2024 In-Person EUREKA! Project List

The following table contains the projects available for the 2024 In-Person EUREKA! Program. Project details are available on the pages following this table. The "Project Title" in this table will hyperlink you to the project information. The "Project Title" on the later pages will hyperlink you to the project or mentor website. The "Department" on the later pages will hyperlink you to the department's website. If you do not see a project or department that interests you, you will have the option to suggest one on your application. Please email us at eureka@clemson.edu with any questions.

Department	Project Title
Agricultural Sciences	Surveys of Agricultural Producers and their Adoption of Climate-Smart Practices
Agricultural Sciences / South Carolina Water Resources Center	Patterns and Trends in Hydro-climatological Data in South Carolina
Automotive Engineering	Driving Safety and Intelligent Vehicles
Automotive Engineering	Convergent Manufacturing: A Promising Passway Toward Sustainable and Cost-Efficient Manufacturing of High-Performance Products
Biological Sciences	Drug-induced Cardiovascular Toxicity and Mitochondrial Dysfunction
Biological Sciences	Salamander Microbiomes
Biological Sciences	Assessment of Histomonas meleagridis Toxicity Utilizing a Chicken Cell Culture Model: An Investigation into the Pathogenicity of the Agent Responsible for Lethal Blackhead Disease in Turkeys
Chemical and Biomolecular Engineering	A Microscale Approach to Mimic Cancer Cell Circulation and Metastatic Seeding
Chemical and Biomolecular Engineering	Predicting Protein Levels from mRNA Levels
Chemical and Biomolecular Engineering	Identification of Paracrine Signaling between Cancer Cells and Healthy Cells in the Tumor Microenvironment
Chemistry	Harnessing the Power of Artificial Intelligence and Deep Eutectic Solvents to Boost Antioxidant Power
Chemistry	Observing RNA Sugar Pucker Using Single-Molecule Atomic Force Microscopy
Chemistry	Designer Crystals and Tunable "Green" Solvents
Civil Engineering	Bio-inspired Drilling into Lunar Regolith
Computing	How to Build a Large Language Model (From Scratch)

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Department	Project Title
Computing	Ensuring Privacy Compliance in Software Development
Computing	Machine Learning-based 3D Reconstruction
Computing	Physics-based Deep Learning for Computer Vision
Electrical and Computer Engineering	Adaptive Multi-Tiered, Multi-Task Base Station Infrastructure For Communication-Denied Environments
Electrical and Computer Engineering	Exploring Security Threats to the Use of Smartphones
Electrical and Computer Engineering	Evaluation of Large Language Models
Electrical and Computer Engineering	Generative AI for Phenotypic Drug Discovery
Electrical and Computer Engineering	Radio Frequency Lab-on-Chip
Engineering & Science Education	Understanding the Experiences of Neurodivergent Learners in Higher Education
Food, Nutrition and Packaging Sciences	Understanding of Retort Processing for Food Safety and Shelf Life of Food Products
Genetics and Biochemistry	AI in Biomedicine: Prediction of Novel Human Disease Genes by Genomic Data Mining
Genetics and Biochemistry	Plant Biotechnology for Enhanced Agricultural Production
Genetics and Biochemistry	DNA Repair and Genome Instability
Genetics and Biochemistry	Exploring Microbial Interactions During Human Infection
Languages/Interdisciplinary Studies	Thomas Green Clemson in Paris: 1826-1831
Marketing	Using Machine Learning to Automate the Assessment of Creative and Entrepreneurial Personality
Materials Science and Engineering	Synthesis and Characterization of Magnetic Particles for Biomedical Applications
Mechanical Engineering	Bioinspired Structural Materials by Design
Mechanical Engineering / Bioengineering	Experimental and Computational Cardiovascular Research
Nursing	Alternative Therapeutics for Anti-Carcinogenic Assessment in Zebrafish Models of Human Breast Cancer
Plant and Environmental Sciences	Climate Resilient Crops for Food Security
Plant and Environmental Sciences	Imparting Drought Tolerance to Crops via Rhizosphere Microbiome
Plant and Environmental Sciences	Understanding the Effect of Arbuscular Mycorrhizal Fungi (AMF) in Obtaining Soil Phosphorus
Plant and Environmental Sciences	Understanding Soil Organic Carbon (SOC) Sequestration and Persistence in Agroecosystems

Project Title: Surveys of Agricultural Producers and their Adoption of Climate-Smart Practices
Mentor: Anastasia Thayer, Assistant Professor
Department: Agricultural Sciences

Project Description:

Climate-Smart Grown in SC is a large multi-year, multi-institution effort funded by the United States Department of Agriculture to increase adoption of climate-smart agricultural practices on leafy green, peanut, and cattle farms across South Carolina. As part of this large multi-disciplinary effort, researchers on the market development team are working to understand adoption decisions, costs and benefits of adoption, and potential market opportunities. In summer 2024, the team will be surveying enrolled producers after their first year enrolled in the program to gather information about their operation and learn more about practice adoption.

Student Involvement:

Interns this year will work with the market development agricultural team to create three survey instruments to be deployed to agricultural producers involved in the project. The survey will focus on questions related to climate-smart practices, adoption challenges, costs and benefits of adoption, product marketing, and other related economic and business questions. As time allows, interns will have the opportunity to manage and clean response data as well as prepare and disseminate findings.

