New Jersey Center for Science, Technology & Mathematics

GROUP SUMMER SCHOLARS RESEARCH PROGRAM

2022 Research Streams *(Tentative & Subject to Change*)*

Medicinal Chemistry & Modern Drug Discovery: Synthesis of Chemokine Receptor Antagonists

Students in this research stream learn basic principles of medicinal chemistry and pharmaceutical research by synthesizing and testing novel receptor antagonists. Students work as part of a multidisciplinary drug discovery team to optimize compounds that can block chemokine receptor signaling. Using real drug discovery screening assays, students test the newly created compounds in collaboration with the Cancer Biology Team to determine effects on the growth and activation of cultured glioblastoma cells.

Analytical Chemistry: Mass Spectrometry in Drug Discovery and Development

In this research stream, we will explore how drugs are metabolized in the human body by studying modern analytical techniques and instrumentation that are used on the frontiers of drug discovery in the pharmaceutical industry. A detailed discussion of two of the most powerful analytical techniques, chromatography (separation) and mass spectrometry (characterization, identification, and quantitation), will be presented. These techniques are vital in the drug development process in order to understand how potential medicines are absorbed, distributed, metabolized, and excreted. Students will isolate, identify, and quantitate drug-like chemical compounds in plants that show anticancer, antibacterial, and antimicrobial activity using biological assays and analytical instruments.

Developmental Biology: Gene Expression and Regulation

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 gene regulation during tissue patterning drives 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.

**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.*

Molecular & Cellular Biology: Exploring Cancer Malignancy

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.

World of Data: Scientific Visualization using Gaming Engines

Modern scientific data is not just big in terms of number of bytes, but also the number of dimensions. Much of what we see in biology, chemistry, and physics is inherently three dimensional. In addition, in the growing field of data science every degree of freedom is a dimension in the data. The World of Data project is 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 Unity Game Engine, along with techniques in machine learning to detect objects in 2 and 3 dimensional microscope data.

Microbiology: Screening for Antibiotic Resistance & Lantipeptides

Bacteria produce compounds that help them survive, for example, by evading antibiotics or threats by other organisms. The increase in antibiotic-resistant bacteria present both environmental and medical concerns. Lantipeptides are compounds produced by microbes, many of which show antimicrobial activity, and thus may have many potential applications. This research stream has two components whereby students will collect and screen soil microbes for antibiotic resistance as well as investigate physiocochemical properties of microbially produced lantipeptides. Students will learn and perform basic microbiology and molecular biology procedures.