



New Jersey Center for Science, Technology & Mathematics

2021 GROUP SUMMER SCHOLARS RESEARCH PROGRAM

RESEARCH STREAMS

Dr. Merritt: Medicinal Chemistry (IN-PERSON)

Students in this research stream will prepare, purify, and characterize a novel chemical compound which will later be tested for inhibition of SARs-CoV-2 the virus that causes COVID-19. Students will receive instruction for use of synthetic organic lab equipment including: rotary evaporators, glassware, automated chromatography systems, nuclear magnetic resonance, and high performance liquid chromatography. Students will learn basic organic and medicinal chemistry background sufficient to understand the molecular structure and properties of organic compounds. Students will participate in hands on laboratory activities, as permitted, and will become proficient in the use of chemical software for drawing chemical structures and calculating properties.

Dr. Joiner: Automated Pollen Detection Using Neural Networks (REMOTE)

The research team will develop and test tools to help scientists better measure and track allergens in real time. Many published measurements on pollen counts are based on incomplete and anecdotal data due to the lack of comprehensive recording, storage, and sharing of pollen count data. The widespread use of and reporting from pollen tracking stations can help this, but analysis of pollen station data is time consuming and manually intensive. We are working on automating the recording, analysis, and reporting of pollen station data, in collaboration with the Pollen Underground network of pollen counting stations. Students in the stream will gain experience programming in python (no prior experience is required), and in using state of the art tools for image manipulation, processing, and object detection using neural networks.

Dr. Coniglio: Molecular Cell Biology (IN-PERSON)

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.

Dr. Niepielko: Introduction to Bioinformatics (REMOTE)

Bioinformatics is an interdisciplinary field where computer programs and databases are used to help solve complex biological questions involving DNA, RNA, and proteins. This scientific workshop serves as an introduction to bioinformatics and will include the general concepts of bioinformatics, data analysis, and use of public bioinformatics databases. Participants will perform hands-on activities using methodologies

that are employed by scientists everyday in order to understand DNA mutations and protein function. At the conclusion of the Bioinformatics workshop, students will gain essential skills in navigating DNA databases, visualizing protein structures, and tracking evolution patterns of key biological proteins. Students must have a windows PC or Mac computer that has access to install software in order to participate in this stream.

Dr. Avirappattu and Dr. Farnum: Supervised Machine Learning (IN-PERSON)

This computer programming research stream introduces the building blocks of machine learning. During the session, students will use hands-on activity based learning focused on problem solving. Participants will use the Jupyter Notebook environment of Python language to explore 1) necessary numerical linear algebra and calculus 2) linear regression 3) logistic regression, and 4) neural networks. The goal for this stream is for students to gain experience in the application and limitations of machine learning. This stream will be in-person during mornings only, with no lunch break (10am-2pm).

Dr. Ramanathan: Analytical Chemistry - Mass Spectrometry in Drug Discovery and Development (IN-PERSON)

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.

Dr. Mahr: COVID-19 Genomic Data (REMOTE)

The research team will perform comparative analysis of viral genomes and analysis of COVID-19 testing data. Although humanity has experienced pandemics in the past, the amount of genomic data from the current SARS CoV-2/COVID-19 pandemic is truly staggering and much of it is available publicly. In fact, so much genomic data is available that hypothesis-driven research can be performed on publicly available online bioinformatics tools. After an introductory virology module and practice with bioinformatics, students will explore the genomic diversity present in different families of viruses and document that diversity using phylogenetic trees. These skills will then be focused on the exploration of genomic diversity of SARS-CoV2. Through out the course, students will give short presentations documenting their findings. Students in this stream will gain a more sophisticated understanding of the epidemiology of SARS CoV-2 and the appearance and spread of viral variants (aka, "mutants").