In addition to the technical aspects of the project, interns will be introduced to the team and work with the project team. This will provide exposure to interdisciplinary, team-based research.

Required Skills / Prerequisites:

No prior experience or skills needed. Knowledge of and/or interest of agriculture is helpful but not required.

Expected Outcomes:

Interns will be directly involved with creation and deployment of the survey instrument. Depending on student interest and time, students could also be working with data produced from the survey and have an opportunity to assist in dissemination of results.

Future Opportunities:

The Climate-Smart Grown in SC project is a large multi-disciplinary, multi-year project. With this in mind, students could use this internship as a way to learn more about the project, other associated researchers, and leverage this opportunity to find or create other undergraduate research opportunities.

Research Location:

Main Clemson University Campus

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Project Title: Patterns and Trends in Hydro-climatological Data in South Carolina

Mentor: C. Prakash Khedun, Assistant Professor

Department: Agricultural Sciences / South Carolina Water Resources Center

Project Description:

"Hydro-climatological extremes (floods and droughts) are an integral part of the hydrological cycle. They are, however, not easy to predict. When they occur, they can have devastating effects on crops, infrastructure, local and state economy, and may in certain cases threaten lives. They are becoming more frequent and their impacts more catastrophic because of a changing climate. South Carolina, due to its location, is periodically subjected to both extremes.

In this project, students will learn how to (i) find and download hydro-climatological data, (ii) frame a hypothesis, and (iii) employ statistical tools and techniques to determine patterns and trends in the data.

Students may also have the opportunity to attend a one-day short course on climate impacts (still under preparation by the PI)."

Student Involvement:

Each student will analyze one hydro-meteorological variable (precipitation, minimum and maximum daily temperature, evapotranspiration, wind, streamflow, etc.) depending on their interest. In the first week, they will be introduced to programming in R (a common statistical programming language) and will be taught a few relevant statistical techniques. They will also be introduced to data repositories at USGS, NOAA, and NASA. In week 2 they will download, clean, and organize their data. They will spend weeks 3 and 4 conducting the analysis and will prepare and present their poster in week 5.

Required Skills / Prerequisites:

Interns should have a basic mathematics and statistics background and be willing to learn computer programming. The PI and his postdoc and graduate students will introduce interns to programming in R. The programming course will be in the newly renovated computer lab at the SC Water Resources Center.

Expected Outcomes:

"The mentor encourages students to continue to develop their work after the completion of this internship for presentation at the 2024 South Carolina Water Resources Conference which will be held in October at the Metropolitan Convention Center in Columbia, SC. This is a two-day conference where students will have the opportunity to listen to a wide range of presentations and interact with researchers across the state.
Should the students wish to continue work the work they started during this internship, I will work with them to publish it in the Journal of South Carolina Water Resources."

Future Opportunities:

This internship will give students the opportunity to learn about research in hydro-climatology. They may eventually pursue graduate degrees in hydrology or climate science or a related field.

Research Location:

Students may choose to work either on the main Clemson University Campus or in the computer lab at the SC Water Resources Center in Pendleton, SC.

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Project Title: Driving Safety and Intelligent Vehicles
Mentor: Bing Li, Assistant Professor
Department: Automotive Engineering

Project Description:

The interns will explore artificial intelligence, ChatGPT and existing technologies for intelligent vehicles and driving safety.

Student Involvement:

The interns will conduct surveys, might run programs, and write reports.

Required Skills / Prerequisites:

Python or alternative-language programming skills are preferred, but not required. Students should be interested in driving safety.

Expected Outcomes:

Students will create a presentation and report as well as have the opportunity to develop software.

Future Opportunities:

The students may publish their research results.

Research Location:

This research project is located at the Clemson University International Center for Automotive Research (CU-ICAR) (https://cuicar.com/) in Greenville, SC. Students who select this project must be commuters. Commuting EUREKA! students choose to provide their own transportation and housing.

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Project Title: Convergent Manufacturing: A Promising Passway Toward Sustainable and Cost-Efficient Manufacturing of High-Performance Products

Mentor: Saeed Farahani, Assistant Professor

Department: Automotive Engineering

Project Description:

This project offers a unique, hands-on research opportunity for students to explore the future of making things. Imagine a factory that's like a Swiss Army knife: it can change and adapt to make all sorts of products, from composite parts to complex energy storage or electronic components, by mixing different materials and ways of making things, all controlled by smart technology. Students will dive into this innovative world this summer, learning how to blend various manufacturing techniques to create new, eco-friendly, and efficient products. They will work closely with international researchers, use their creativity to solve real-world problems, and, at the end of the program, share their discoveries through a poster presentation. This experience is not just about making things; it's about imagining the factories of the future and learning the research skills needed to turn those visions into reality.

Student Involvement:

The selected interns will be actively engaged in every phase of a small project related to the convergent manufacturing concept, starting with a brief literature review on the field of sustainable and efficient manufacturing. They will participate in the design, development, and testing of new manufacturing solutions by combining AM, injection, and forming processes under the guidance of experienced faculty, postdocs, and Ph.D. students. This hands-on involvement includes working with advanced manufacturing equipment at Convergent Manufacturing Lab (CML) as well as Clemson Composites Center (CCC) located in CU-ICAR campus (Greenville). They will be involved in conducting experiments to test the efficiency and sustainability of the products, and they help create and analyze data to understand the impact of various manufacturing techniques.

