BTPC3005 OMICS TOOLS AND TECHNIQUES (3-0-0)

Module – I: (08 Hours)
Genomics and Genome Analysis: Introduction to Genomics Structural, functional, and comparative genomics,Genome Sequencing Technologies – Sanger, NGS (Illumina, PacBio, Oxford Nanopore), Genome Annotation and Assembly – Tools and strategies, Gene Prediction Algorithms – ORF detection and promoter analysis, Applications of Genomics – Agriculture, medicine, and microbial genomics

Module – II: (08 Hours)
Transcriptomics: Overview of Transcriptomics – mRNA, non-coding RNA, expression profiling, RNA Extraction and Quality Control – Techniques and QC parameters, Microarrays and qPCR – Principles and comparative analysis, RNA Sequencing (RNA-Seq) – Workflow, analysis tools, and applications, Differential Gene Expression Analysis – Bioinformatics pipelines and interpretation.

Module – III: (08 Hours)
Proteomics: Introduction to Proteomics – Types and scopes. Protein Separation Techniques – 1D/2D gel electrophoresis, chromatography.Mass Spectrometry in Proteomics – MALDI-TOF, LC-MS/MS, Protein Identification and Quantification – Label-free and isotope-labeling methods, Protein-Protein Interactions and Network Analysis – Co-IP, yeast two-hybrid, STRING database.

Module – IV: (08 Hours)
Metabolomics: Basics of Metabolomics – Primary and secondary metabolites. Sample Preparation and Extraction Methods – For plant, microbial, and animal tissues. Analytical Techniques – NMR, GC-MS, LC-MS., Data Processing and Multivariate Analysis PCA, PLS-DA, and clustering. Applications of Metabolomics – Biomarker discovery, nutrition, and plant-microbe interaction studies.

Module – V: (08 Hours)
Integrative Omics and Applications: Concept of Systems Biology – Integration of multi-omics data. Bioinformatics Tools for Omics Integration – Cytoscape, OmicsNet, PathVisioPersonalized and Precision Medicine – Role of multi-omics. Omics in Drug Discovery and Toxicology – Target identification, ADMET profiling.Challenges and Future Directions in Omics Research – Data interpretation, ethics, and big data.

Course outcomes (Cos)
1) Explain the principles and applications of genomics, transcriptomics, proteomics, and metabolomics.
2) Interpret high-throughput data from omics technologies using bioinformatics tools.
3) Apply omics approaches to identify genes, proteins, and metabolites involved in biological processes.
4) Analyze differential gene/protein expression using omics platforms for disease or trait studies.
5) Evaluate integrative omics approaches for systems biology and personalized medicine.

Program outcomes (Pos)-
1) Apply knowledge of mathematics, science, and engineering to solve biotechnology problems.
2) Identify, formulate, and analyze complex problems using knowledge of omics technologies.
3) Design and conduct experiments using genomics and proteomics tools.
4) Use research-based knowledge and bioinformatics tools for data analysis and interpretation.
5) Select and use modern omics and computational tools for biotechnological practices.

Program Specific Outcomes (PSOS)-
1. Utilize omics tools and techniques to explore molecular mechanisms in biological systems for applications in health, agriculture, and environment.
2. Integrate multi-omics data using computational tools for research, diagnostics, and biotechnological innovations.

Books:
1. Jeremy Ramsden, Bioinformatics: An Introduction, Springer
2. Debmalya Barh et al., Omics Technologies and Bio-engineering, Academic Press.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, Wiley-Blackwell.