OMICS APPROACHES IN PLANT SCIENCE (BPS 524)

S. No.	Topics
1.	**Introduction to 'omics':** Introduction to Genomics, Transcriptomics, Protemomics, Metabolomics and Metagenomics
2.	**Introducing Genomics:** Structural genomics, functional genomics, Epigenomics, Comparative genomics, Phylogenomics.
3.	**Epigenetics:** DNA methylation, histone methylation and acetylation, microRNAs, and genomics approaches to studying epigenetics.
4.	**Structural genomics:** Major features of plant genomes - Organization, size, diversity, transposable elements, microsatellites and other repetitive DNA, gene density, colinearity, plant genome size variation, genome size expansion and contraction. Genome sequencing, Whole genome shotgun sequencing, Physical mapping of genomes, Clone-by-clone sequencing, In silico methods for Data Management, New generation sequencing technologies, Bioinformatics tools to analyse genomes, Examples of sequenced genomes (yeast, Arabidopsis and rice), Applications of structural genomics
5.	**Metagenomics:** Sources of metagenomes, making of libraries of DNA, cDNA, rRNA etc. for microbial diversity analysis, Applications of metagenomics.
6.	**Plant Functional genomics:** Bioinformatics tools to predict genes, their functions, regulatory regions, non-coding regions etc. In vivo methods of functional genomics, T- DNA mutagenesis, Transposon tagging, Gene traps, enhancer traps, Gain of function approaches, Gene overexpression and T- DNA activation tagging, Gene discovery using inverse PCR, plasmid rescue and TAIL-PCR methods, Chemical mutagenesis and High- throughput TILLING, Physical mutagenesis, Gene silencing methods using RNAi, Targeted knockout of gene using Homologous recombination and, Genome editing using Zinc-finger Nucleases, TALENS, CRISPRs etc.
7.	**Epigenomics:** DNA methylation, histone modifications (methylation and acetylation etc.), and genomics approaches to studying epigenetics, Whole-genome bisulfite sequencing (BS-seq), ChIP (chromatin immunoprecipitation) sequencing (ChIP-seq).
8.	**Comparative genomics:** Comparative mapping, collinearity and synteny of maps, Molecular evaluation of plant genomic diversity using methods like Restriction fragment length polymorphism (RFLP), Random amplified polymorphism (RAPD), Amplified fragment length polymorphism (AFLP), Microsatellite analysis and Short nucleotide polymorphism (SNP) analysis and, Chloroplast DNA diversity, Applications of comparative genomics.

9.	**Phylogenomics:** DNA-based phylogenetic trees, Phylogeny Softwares, Application of phylogenomics.
10.	**Transcriptomics:** Gene expression, EST contigs, cDNA libraries, macroarrays, microarrays, whole transcriptome sequencing, transcript profiling, sRNA sequencing (sRNA-seq), Applications of transcriptomics.
11.	**Proteomics:** Protein isolation and identification methods SDS -PAGE, Iso-electric focussing, 2D gel electrophoresis, Peptide sequencing, Mass Spectrometry methods used in proteomics, Peptide data bases, Immunological methods to study protein functions, Protein-protein and Protein-DNA interactions, Comparative proteomics,
	subcellular proteomics, quantitative proteomics
12.	**Metabolomics:** Metabolites and metabolome, Metabolite extraction, separation and detection, Mass Spectrometry methods used in metabolomics, Data bases for Metabolites, Linking genes to metabolites, Applications of Metabolomics including Pharmacogenomics and drug designing.
13.	**Ionomics:** Characterization of the plant ionome (Single Ion Vs Multiple ions at a time). High-Throughput Ion Profiling using Atomic Absorption Spectroscopy (AAS), inductively coupled plasma optical emission spectroscopy (ICPOES), and inductively coupled plasma spectroscopy (ICP-MS), In vivo techniques for individual elements such as x-ray spectroscopy, Linking ionome, genome and proteome.
14.	**Applications:** Integrated OMIC approaches to study plant biology, Agricultural applications, therapeutic application, Application in studying Population, evolution and ecology, Phylogenomics, Chloroplast genomics, Synthetic genomics etc.
15.	**Practical:** Plant Genome Databases, Computational tools to explore plant genome Comparative genomics: Comparison of genome sequences using tools of bioinformatics Advanced genomic technologies: TILLING and Eco-TILLING. Linking genome sequences to phenotypes. Tools of transcriptomics, proteomics and metabolomics.

Suggested Readings:

1. Palzkill T. 2002. Proteomics. Kluwer.
2. Paterson AH. 1996. Genome Mapping in Plants. Academic Press.
3. Somers, Daryl J., Langridge, Peter, Gustafson, J.P. (Eds.), 2009 Plant Genomics: methods and protocols. Springer.
4. Christopher A. Cullis. 2004. Plant genomics and Proteomics. Wiley.
5. Hardy, Nigel W., Hall, Robert D. (Eds.) 2015. Plant Metabolomics: methods and protocol.
6. Chittaranjan Kole, Albert G. Abbott (Eds.). Principles and Practices of Plant Genomics.

7. Morot-Gaudry J.F., P Lea, J-F Briat. (Eds.) (2007) Functional Plant Genomics. CRC Press.
8. Khalid Meksem, Guenter Kahl. (2006) The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, John Wiley & Sons.
9. Erich Grotewold (2005) Plant Functional Genomics, Humana press.
10. Wagner, Govind P. Rao Plant Genomics and Bioinformatics.
11. Cullis, C. A. (2004). Plant Genomics and Proteomics. Agrosciences, New Delhi.
12. Reece, R. J. (2004). Analysis of Genes and Genomes. Agrosciences, New Delhi.
13. Brown, T. A. (2007). Genomes, 3/e. Garland Science, New York.
14. Stein (2003). Fundamentals of Protein Biotechnology. Atlas Books, New Delhi.
15. Raúl Alvarez-Venegas, Clelia De la Peña, Juan Armando Casas-Mollano. 2014. Epigenetics in Plants of Agronomic Importance: Fundamentals and Applications. Springer.
16. Gideon Grafi and Nir Ohad. 2013. Epigenetic Memory and Control in Plants. Springer.
17. Jonathan Wendel, Johann Greilhuber, Jaroslav Dolezel, Ilia J. Leitch. 2012. Plant Genome Diversity. Springer.
18. Igor Kovalchuk, Franz J. Zemp. 2011. Plant Epigenetics: Methods and Protocols. Springer Protocols. Springer.
19. Nigel W. Hardy, Robert D. Hall. 2012. Plant Metabolomics: Methods and Protocols. Springer Protocols. Springer.
20. Xiaoquan Qi, Xiaoya Chen, Yulan Wang. 2014. Plant Metabolomics: Methods and Applications. Chemical Industry Press. Springer.
21. Diana Marco (Ed.). 2011. Metagenomics: Current Innovations and Future Trends. Horizon Scientific Press.