Required Skills / Prerequisites:

Prior experience or familiarity with CAD software (such as SolidWorks or AutoCAD) for designing prototypes is highly beneficial. Additionally, a basic grasp of mathematics, particularly in areas related to algebra and geometry, is essential to engage in the project's analytical aspects effectively. While not mandatory, previous exposure to or

coursework in materials science, manufacturing processes, or digital fabrication techniques would be advantageous. Enthusiasm for learning new technologies and a collaborative spirit are also crucial for success in this immersive research experience.

Expected Outcomes:

Upon completion of the program, interns are expected to have the opportunity to contribute to research publications and possibly present at professional meetings, such as any relevant conferences. They will gain hands-on experience with cutting-edge manufacturing technologies at CML and CCC, proficiency in CAD software, and a deep understanding of sustainable manufacturing practices. This experience will prepare them for advanced studies and research opportunities in engineering, enhance their candidacy for prestigious scholarships, and open doors to internships and careers in the manufacturing companies and R&D institutions that directly work with research group.

Future Opportunities:

Interns can be hired as Research Assistants during the remaining part of their undergraduate program and will be offered to join the research group as graduate students with a full scholarship and competitive stipend.

Research Location:

This research project is located at the Clemson University International Center for Automotive Research (CU-ICAR) (https://cuicar.com/) in Greenville, SC. Students who select this project must be commuters. Commuting EUREKA! students choose to provide their own transportation and housing.

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Project Title: Drug-induced Cardiovascular Toxicity and Mitochondrial Dysfunction
Mentor: Qing Liu, Assistant Professor
Department: Biological Sciences

Project Description:

The team is using human stem cells to make 2D and 3D cardiac models, and is using this models to understand cardiovascular diseases and toxicology. Mitochondria is the powerhouse for energy production (ATP) of the heart. One major project is to understand the mechanism of mitochondrial dysfunction in cardiovascular diseases. The team will apply interdisciplinary and cutting-edge technologies to investigate this scientific question, to promote human health.

Student Involvement:

The students will be mentored by both Dr. Liu and graduate students in the lab. They will attend routine monthly lab meetings and meet in-person with Dr. Liu (every two weeks). The students will read scientific papers, learn stem cell culturing, 2D and 3D cardiac differentiation, and molecular biology techniques. The students will also present their work in the lab meeting and in the public seminar (if possible).

Required Skills / Prerequisites:

Basic laboratory techniques such as pipetting, lab maintenance, reading, and basic biology knowledge are required.

Expected Outcomes:

Students will conduct presentations in the lab meeting and have the potential for authorship in the publications.

Future Opportunities:

Dr. Liu will provide a reference letter and support for students' future fellowships or other applications (graduate or medical schools in future). Students can also continue working in the lab for research credits or CI program.

Research Location:

Main Clemson University Campus

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Project Title: Salamander Microbiomes
Mentor: Sharon Bewick, Assistant Professor
Department: Biological Sciences

Project Description:

Clemson is located in the global salamander diversity hotspot. There are more salamander species here than anywhere else in the world. Sometimes it gets confusing trying to keep all of the species straight. And guess what? It seems like the salamanders get confused themselves… because in many locations throughout the southeast, salamanders of different species mate with one another. When they do this they produce what's known as hybrids. The Bewick lab is interested in knowing what the skin microbiomes (the group of microbial taxa living on salamander skin) of hybrid salamanders look like. Are hybrid microbiomes similar to one parent, intermediate to both parents or totally different from either parent (a phenomenon known as transgressive segregation). The Bewick lab's goal is to use 16S rRNA sequencing - a way of 'looking' at the microbiomes - to compare the microbiomes of hybrids with the microbiomes of their parent species. This is important, because microbiomes are important to animal health. Thus, by examining the hybrid microbiomes they can get a sense of whether hybrids have advantages or disadvantages relative to their parent species.

Student Involvement:

Students will participate primarily in lab work, learning skills like DNA extraction, library prep and PCR. Students will also learn basic bioinformatics pipelines for analyzing 16S rRNA data and interpreting microbiomes (R). Because of the time involved, the datasets and analysis that the students work on will be distinct from the datasets they are generating in the lab.

Required Skills / Prerequisites:

No skills or knowledge are required, though students should enjoy lab work and be comfortable/enjoy learning quantitative skills (i.e., not math phobic).

Expected Outcomes:

The students will learn to use software like Qiime (including basic command line) and R. They will also learn methods for 16S rRNA sample preparation. Interested students who choose to continue on in the lab will have the opportunity to be authors on publications, but this will not be guaranteed if students only participate in the EUREKA! program.

Future Opportunities:

Students can join the lab through a variety of mechanisms, including CI, volunteer, Federal Work Study, etc. depending on their interests and financial situation. Students who continue on in the lab will be able to participate in other dimensions of the project, for example fieldwork collecting microbiome samples. They will also be encouraged to participate in other related projects on other species groups (lizards, fish, etc.)

