



# INTERNATIONAL VIRTUAL RESEARCH INTERNSHIP PROGRAM ON GENOMICS AND BIOINFORMATICS

*Embark on a Profound Exploration of Genomics and Bioinformatics, where you'll Master Essential Skills, Foster Global Collaboration, and Translate Your Research into Publishable Discoveries of Significance and Impact.*

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:** Microbial Research

**Research Focus:** Clinical Genomics

**Research Topic:** One Health Approach for Tracking Outbreaks and Spread of Pathogens through Comparative Genomics of Mobile Genetic Elements

**Research Aim:** To implement a One Health approach integrating human, animal, and environmental data to track outbreaks and spread of pathogens, focusing on the role of mobile genetic elements, through comprehensive comparative genomics analysis

**Research Objectives:**

- **Integrate Human, Animal, and Environmental Genomic Data:** Gather genomic data from human clinical samples, animal reservoirs, and environmental sources, focusing on mobile genetic elements. Establish data-sharing mechanisms to facilitate collaboration between different sectors.
- **Perform Comparative Genomics Analysis for Outbreak Tracking:** Conduct comparative genomics analysis to identify genetic similarities and differences between pathogen strains from human, animal, and environmental sources. Trace transmission pathways and potential sources of outbreaks.
- **Investigate Evolutionary Dynamics of Mobile Genetic Elements:** Study the evolutionary dynamics of mobile genetic elements in pathogens, including their role in the emergence of antimicrobial resistance and virulence. Identify hotspots of genetic exchange and potential drivers of spread.

## LEARNING OBJECTIVES

- **Understand One Health Approach for Infectious Disease Surveillance:** Develop an understanding of the One Health approach and its importance in tracking outbreaks and spread of pathogens across human, animal, and environmental domains.

- **Master Comparative Genomics Analysis for Outbreak Tracking:** Acquire proficiency in comparative genomics analysis techniques to compare pathogen strains from different sources and trace transmission pathways during outbreaks.
- **Investigate Evolutionary Dynamics of Mobile Genetic Elements:** Gain expertise in studying the evolutionary dynamics of mobile genetic elements in pathogens, including their contribution to antimicrobial resistance and virulence.
- **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
<b>General Classes</b>	Overview of genomics, bioinformatics, and their applications in various fields	<b>Week 1</b>
	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	
	Genomics Data and its Analysis using cutting-edge tools (Practical DNA, RNA and Protein samples)	
<b>Specialized Classes</b>	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	
<b>PRACTICAL SESSIONS</b>		
<b>Data Acquisition and Preprocessing</b>	<b>Collection of WGS (NGS) Genomic Data:</b> Gather whole-genome sequencing data of multi-drug resistant pathogenic bacteria strains from relevant sources and databases.	<b>Week 2</b>
	<b>Table 1: Construction of General Sequence Properties:</b> via data table based on genome information which includes accession number, raw data size, sources, geographical regions platform, genome type, layout, file types, etc.	
	<b>Quality Control:</b> Assess data quality, perform trimming, and filter out low-quality reads to ensure reliable results.	
	<b>Write Up:</b> Reads Processing and Genome Assembly	
<b>Comprehensive Genome Analysis</b>	<b>Functional Annotation:</b> <b>Gene prediction, Protein features, Specialty features, Chromosomal properties, and Circus-view, among others.</b>	<b>Week 3</b>
	<b>Write Up:</b> Functional Genome Annotation	
<b>Genomics Insights into the Dynamics of Mobile Gene Elements</b>	<b>Table 2: Construction of Chromosomal Genome Properties: CDS, Genes, RNA, Hypothetical Protein, Functional Protein, Go assignments, PGfam, Cripsr, etc.</b>	
	<b>Mobilome Profile Study:</b> Identification of Mobile Genetic Elements (MGEs): Specifically focus on mobile genetic elements such as plasmids, transposons, and phages. These elements can carry antibiotic-resistance genes, virulence factors, and other traits that contribute to the spread of pathogens.	<b>Week 4</b>
	<b>Write Up:</b> Mobilome Profile Study	
	<b>Statistical Analysis:</b> <ul style="list-style-type: none"> <li><b>Figure 1: Comparative Heatmap of MGE between strains</b></li> </ul>	

	<ul style="list-style-type: none"> <li>• <b>Table 3:</b> MGE genes and their putative functions.</li> <li>• <b>Figure 2:</b> Expression level of MGEs across strains</li> <li>• <b>And More Other visualization</b></li> </ul>	<b>Week 5</b>
	<p><b>Phylogenetic Analysis:</b> Construct phylogenetic trees based on the genomic data to infer the evolutionary relationships between different strains of the pathogen. This helps identify clusters of closely related isolates and track the transmission routes during outbreaks.</p> <ul style="list-style-type: none"> <li>• <b>Write Up on Materials and Methods</b></li> <li>• <b>Figure 3:</b> Phylogenetics Analysis of the MGEs</li> <li>• <b>Figure 4:</b> Alignment View of the Sequences</li> <li>• <b>Figure 5:</b> Matrix View of the Alignments</li> </ul>	<b>Week 6</b>

### **RESEARCH PROJECT OUTLINE FOR PUBLICATION**

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

### **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.