

Project Title: Engineering and Control of Genetic Biosensors for Environmental Monitoring

Host Laboratory: Synthetic Biomimetic Engineering Lab, Ashesi University

Focus Area: Synthetic Biology, Genetic Circuits, and Environmental Sensing

Duration: Summer Research Exchange

Project Overview

The Synthetic Biomimetic Engineering Lab at Ashesi University develops innovative biological tools for detecting environmental pollutants. Our current focus is on engineering biosensors that can identify and quantify heavy metals and other contaminants in water systems. These biosensors are based on genetically engineered microorganisms that produce measurable signals — such as color change or fluorescence — in response to specific pollutants.

This summer project seeks to optimize the performance of our biosensors by improving their underlying genetic circuits. Using principles from control theory and systems biology, the team will explore new designs that introduce regulatory features like feedback loops and signal amplification mechanisms to make biosensor responses more robust, sensitive, and tunable.

Project Goals

Interns will work collaboratively to:

- Design and simulate genetic circuits incorporating feedback and control elements.
- Build and test biosensor constructs in suitable microbial chassis.
- Characterize sensor performance under varying environmental conditions.
- Apply modeling and data analysis to evaluate system dynamics and stability.
- Contribute to open documentation of genetic circuit designs and experimental data.

Learning Outcomes

By participating in this project, interns will gain hands-on and conceptual experience in:

- Synthetic biology design and molecular cloning techniques.
- Genetic circuit modeling using computational tools (e.g., MATLAB, or SBOL).
- Principles of feedback and control in biological systems.
- Quantitative data analysis and biosensor performance evaluation.
- Open science practices and collaborative research in interdisciplinary teams.

Impact

This project supports the development of low-cost, locally deployable biosensors for environmental monitoring across Africa. By integrating engineering control concepts into biological design, the work contributes to advancing smart, responsive biotechnologies that can detect pollutants and support sustainable water management.

Project Summary: Open Bioeconomy Molecular Enzyme Production Initiative

Host: Synthetic Biomimetic Engineering Lab, Ashesi University & African Regional Hub — Open Bioeconomy Project

Focus Area: Synthetic Biology and Molecular Diagnostics

Duration: Summer Research Exchange

Overview

The Open Bioeconomy Project aims to democratize access to essential biotechnology reagents by developing open, locally reproducible production workflows for key molecular biology enzymes. As part of the African Regional Hub, our team is focused on establishing a scalable and cost-effective process for producing, characterizing, and validating molecular diagnostic enzymes used in research and disease detection.

Project Goal

The primary objective is to create an open-source production pipeline — from plasmid to purified enzyme — for critical reagents such as polymerases, reverse transcriptases, and other diagnostic enzymes used in molecular assays (e.g., PCR, LAMP, CRISPR-based diagnostics).

Interns will work collaboratively to:

- Transform and express recombinant enzymes using bacterial expression systems.
- Optimize growth and induction conditions to maximize enzyme yield.
- Purify and characterize enzyme activity using standard biochemical assays.
- Document and share open protocols and data through the Open Bioeconomy repository.

Learning Outcomes

Interns will gain hands-on experience in:

- Molecular cloning, transformation, and recombinant protein expression.
- Enzyme purification and activity testing (e.g., SDS-PAGE, functional assays).
- Lab data documentation, reproducibility, and open science practices.
- Collaborative research within an international open biology network.

Impact

This project supports Africa's growing role in the global bioeconomy by building regional capacity for enzyme manufacturing and diagnostic reagent production. The outcomes will contribute to reducing reliance on imported reagents and fostering local innovation ecosystems for biotechnology and public health.