Research Location:

Main Clemson University Campus

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Project Title: Assessment of Histomonas meleagridis Toxicity Utilizing a Chicken Cell Culture Model: An Investigation into the Pathogenicity of the Agent Responsible for Lethal Blackhead Disease in Turkeys

Mentor: Zhicheng Dou, Associate Professor
Department: Biological Sciences

Project Description:

Histomonas meleagridis is responsible for causing the lethal blackhead disease in turkeys. This pathogen is capable of breaching the turkey's epithelial barrier during infection, allowing entry into the circulatory system and triggering severe inflammation in various organs, such as the liver. However, the precise molecular mechanisms governing the crossing of the epithelial barrier by Histomonas remain elusive. To address this gap, developing an in vitro tissue culture model is imperative. In this proposed project, students will cultivate a chicken cell line to assess the extent of host cell damage by Histomonas parasites using advanced imaging techniques. Additionally, the project will focus on elucidating the molecular pathways through which these parasites harm host cells.

Student Involvement:

The students will collaborate as a team along with the laboratory Principal Investigator and graduate students to conduct the experiments. Their tasks include culturing the chicken HD-11 cell lines to establish a tissue culture model for Histomonas infection. Furthermore, they will evaluate various inhibitors to assess their effectiveness in controlling Histomonas infection using the tissue culture model.

Required Skills / Prerequisites:

General biology lab skills from high school is highly preferred.

Expected Outcomes:

If the students are interested in this project, they are encouraged to take Dr. Dou's creative inquiry course or undergraduate research course later.

Future Opportunities:

Dr. Dou offers Creative Inquiry and undergraduate research courses. The students from these courses have opportunities of presenting their research findings in local and regional meetings and publish them on the journals.

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Main Clemson University Campus

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Project Title: A Microscale Approach to Mimic Cancer Cell Circulation and Metastatic Seeding
Mentor: Adam Melvin, Associate Professor
Department: Chemical and Biomolecular Engineering

Project Description:

The goal of this project is to develop microfluidic devices capable of recreating the biophysical forces cancer cells are exposed to during metastatic spread and then growing these cells using 3D culture (and co-culture) in the form of tiny tumors called spheroids. The development of this technology will provide new insight into how cancer cells gain a competitive advantage during metastasis.

Student Involvement:

The students will be expected to perform nearly all hands-on tasks associated with the project. This can include performing cell culture, fabricating microfluidic devices, assembling the devices, optimizing device parameters and using the device(s) to study various biological outcomes. It is the intent to have the student be an active, contributing member of the group.

Required Skills / Prerequisites:

No specific skills are required for the students to be involved in this project.

Expected Outcomes:

Ideally the students would like to continue working on the project through the CI program which, with continued involvement, could lead to presentations (local, regional, national), and publications.

Future Opportunities:

All students will be invited to continue the work through the Clemson Creative Inquiry program as all of these projects are associated with active CIs lead by Dr. Melvin.

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Main Clemson University Campus

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Project Title: Predicting Protein Levels from mRNA Levels
Mentor: Marc Birtwistle, Associate Professor
Department: Chemical and Biomolecular Engineering

Project Description:

The central dogma of molecular biology gives rise to the expectation that as mRNA levels rise and fall, protein levels will follow suit. However, it is now appreciated that this is an exception rather than the norm. For which human genes does such quantitative central dogma thinking hold? How well can we predict protein levels given measurement of mRNA levels? Are there classes of gene function that are enriched for adherence or non-adherence to the central dogma? This project uses analysis of large publicly available datasets to answer these fundamental biological questions.

Student Involvement:

Students will learn how to use modern bioinformatics techniques to analyze proteomics and mRNA sequencing data that are publicly available. They will also develop skills in and use python to create code pipelines for analyzing such data. Students will develop an understanding of gene ontologies and how to analyze for enrichment of gene sets.

Required Skills / Prerequisites:

Some basic programming knowledge (Python preferred) would be beneficial.

Expected Outcomes:

The research will hopefully lead to publication.

Future Opportunities:

continue the research project in the lab

Research Location:

Main Clemson University Campus

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Project Title: Identification of Paracrine Signaling between Cancer Cells and Healthy Cells in the Tumor Microenvironment

Mentor: Adam Melvin, Associate Professor

Department: Chemical and Biomolecular Engineering

Project Description:

The goal of this project is to develop a microscale technology capable of the dynamic co-culture (and tri-culture) of cancer cells, stromal cells, and immune cells to elucidate the biomolecules utilized by cancer cells to force healthy cells to switch from an 'anti-cancer' phenotype to a 'pro-cancer' phenotype.

Student Involvement:

The students will be expected to perform nearly all hands-on tasks associated with the project. This can include performing cell culture, fabricating microfluidic devices, assembling the devices, optimizing device parameters and using the device(s) to study various biological outcomes. It is the intent to have the student be an active, contributing member of the group.

Required Skills / Prerequisites:

No specific skills are required for the students to be involved in this project.

Expected Outcomes:

Ideally the students would like to continue working on the project through the CI program which, with continued involvement, could lead to presentations (local, regional, national), and publications.

