Bioinformatics Course Curriculum

Module I: Basic Bioinformatics Course Structure

Day 1: Introduction to Bioinformatics

- Overview of bioinformatics and its importance
- Key applications in biology and medicine
- Basic terminology

Day 2: Biological Databases

- Introduction to primary databases (NCBI, EMBL, DDBJ)
- Sequence databases (GenBank, RefSeq, UniProt)
- Structure databases (PDB)
- Browsing and retrieving data

Day 3: Sequence Alignment

- Basics of sequence alignment
- Pairwise alignment (global and local)
- Tools: BLAST, FASTA
- Practical session on using BLAST

Day 4: Multiple Sequence Alignment

- Introduction to multiple sequence alignment
- Tools: Clustal Omega, MUSCLE
- Applications of multiple sequence alignment
- Hands-on session

Day 5: Phylogenetics

- Basics of phylogenetic analysis
- Tree building methods (neighbor-joining, maximum parsimony)
- Tools: MEGA, PhyML
- Constructing and interpreting phylogenetic trees

Day 6: Genomics and Genome Browsers

- Introduction to genomics
- Genome browsers (UCSC Genome Browser, Ensembl)
- Viewing and interpreting genomic data
- Practical session

Day 7: Transcriptomics

- Introduction to RNA-seq
- Data formats and preprocessing
- Tools for RNA-seq analysis
- Differential expression analysis

Day 8: Proteomics

- Basics of proteomics
- Protein structure prediction
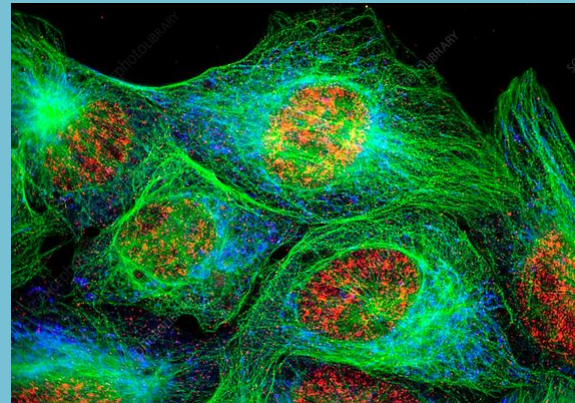
- Tools: ExPASy, SWISS-MODEL
- Practical session on protein analysis

Day 9: Functional Genomics

- Gene ontology and pathway analysis
- Tools: DAVID, KEGG
- Practical session on functional annotation

Day 10: Introduction to Programming in Bioinformatics

- Basics of Python/R programming
- Libraries and tools for bioinformatics (Biopython, BioConductor)
- Simple scripting for bioinformatics tasks

Day 11: Data Visualization

- Importance of data visualization
- Tools: R (ggplot2), Python (matplotlib, seaborn)
- Practical session on creating bioinformatics visualizations

Module II: Advanced Bioinformatics Course Structure

Day 12: Advanced Sequence Analysis

- Advanced techniques in sequence alignment
- Hidden Markov Models (HMMs)
- Tools: HMMER
- Practical session on using HMMs

Day 13: Next-Generation Sequencing (NGS) Technologies

- Overview of NGS platforms and technologies
- Data formats (FASTQ, BAM, VCF)
- Quality control and preprocessing
- Practical session on NGS data handling

Day 14: Advanced Genomics

- Comparative genomics
- Genome assembly and annotation
- Tools: SPAdes, AUGUSTUS
- Practical session on genome assembly

Day 15: Transcriptomics and Single-Cell RNA-seq

- Advanced RNA-seq analysis

- Single-cell RNA-seq analysis
- Tools: Cell Ranger, Seurat
- Practical session on single-cell data analysis

Day 16: Epigenomics

- Introduction to epigenomics
- DNA methylation and histone modifications
- Tools: Bismark, MACS2
- Practical session on epigenomic data analysis

Day 17: Proteomics and Metabolomics

- Advanced proteomics techniques
- Mass spectrometry data analysis
- Metabolomics analysis
- Tools: MaxQuant, MetaboAnalyst
- Practical session on proteomics and metabolomics

Day 18: Structural Bioinformatics

- Protein structure prediction and modeling
- Molecular dynamics simulations
- Tools: GROMACS, PyMOL
- Practical session on protein modeling

Day 19: Systems Biology

- Introduction to systems biology
- Network analysis (gene, protein, metabolic networks)
- Tools: Cytoscape, STRING
- Practical session on network analysis

Day 20: Data Integration and Multi-Omics

- Integrating different types of omics data
- Multi-omics approaches
- Tools: iCluster, MOFA
- Practical session on data integration

One week: Advanced Data Visualization (Day 21-30)

- Complex visualizations in R and Python
- Interactive visualizations (Shiny, Plotly)
- Practical session on creating advanced visualizations and analysis NGS Data

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DATA ANALYTICS