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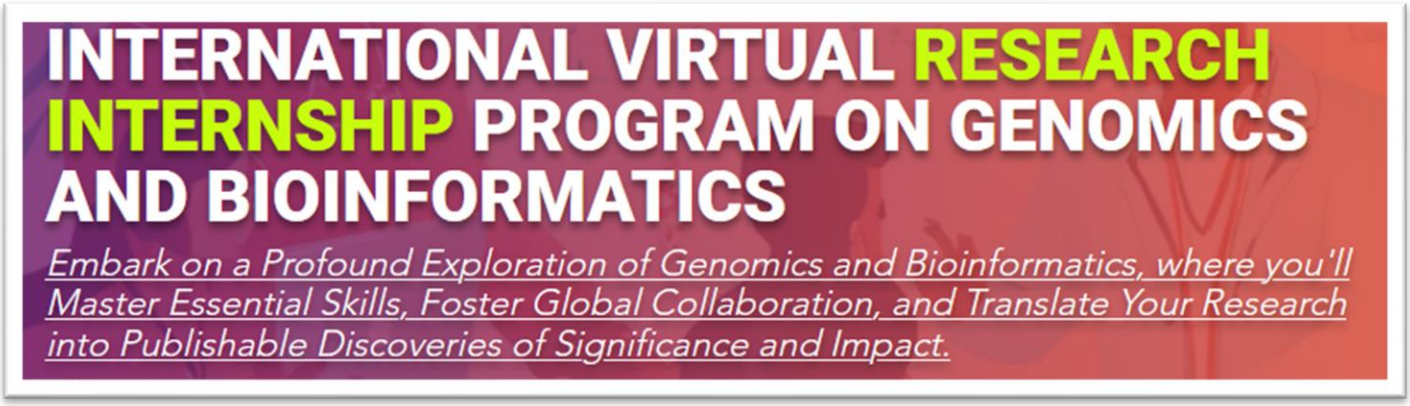

*We envision inspiring and empowering life scientists to leverage **GENOMICS AND BIOINFORMATICS** to tackle critical challenges, drive innovation, and promote sustainable progress across the globe.*

Research Domain: Comparative Microbial Research
Research Focus: Clinical Genomics of Infectious Diseases.
Research Topic: Comparative Genomics to Elucidate the Genetic Diversity, Evolution, and Functional Capabilities of Pathogens Causing the Same Diseases Across Different Countries
Research Aim: To use comparative genomics to uncover the genetic diversity, evolutionary relationships, and functional capabilities of pathogens from different species causing the same diseases across various countries, enhancing our understanding of their mechanisms of pathogenicity, resistance, and adaptation.
Research Objectives:

- **Elucidate Evolutionary Relationships and Genetic Diversity**: Perform phylogenomic analysis and whole genome alignment to understand the evolutionary relationships, conserved regions, and structural variations among pathogens from different species causing the same diseases across various countries.
- **Characterize Functional Capabilities and Genomic Features**: Identify and analyze chromosomal genome features, and differentiate core and accessory genomes using pan genomics and Average Nucleotide Identity (ANI) to understand pathogenicity, virulence, resistance mechanisms, and species delineation.

LEARNING OBJECTIVES

- **Understand Phylogenomics in Comparative Genomics**: Develop the ability to construct and interpret phylogenetic trees based on whole genome data from different species and countries, understanding evolutionary relationships among pathogenic strains.
- • **Identify Chromosomal Genome Features**: Gain expertise in identifying and characterizing chromosomal genome features, including gene content, organization, and structural variations, to understand their role in pathogenicity, virulence, and resistance mechanisms.

- • **Perform Whole Genome Alignment**: Acquire proficiency in aligning whole genomes to identify conserved and variable regions and detect structural variations that contribute to genetic diversity across species and regions.
- • **Explore Pan Genomics and ANI**: Learn to construct and analyze pan genomes to differentiate between core and accessory genomes, and use ANI to assess genetic similarity and delineate species boundaries, enhancing understanding of pathogen diversity and adaptation.
- **Craft Research Papers for Publication:** Learn how to synthesize and present your findings coherently, culminating in the preparation of research papers suitable for publication, contributing to the broader understanding of the evolution and dissemination of infectious diseases.