Future Opportunities:

All students will be invited to continue the work through the Clemson Creative Inquiry program as all of these projects are associated with active CIs lead by Dr. Melvin.

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Main Clemson University Campus

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Project Title: Harnessing the Power of Artificial Intelligence and Deep Eutectic Solvents to Boost Antioxidant Power

Mentor: Carlos Garcia, Professor

Department: Chemistry

Project Description:

Despite more than 150 years of research, lipid oxidation remains a major challenge for the food industry due to the complexity of the products and the multiple elements that influence oxidation. Chemically, the oxidation of lipids is a dynamic process that leads to the formation of volatile compounds (carboxylic acids, aldehydes, and ketones) that impart unpleasant flavors and decrease the overall quality of food (appearance, texture, etc.). To control this process, antioxidants are commonly added to foods, often in combinations of two or more compounds, that aim to combine multiple mechanisms. When it works, this strategy effectively increases the total antioxidant capacity of the mixture and allows one to decrease the total amount of antioxidant used and/or extend the shelf-life of foods. This project seeks to leverage the power of artificial intelligence and data science to streamline the development of novel antioxidant formulations. Students will leverage and expand the team's existing deep eutectic solvent (DES) AI model to develop the first series of functional DES, integrating synergistic mixtures of antioxidants in their structure.

Student Involvement:

Students will also experimentally verify the predictions of the team's models using real samples of fats (lard, tallow, chicken) and oils (soybean, rapeseed, olive). These results will allow the team to compare the oxidation process for bare samples with samples mixed with the individual antioxidants, samples mixed with synergistic mixtures, and samples mixed with the DES forms of the synergistic combinations.

Required Skills / Prerequisites:

Basic chemistry knowledge is required and experience with python / AI is beneficial.

Expected Outcomes:

The students will present a poster at the end of the program and hopefully publish their work.

Future Opportunities:

Students will have opportunities for professional development throughout their time working on this project.

Research Location:

Main Clemson University Campus

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Project Title: Observing RNA Sugar Pucker Using Single-Molecule Atomic Force Microscopy
Mentor: David Jacobson, Assistant Professor
Department: Chemistry

Project Description:

The nucleic acids (DNA and RNA) store and transmit genetic information in cells. Although both have similar chemical structures consisting of an alternating backbone of phosphate groups and sugar rings with attached bases, subtle differences cause the RNA sugar to occur in a compact configuration whereas the DNA sugar occurs in an extended configuration (referred to as having different "sugar pucker"). Quantum chemistry calculations have predicted the degree of thermodynamic stability of the compact configuration in RNA, but no experimental measurements have tested this value. The goal of this project is to use an atomic force microscope (AFM) to exert mechanical force on an RNA chain to induce the transition between compact and extended sugar pucker. The force at which this transition occurs will reflect the energetic difference between the configurations, since work equals force times distance. Such information would contribute to the basic physical-chemical understanding of one of the most important molecules in biology.

Student Involvement:

The major tasks the student will undertake will be (1) preparing a single-stranded RNA sample using molecular biology/biochemical techniques, (2) confirming size and purity of the sample using gel electrophoresis, (3) using surface chemistry to attach the sample to a glass substate and to the AFM cantilever, and (4) performing the AFM experiment itself.

Required Skills / Prerequisites:

No specific prior skills, other than an interest in chemistry/biophysics are required.

Expected Outcomes:

The project will expose the student to basic biological and chemical laboratory techniques, as well as to using cutting-edge single-molecule biophysics approaches.

Future Opportunities:

It is hoped that the student will want to continue this research during their time at Clemson, leading to a publication of their results in the scientific literature. Beyond the basic measurement of thermodynamic stability, there are interesting questions to be asked about how nucleic-acid sugar pucker depends on the sequence of bases, which are the part of the molecule that contain the genetic information.

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Main Clemson University Campus

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Project Title: Designer Crystals and Tunable "Green" Solvents
Mentor: William Pennington, Alumni Distinguished Professor and Chair
Department: Chemistry

Project Description:

Our group studies intermolecular interactions, not the bonds in a molecule, but the "bonds" between molecules. These interactions are of primary importance for determining the physical (and sometimes chemical) properties of a substance. In particular, we are interested in halogen bonds, which are very similar in strength and character to more familiar hydrogen bonds, the intermolecular interaction responsible for water being a room-temperature liquid and for holding our DNA together. Our focus is on using halogen bonds to design cocrystalline materials (i.e. crystals made up of two or more different molecules) and deep eutectic solvents, which are formed by combining two or more solid substances to form a physical mixture which is a liquid at room temperature. As an example of the utility of cocrystals, consider a new drug that might be very effective at treating a disease, such as diabetes. If the drug is not soluble in our biological system, then it isn't available in the body to attack the disease. By combining the drug molecule with a very soluble partner, a cocrystal can be made which is soluble in our biological system, so the cocrystal acts a drug delivery device to enhance the medicinal value of the drug. Alternatively, if two different molecules combine to form a physical mixture (as opposed to a cocrystal which is more of a chemical mixture), the properties of either substance will be affected by the presence of the other. The most common property to be affected is the melting point, and the melting point of a physical mixture will always be lower than that either component. Putting salt on an icy street is a great example of this. the ice and salt combine to form a physical mixture with a lower melting point than that of ice, so the ice will melt even though the temperature is below the freezing point of water. If the two components interact strongly with each other, as through hydrogen bonds or halogen bonds, the freezing point may be deeply depressed (to a much lower temperature than that of an ideal mixture). If such a mixture is a liquid at room temperature, it is called a deep eutectic solvent (DES). We are making DESs that utilize halogen bonding and we have found that these may be useful for remediation of pollutants from water and for serving as very effective electrolytes for electronic devices such as dye-sensitized solar cells and lightweight batteries.

