School of Integrative Science and Technology

GROUP SUMMER SCHOLARS RESEARCH PROGRAM

2023 Research Streams *(Tentative & Subject to Change*)*

Evolution and Developmental Biology
(Dr. Matthew Niepielko)

During animal development, a handful of highly conserved cell signaling pathways regulate when and where genes are expressed within a developing tissue. This process, called tissue patterning, is an essential step to ensure that animals' organs develop in the correct location and at the right time. A growing body of evidence suggests that changes in gene regulation during tissue patterning drive the evolution of new animal structures and morphologies. In our lab, we use Drosophila, the common fruit fly, as a model system to investigate the underlying mechanisms that tightly regulate gene expression during development. Additionally, we explore how these mechanisms evolve and give rise to new morphologies using a combination of computational and molecular techniques.

Molecular & Cellular Biology: Exploring Cancer Malignancy
(Dr. Salvatore Coniglio)

Participants in this research stream will learn the basics in molecular biology and host discussions surrounding how cells acquire and integrate information from the extracellular environment with a focus on cancer biology. Activities that focus on signal transduction, gene expression and protein expression in cancers will be the primary focus. Using a hands-on approach with image analysis software, students will learn how scientists quantify changes in gene and protein expressions in tumors.

GSSRP summer research project: Earthworm Chemoreception and Feeding Behavior
(Dr. Cecil J. Saunders)

Description: Earthworms fulfill critical ecological roles in soil and agricultural maintenance. Several studies have shown that earthworms are attracted to complex mixtures of chemicals in soil, but few studies have attempted to determine what individual molecules stimulate earthworm feeding systematically. Most animals detect the presence of glutamic acid and other

free amino acids – an indication of a source of protein – and respond with appetitive behaviors. We have developed a novel feeding assay for earthworms by exploiting the universal phenomenon that hungry animals will typically consume more of better-tasting (appetitive) food substrates than substrates with neutral or aversive hedonic valances. For this assay, earthworms are food restricted for 2-3 days in containers containing 1- 2 cm of 5% agar to provide moisture. Subsequently, dry soil and amino acid solution are combined, and an earthworm allow to feed on this soil for 1 hour. Earthworms are then placed on a light table to enable visualization of their GI tract and the soil eaten during the trial; the amount of soil each earthworm consumes is calculated as a fraction of its body length. Under control conductions (water only added to the soil), earthworms typically eat until 40% of their GI tract is full of soil; when 50 µM L- Glutamic acid is added to the soil, earthworms eat until 60% of their GI tract is full. We propose having
GSSRP summer students test the other biologically relevant biomolecules, including other amino acids, in this assay. Participation in these experiments will expose students to basic animal behavior research, experimental design, solution preparation, and provide many opportunities to practice collecting, recording, and analyzing scientific data. As time permits, students will observe the molecular and cellular assays used to determine the identity of the receptor proteins and sensory cells that the earthworms use to detect chemicals in their environment.

Introduction to Data Analytics and Computer Vision
(Dr. George Avirappattu and Dr. David Joiner)

Finding and characterizing objects in pictures and video is a major challenge in computing today, with implications for a wide range of technological advances. Object detection in 3D images, especially of scientific data, poses additional challenges. Participants in this stream will work with 3D data showing the growth of stem cells from fruit flies and will produce images in 3D. These images will then be analyzed using computer vision techniques to find, tag, and count the data. No prerequisite knowledge is needed, other than a strong interest in learning how to create code and use technology to do science. You will begin by learning how to use the Python computer language in a cloud-based environment, with examples in the mathematics behind modern data science, specifically classification and regression. These skills will be applied to analysis of real 3D data taken from other GSSRP streams, and you will compare different computer vision techniques to determine which is the most efficient and accurate. Students will get experience working on Kean's HPC system.

Gamified Immersive Visualizations Enhancing STEM (GIVES) - Playing with Data
(James Chikwem)

Modern scientific data is not just big in terms of number of bytes, but also the number of dimensions. Science Technology Engineering and Math (STEM) data algorithms always get more interesting as they increase exponentially in dimensions but are still mostly taught in

two-dimensional mediums like books and screens. The GIVES project intends on enhancing the dimensions of learning about the world of data utilizing eXtended Reality (XR) technology with a focus on building science visualization in the metaverse, mixing gaming technology, virtual reality, science visualization, and data science into a single package. Students will gain experience using computer graphics and game technology like Blender, Unity Game Engine, Photoshop, and Aero along with techniques in machine learning to detect objects in 2 and 3 dimensional microscope data.

The Role of Biofuels in the Future as a Sustainable Energy Source (John Tang)

Organic waste comprises 21.4% of all solids diverted to landfills in the United States. This is an underutilized resource that can be directly transformed into a green and sustainable energy source. In this project, we will tackle practical issues for the mass production of biofuels as an energy source in biological and chemical aspects. Various feedstocks, pre-treatments, bacteria cultures and separation processes will be investigated for optimal parameters. Basic laboratory techniques such as analytical instrumentation and cultivating bacteria will be essential towards producing significant results. Separation processes such as single stage and fractional distillation, and gas chromatography will be heavily employed while conducting research. Students will generate trendlines from multivariable problems and navigate potential solutions to overcome real world biochemical processes.

**Note that proposed research streams are tentative and subject to change. While we will try to accommodate preferences, we cannot guarantee placements. Research streams are capped for safety reasons and to guarantee the best learning experience for all participants. Students will be notified of their research stream placement at the time of acceptance and switching streams is not permitted. Research streams and program format are subject to change and are dependent on ongoing Covid-19 emergency circumstances.*