



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/Infectious Diseases.

Research Focus: Clinical Genomics of Infectious Diseases.

Research Topic: Comparative Genomics of Multidrug-Resistant *Pathogens* in Healthcare and Natural Environments

Research Aim: Understanding the genetic mechanisms underlying multidrug resistance pathogens and comparing strains from clinical and environmental sources.

Research Objectives:

- **Identify and Compare Genetic Determinants of Multidrug Resistance:** Catalog genes associated with multidrug resistance in pathogens from healthcare and natural environments, and perform comparative genomic analyses to find similarities and differences between clinical and environmental strains.
- **Understand Mechanisms and Spread of Resistance:** Investigate the transfer mechanisms of resistance genes and analyze evolutionary dynamics to inform public health strategies and enhance diagnostic and therapeutic approaches.

LEARNING OBJECTIVES

- **Comprehend the Molecular Foundations of Infectious Diseases:** Develop a deep understanding of the molecular mechanisms underlying infectious diseases, particularly focusing on pathogenic bacteria and their multi-drug resistance traits.
- **Master Bioinformatics Tools and Techniques:** Acquire proficiency in utilizing bioinformatics tools and methodologies tailored to the analysis of genomics data within the context of clinical infectious diseases research.
- **Navigate Disease-Specific Databases:** Familiarize yourself with specialized databases and resources pertinent to the field of clinical genomics, specifically relating to infectious diseases caused by pathogenic bacteria.

- **Interpret Genomics Data for Insights:** Develop the skills to analyze and interpret complex genomics data, extracting meaningful insights into the phylogeographic patterns, evolutionary dynamics, and transmission routes of multi-drug resistant pathogenic bacteria.
- **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	Week 1
	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)	
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	
Genomic Insights into Drug Resistance and Mechanisms of Adaptation	Resistome Profile Study: Understanding the mechanisms underlying antibiotic resistance and its relevance to the spread and evolution of multi-drug resistant pathogenic bacteria.	Week 4
	Write Up 3: Resistome Profiling Analysis	
	Statistical Analysis: <ul style="list-style-type: none"> Figure 2: Heatmap of antibiotic resistance genes (ARG) types across strains (Antibiotic Class) 	Week 5

	<ul style="list-style-type: none"> • Figure 3: Prevalence of AMR genes across strains • Figure 4: Percentage distribution of ARG resistance mechanism • Figure 5: Relative distribution of AMR genes in antibiotics • Table 3: Shared resistance genes and their putative functions between strains • And More Other visualization 	
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RESEARCH PROJECT OUTLINE FOR PUBLICATION

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