Student Involvement:

Students in our lab will work under the supervision of a graduate student. They will explore various combinations of substances to make either cocrystals of DESs. Once made, they will be analyzed through a variety of techniques to

identify the role of the halogen bonds and to understand the correlation between the structure of the material and it's properties. The goal will be to prepare cocrystals with more desirable physical properties for a given function or to make DESs that are effective for pollutant remediation.

Required Skills / Prerequisites:

Only a very basic knowledge of the fundamentals of chemistry is needed. Anything else will be taught as we go, and the best way to learn is to "do!"

Expected Outcomes:

It is our expectation that our students will be coauthors on peer-reviewed journal articles based on our results and that they will be given the opportunity to present their work at professional conferences. After working on the project they will be exposed to a number of new techniques including structural analysis using X-ray diffraction, thermal analysis and various spectroscopic methods. We are also incorporating more computational analysis into our project, and students will be able to learn how to use a variety of software packages.

Future Opportunities:

While there is no obligation past the five week term of EUREKA! we invite our students to continue working on their projects as they progress throughout their academic career. Most of our EUREKA! students have done this, and many have ended up with several papers and having given a number of presentations.

Research Location:

Main Clemson University Campus

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Project Title: Bio-inspired Drilling into Lunar Regolith
Mentor: Qiushi Chen, Associate Professor
Department: Civil Engineering

Project Description:

NASA's Artemis program aims to land the first woman and first person of color on the Moon and establish the first long-term presence on the Moon, using innovative technologies to explore more of the lunar surface than ever before. Recently, plants and animals and their burrowing mechanisms have become a source of inspiration for novel terrestrial subterranean robots. While still in its infancy, bio-inspired solutions have great potential for NASA's space exploration applications. In this EUREKA! project, students will develop an initial understanding of icy lunar regolith, investigate various bio-inspired drilling and burrowing technologies, and explore their potential as an innovative, energy-efficient solution for in situ characterization and drilling into lunar regolith.

Student Involvement:

The research interns will work within a team of graduate and undergraduate students and faculty mentor. In this research, students will aim to answer the following key research questions:
(1) what are nature's (i.e., plants and animals) solutions to drilling and burrowing into earthen regolith?
(2) what bio-inspired drilling and burrowing technologies have been developed, their hypothesis, and limitations (in particular, limitations with respect to potential lunar applications)?
(3) what are the fundamental material properties of icy lunar regolith and the technical challenges when drilling icy lunar regolith?
Revolving around these research questions, the following activities are planned for the interns:
(1) Survey and understand different types and mechanisms of drilling and burrowing in nature.
(2) Conduct a state-of-the-art review of bio-inspired drilling and burrowing technologies, develop an understanding of bio-inspired design and engineering, and identify 1-2 candidate technologies for lunar drilling applications.
(3) Compile a knowledge base of icy lunar regolith and assist graduate students with ongoing research efforts to experimentally characterize lunar regolith.
(4) Assist graduate students with the modeling of the drilling into lunar regolith, help process research data
(5) Complete the required final report.

Required Skills / Prerequisites:

Students should have strong motivation and interest in NASA research. They should also be able to critically analyze and process technical information from a variety of resources (technical papers, reports, websites, databases, etc.). Students need to be familiar with Microsoft Office and willing to learn new experimental methods and new computer software.

Expected Outcomes:

The interns can present their research outcomes at Clemson's Annual Summer Undergraduate Research Poster Symposium.

Future Opportunities:

"After the interns complete their research experience, there are multiple opportunities to continue getting involved:
(1) Creative Inquiry: students may choose to join Dr. Chen's Creative Inquiry project (#1016 Martian and Lunar Soil Simulants – Characterizations and Feasibility as Building Materials; course number: CE1990/2990/3990-123) in Fall, Spring or Summer semesters.
(2) NASA SC Space Grant Consortium (SCSGC) projects: Dr. Chen has multiple ongoing SCSGC projects that hire and support undergraduate students to conduct NASA-related research."

Research Location:

Main Clemson University Campus

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Project Title: How to Build a Large Language Model (From Scratch)
Mentor: Kai Liu, Assistant Professor
Department: Computing

Project Description:

Large Language Model (LLM), a language model notable for its ability to achieve general-purpose language generation and understanding, has been extremely successful and widely used in many domains. The team will discover how LLMs work from the inside out and build their own small-but-functional model for educational purposes mirrors the approach used in creating large-scale foundational models such as those behind ChatGPT.

Student Involvement:

Students will learn how LLM works and the principles before writing the codes and implementing the model step by step as a team under the faculty's guidance.

Required Skills / Prerequisites:

Students should be fluent in Python and Pytorch.

