Centre for Plant Sciences
School of Basic and Applied Sciences
Central University of Punjab, Bathinda

Ph.D Program in Plant Sciences

Academic Session
2017-18
Centre for Plant Sciences

<table>
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<tr>
<th>S.No</th>
<th>Paper Code</th>
<th>Course Title</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Cr</th>
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<tbody>
<tr>
<td>1</td>
<td>LSS.701</td>
<td>Research Methodology and Computer applications</td>
<td>4</td>
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<td>2</td>
<td>LPS.702</td>
<td>Advanced Genomics</td>
<td>4</td>
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<td>3</td>
<td>LPS.703</td>
<td>Advances in Stress Biology</td>
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<td>4</td>
<td>LPS.704</td>
<td>Advanced Molecular Systematics</td>
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<td>5</td>
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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


**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...
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in biology (design and types of primers) genome projects (human, *Arabidopsis* and other genome projects), NCBI, UCSC and other database searches.

**Suggested Reading:**

**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.

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<tr>
<th>Unit I</th>
<th>18 Lectures</th>
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<tr>
<td>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.</td>
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<th>Unit II</th>
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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:**


**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


**Unit. III**
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:

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
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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, Syplesiomorphy 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:
2. Phylogenetic Analysis of Morphological Data (Smithsonian Series in Comparative Evolutionary Biology), John J. Wiens. Smithsonian Books, 978-1560988168
5. Inferring Phylogenies, Joseph Felsenstein, Sinauer Associates, 978-0878931774
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**LBM.702: Advanced Biochemistry. Credits: 4**

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<tr>
<td><strong>Metabolism</strong>: Recent advances in amino acid, carbohydrate, lipid and nucleotide metabolism; Electron transport and oxidative phosphorylation</td>
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<td><strong>Enzymes</strong>: Nucleases, Proteases, Lipases, and other enzymes; Role in human and plant diseases.</td>
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<td><strong>Unit. III</strong></td>
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<td><strong>Xenobiotic Metabolism</strong>: Chemical nature of xenobiotic; Transport of xenobiotic within the body; Fate of metabolism; Biotransformation; Detoxification; Examples of xenobiotic metabolism.</td>
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<td><strong>Unit. IV</strong></td>
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<td><strong>Stress Biology</strong>: 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</td>
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**Suggested Reading:**

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