richard, J. (2009). *Introduction to Biostatistics and Research Methods.* PHI learning.
8. Christensen, L. (2007). *Experimental Methodology*. Boston: Allyn & Bacon.
9. Fleming, D. O. and Hunt, D.L. (2006). *Biological Safety: Principles and Practices*. American Society for Microbiology, USA.
10. Rockman, H. B. (2004). *Intellectual Property Law for Engineers and Scientists*. Wiley-IEEE Press, USA.
11. Shannon, T. A. (2009). *An Introduction to Bioethics*. Paulist Press, USA.
12. Vaughn, L. (2009). *Bioethics: Principles, Issues, and Cases.* Oxford University Press, UK.
13. WHO (2005). *Laboratory Biosafety Manual*. World Health Organization. House ISBN: 978-81-8487-180-7.

LPS.702: Advanced Genomics. Credit Hours: 3.

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: The students will be expected to gain knowledge in the frontier fields of high throughput DNA sequencing and applied aspects of genomics.

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. Lodish, H., Berk, A., Chris, A. K., Krieger, M. (2008), Molecular Cell Biology. W.H. Freeman.
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

LPS. 703: Advances in Stress Biology. Credits: 4. Semester-1

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: The student/scholar shall be benefited with the focused course on recent advances in oxidative stress biology and its management. 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. The student/scholar shall be able to use acquired knowledge for scientific research, recognisable in national and international platform.

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 antioxidants in 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 Publishing Professional. USA.
3. Buchanan, B.B. and Gruissem, W. (2005). *Biochemistry and molecular biology of plants.* IK International Pvt. Ltd. New Delhi, India.
4. Forman, H.J. and Cadenas E. (1997). *Oxidative Stress and Signal Transduction*. 1st Edition Springer.
5. Hensley, K. and Robert, A.F. (2009). *Methods in Biological Oxidative Stress.* 1st edition Academic 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. Orcutt, D.M. and Nilsen, E.T. (2000). *Physiology of Plants Under stress*. J. Wiley, USA.
10. Primrose, S.B and Twyman, R. (2011) *Principles of Gene Manipulation and Genomics*, 8th edn. Blackwell Publishing. Society of Plant Biologists, USA
11. Snusted, D.P. and Simmons, M. J. (2010). *Principles of Genetics*. John Wiley & Sons, New York.
12. Sunkar, R. 2012. MicroRNAs in Plant Development and Stress Responses (Signaling and Communication in Plants). Springer Publications. New Delhi.
13. Voet, D., Voet, J.G. and Pratt C.W. (2008). *Principles of Biochemistry*. 3rd Edition, CBS Publishers & Distributors, New Delhi.

LPS.704: Advanced Molecular Systematics. Credits: 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: This graduate-level course is suitable to students working on taxonomy, molecular systematics, phylogenetic systematics, biodiversity, DNA barcoding and allied

disciplines. 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 of DNA 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
2.Phylogenetic Analysis of Morphological Data (Smithsonian Series in Comparative Evolutionary Biology), John J. Wiens. Smithsonian Books, 978-1560988168
3 Phylogenetics: Theory and Practice of Phylogenetic Systematics, E. O. Wiley & Bruce S. Lieberman, Wiley-Blackwell, 978-0470905968
4.Phylogenetic Trees Made Easy: A How To Manual, Fourth Edition, Barry G. Hall, Sinauer Associates, Inc. 978-0878936069
5. Inferring Phylogenies, Joseph Felsenstein, Sinauer Associates, 978-0878931774
6. Phylogenetics (Oxford Lecture Series in Mathematics and Its Applications), Charles Semple & Mike Steel, Oxford University Press, 978-0198509424

7. Plant Systematics: A Phylogenetic Approach, Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellog, Peter F. Stevens & Michael J. Donoghue, Sinauer Associates, 978-0878934072
8. 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
9. Bast, F (2015) Tutorial on Phylogenetic Inference Part-1. *Resonance* 20 (4) 360-367
10 Bast, F (2015) Tutorial on Phylogenetic Inference Part-2. *Resonance* 20 (5) 445-457
11.Tree Thinking 2015) An Introduction to Phylogenetic Biology. David Baum and Stacey Smith. Roberts and Company Publishers

LBM.702: Advanced Biochemistry. Credits: 4

Unit. I **18 Lectures**

Metabolism: Recent advances in amino acid, carbohydrate, lipid and nucleotide metabolism; Electron transport and oxidative phosphorylation

Unit. II **18 Lectures**

Enzymes: Nucleases, Proteases, Lipases, and other enzymes; Role in human and plant diseases.

Unit. III **18 Lectures**

Xenobiotic Metabolism: Chemical nature of xenobiotic; Transport of xenobiotic within the body; Fate of metabolism; Biotransformation; Detoxification; Examples of xenobiotic metabolism.

Unit. IV **18 Lectures**

Stress Biology: The stress response; Biomarkers of chronic stress and their role in diagnosis and therapy; Metabolic and neuroendocrine biomarkers; Exocytosis and ER Stress: Role of disruptive function of glycosylation/inter- and intra-molecular disulfide bond formation

Suggested Reading:

Research papers and reviews published in peer-reviewed international journals in the above areas