Expected Outcomes:

Students will build and train a LLM for a specific domain (say US. history or mathematics history) which will inspire others for different areas.

Future Opportunities:

If students successfully complete the project, they are expected to submit one paper to a prestigious conference venue and there are numerous industry internship opportunities upon its success.

Research Location:

Main Clemson University Campus

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Project Title: Ensuring Privacy Compliance in Software Development

Mentor: Long Cheng, Assistant Professor

Department: Computing

Project Description:

With the rise of appification, many open platforms across web, IoT, virtual reality, and autonomous vehicles domains allow third-party developers to create and publish applications (apps) on different app stores, such as Chrome plugins store, Amazon Alexa skills store, and Samsung SmartThings apps store. These apps may collect massive personal information from users. Under these circumstances, it is essential to comply with privacy regulations (such as GDPR, HIPPA, and CCPA) and obtain appropriate consent when collecting, processing, and storing personal data through apps. Transparent privacy policies should be provided by third-party developers to inform users about the purposes, scope, and retention of data collected. Privacy non-compliance issues are quite serious and could lead to costly fines. For example, Amazon recently paid a $25M fine for violating children's privacy with Alexa. In this project, students will learn to use existing tools and natural language processing (NLP) technologies to identify privacy non-compliance issues within privacy policy documents on different platforms.

Student Involvement:

In this project, the team will perform data analysis of Privacy Compliance in Emerging Appified Platforms. The team plans to design a set of tools to facilitate third-party developers in creating privacy-compliant apps in different platforms, including 1) Nature Language Processing (NLP)-based data practice analysis of privacy policies, 2) privacy non-compliance detection with static code analysis, 3) privacy non-compliance detection with static analysis, and 4) automatically generating easy-to-digest privacy policy from app code.

Tentative student activities include working on privacy regulations (students will get familiar with Privacy regulations such as GDPR, CalOPPA, and CCPA, and learn what information should be included in a privacy-compliant software application), data collection (students will learn how to gather a privacy policy dataset from app stores) and privacy policy analysis (students will learn how to use Large Language Models (LLMs) such as ChatGPT to automatically analyze privacy policy documents and detect potential privacy non-compliance issues).

Required Skills / Prerequisites:

Students should possess basic programing skills, in particular Python programing language.

Expected Outcomes:

We expect research interns to be involved in a paper publication.

Future Opportunities:

Research interns have opportunities to continue to do undergraduate research after the summer program ends.

Research Location:

Main Clemson University Campus

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Project Title: Machine Learning-based 3D Reconstruction
Mentor: Siyu Huang, Assistant Professor
Department: Computing

Project Description:

The team will take photos of scenes with smart phones, then the goal is to reconstruct a high-quality 3D model of scenes from these photos. The project involves developing new machine learning methods for those challenging novel view synthesis problems.

Student Involvement:

Students will work as a team. Students will first learn the basics of machine learning and computer vision (especially 3D vision). Then, they will be guided to implement and improve existing state-of-the-art novel view synthesis methods.

Required Skills / Prerequisites:

Students should possess basic knowledge in linear algebra and probability as well as coding in Python and Pytorch.

Expected Outcomes:

Novel and promising results will be extended into top-tier conference submissions.

Future Opportunities:

Excellent and motivated students will have the opportunity to work on research projects in the lab in the future.

Research Location:

Main Clemson University Campus

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Project Title: Physics-based Deep Learning for Computer Vision
Mentor: Nianyi Li, Assistant Professor
Department: Computing

Project Description:

Motion field is defined as the projection of image velocity of 3D surface points onto the imaging plane of a visual sensor. Understanding and computation of the motion field of natural scenes is a fundamental problem of numerous vision-based technology, which includes video compression, image interpolation, image-based 3D reconstruction, robotics navigation, object segmentation and tracking etc. In this project, students will learn how to use machine learning methods to build computational motion field models.

Student Involvement:

Research interns will work as a team to construct the deep learning models to predict object's moving track by taking a video as input. Each member will work on both algorithm development and data collection.

Required Skills / Prerequisites:

Students should have a good background in algebra and calculus, and know at least one kind of high-level programming language such as JAVA, C++, and C#.

Expected Outcomes:

1) Student will learn Python programing language.
2) Students are able to understand the basic idea of machine learning and deep learning algorithms.
3) Students can use deep learning methods to predict motion field of moving object.

Future Opportunities:

Research Interns with good performance are able to continue working in the lab as paid undergraduate research members

Research Location:

Main Clemson University Campus

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Project Title: Adaptive Multi-Tiered, Multi-Task Base Station Infrastructure For Communication-Denied Environments

Mentor: Fatemeh Afghah, Associated Professor

Department: Electrical and Computer Engineering

Project Description:

"This project explores ways to improve how cellular networks work, especially during tough times like natural disasters or emergencies. Right now, these networks can sometimes struggle to stay reliable when there's a lot of demand or if something happens to the towers that send out signals.

To tackle this issue, the team is looking into using special flying and driving machines called autonomous unmanned aerial vehicles (UAVs) and autonomous vehicles. These machines can quickly set up temporary cellular networks, providing communication services in places where they're needed most. But they can do more than just that – they can also help with things like making maps of big areas fast, working in dangerous areas, delivering emergency supplies, and finding and rescuing people.