EXPECTATIONS WHILE UNDERTAKING THIS INTERNSHIP PROGRAM:

- **Knowledge of Genomics and Bioinformatics:** Develop a solid foundation in genomics and bioinformatics, including an understanding of key concepts, methodologies, and technologies used in the program
- **Proficiency in Data Analysis:** Gain proficiency in analyzing genomic data using bioinformatics tools and software. This includes skills in data preprocessing, quality control, data visualization, and statistical analysis.
- **Research Skills:** Acquire research skills necessary for conducting genomics and bioinformatics studies. This includes formulating research questions, designing experiments, collecting and analyzing data, and interpreting research findings.
- **Critical Thinking and Problem-Solving:** Develop critical thinking skills to analyze complex genomic and bioinformatics problems and propose creative solutions. You would be able to evaluate scientific literature, identify research gaps, and contribute to the advancement of knowledge in the field.
- **Computational Skills:** Gain proficiency in software and applications commonly used in bioinformatics, such as Geneious software, web servers etc. to analyze genomics data and interpret results
- **Communication Skills:** You would be able to effectively communicate your research findings and scientific concepts to both technical and non-technical audiences. This includes writing scientific reports, presenting research orally, and participating in scientific discussions and collaborations.
- **Collaboration and Teamwork:** Be able to develop skills in collaborating with peers and professionals in multidisciplinary research teams. This includes effective communication, teamwork, and the ability to contribute constructively to group projects.
- **Professional Development:** You would be able to develop a professional mindset, including skills in time management, organization, and project management. They should also be aware of current trends and advancements in genomics and bioinformatics, and actively seek opportunities for professional growth and development.
- **Publication and Dissemination:** Contribute to the scientific community by publishing their research findings in peer-reviewed journals

CLASSES	TOPICS/FOCUS	SCHEDULE & DELIVERABLES
General Classes	Overview of genomics, bioinformatics, and their applications in various fields	
	Understanding the central dogma of molecular biology	
	Introduction to genomics technologies and data generation	
	Data formats in Genomics and Bioinformatics (Practical)	
	Internet tools and Databases (Practical on data retrieval, Blast etc.)	
	Introduction to software tools and their installation, web servers, and pipeline tools (Practical), Basic Linux Command Line Interface	**Week 1**
	Genomics Data and its Analysis using cutting-edge tools (Practical DNA, RNA and Protein samples)	
Specialized Classes	Introduction to clinical genomics of infectious diseases	
	The experimental application of each of these in your field of study	
	Problem identification relative to the above area in the healthcare, industrial, and other life science research space	
	The use of critical thinking and problem-solving tools to design a hypothesis in solving identified problems	
PRACTICAL SESSIONS		
Data Acquisition and Preprocessing	**Collection of WGS (NGS) Genomic Data:** Gather whole-genome sequencing data of multi-drug resistant pathogenic bacteria strains from relevant sources and databases.	**Week 2**
	Table 1: Construction of General Sequence Properties: via data table based on genome information which includes accession number, raw data size, sources, geographical regions platform, genome type, layout, file types, etc.	
	Quality Control: Assess data quality, perform trimming, and filter out low-quality reads to ensure reliable results.	
	Write Up 1: Reads Processing and Genome Assembly	
Comprehensive Genome Analysis	**Functional Annotation:** Gene prediction, Protein features, Specialty features, Chromosomal properties, and Circus-view, among others.	**Week 3**
	Write Up 2: Functional Genome Annotation	
	Table 2: Construction of Chromosomal Genome Properties: CDS, Genes, RNA, Hypothetical Protein, Functional Protein, Go assignments, PGfam, Cripsr, etc.	
Comparative Genome Analysis in the Evolution and Diversity of the Pathogens	**Phylogenomics:** Fundamentals of phylogenetic analysis, constructing phylogenetic trees, and case studies on evolutionary relationships among pathogens. **Figure 1: Phylogenomics Tre**	**Week 4**
	Write Up 3: Phylogenetics	
	Average Nucleotide Identity (ANI): Understanding ANI, calculating genetic similarity, species delineation, and genomic similarity thresholds.	

	Figure 2: Heatmap of the ANI of the Genomes	
	Whole Genome Alignment: Techniques for genome alignment, identifying conserved and variable regions, and detecting structural variations such as insertions, deletions, and rearrangements. **Figure 4:** Alignment View	**Week 5**
	Write Up 4: Whole Genome Alignment Study	
	Pan Genomics: Constructing pan genomes, differentiating between core and accessory genomes, and identifying unique genes and their functions. **Figure 5:** Genome Map View	
	Write Up 4: Pan Genome studies.	

RESEARCH PROJECT OUTLINE FOR PUBLICATION

Research Outline	Finalizing Materials and Method	
	Result Writing	**Week 6**
	Discussion and Conclusion	
	References and Abstract	**Week 7 - 8**
Round Up	Certification and Recommendation Letter	
	Follow-up and Publication	**Week 9**

PROGRAM OUTLINE AND SCHEDULE

NOTE THE FOLLOWING:

- CLASS TIME: 3 PM GMT.
- ASSIGNMENT: is to be done within 5 days after class and must be submitted before the next class
- Absent from classes should not be more than 3 consecutive times with a genuine excuse, else you lose your spot in the internship program.