The main goal is to create a smart system called an aerial and vehicular base station (MTBS) that can adapt and do lots of tasks at once. This system will make the cellular network coverage better and make sure the service is top-notch, even in tricky situations.

The research team is also working on some important research parts of the project. First, they are figuring out how to make models and plans for the UAVs and base stations so they can work well in places like disaster zones. Second, the team is designing ways to plan the routes these machines take to make sure they use their time and energy efficiently. And finally, they are testing everything out in special test environments to make sure it all works like it should.

The cool thing is, when they are done, they will have some tools and programs that teachers and professionals can use to learn more about this kind of technology. It's all about making sure the team is ready to help out when things get tough."

Student Involvement:

"The research interns will work with the team on exciting tasks. Interns will either help the team create models and plans for the flying and driving vehicles the team will use in the project, or design trajectories for these vehicles to follow so they can perform their tasks in an optimized way.

Interns will also assist the team in testing how well the system works. The team will use special computer programs and test environments to simulate different situations and see how the technology holds up. Interns will use cool testbeds like POWDER and Colosseum, along with network simulators like ns-3 and Omnet++, to help with these tests."

Required Skills / Prerequisites:

"The interns are expected to have at least one of the following skills:
i) Programming
ii) Strong mathematical background
iii) Hands-on experience for working with basic tools
iv) Machine learning knowledge"

Expected Outcomes:

The interns, based on the tasks that will be assigned to them, will learn how to use the corresponding testbed or simulator. They will learn how to collect data and perform performance evaluations. The work will hopefully lead to publication, so the students will learn how to write and prepare a research paper.

Future Opportunities:

Such a valuable research experience will prepare the students for the next chapter of life whether it will be a graduate program or industrial company. It will strongly enrich their resume and is considered as a showcase for their ability.

Research Location:

Main Clemson University Campus

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Project Title: Exploring Security Threats to the Use of Smartphones
Mentor: Lan Zhang, Assistant Professor
Department: Electrical and Computer Engineering

Project Description:

This project aims to explore security threats to the use of smartphones, arising from recent advances in artificial intelligence technologies as well as new hardware features.

Student Involvement:

There are several internship positions available for working in teams to explore security threats in smartphone use. The mentor will assign tasks based on personal interests and expertise.

Required Skills / Prerequisites:

Interns are expected to be familiar with smartphone platforms, such as Android, and/or have some background in artificial intelligence technology.

Expected Outcomes:

Other outcomes include smartphone related datasets, open-source code, and potential publications.

Future Opportunities:

Students will gain research expertise regarding software and hardware smartphone platforms as well as certain AI expertise.

Research Location:

Main Clemson University Campus

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Project Title: Evaluation of Large Language Models

Mentor: Yongkai Wu, Assistant Professor

Department: Electrical and Computer Engineering

Project Description:

This project aims to develop a comprehensive evaluation platform for assessing the capabilities and performance of large language models (LLMs), such as ChatGPT. In the era of AI and machine learning, LLMs have emerged as powerful tools for processing and generating human-like text, making it crucial to evaluate their abilities accurately. This platform will serve as a critical resource for researchers, developers, and educators to benchmark LLMs across various metrics, including accuracy, fairness, bias, and creativity.

Student Involvement:

Interns will be directly involved in conceptualizing, designing, and developing the evaluation platform. Responsibilities will include literature review, metric design, programming, data analysis, and documentation.

Required Skills / Prerequisites:

Basic Python programming experience is required. Students should also possess the ability to analyze complex data and draw meaningful conclusions. Strong written and verbal communication skills for documentation and presentation purposes is also needed.

Expected Outcomes:

Publication and new software. The results will be wrapped up and published in top AI venues. The evaluation platform will be released as open-source software.

Future Opportunities:

Upon completion of their research experience, students may have opportunities to:
Co-author research papers or publications based on their findings.
Present their work at conferences or seminars.
Collaborate with researchers and professionals in the field of AI and machine learning.
Continue their research in advanced studies or professional projects.

Research Location:

Main Clemson University Campus

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Project Title: Generative AI for Phenotypic Drug Discovery
Mentor: Xiaoyong (Brian) Yuan, Assistant Professor
Department: Electrical and Computer Engineering

Project Description:

This project aims to develop a novel generative AI tool (e.g., diffusion models) to enrich high-content cellular data for improving drug discovery.

Student Involvement:

The research intern will collect public high-content cellular data for morphological profiling and develop a generative AI tool for data augmentation. The research intern will be involved in the whole pipeline of research, including data collection, data preprocessing, program development, and evaluation.

Required Skills / Prerequisites:

Programming experience is required. Knowledge about Python and machine learning is preferred.

Expected Outcomes:

The expected outcomes include the preprocessed datasets and the developed AI tool with source code and the documents.

Future Opportunities:

The students will have opportunities to publish and present papers at top AI and biomedical conferences and release open-source code repository.

Research Location:

Main Clemson University Campus

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Project Title: Radio Frequency Lab-on-Chip
Mentor: Pingshan Wang, Professor
Department: Electrical and Computer Engineering

Project Description:

What is the next big thing after computing technology that changed the world? What is the new field that challenges one's imagination and creativity? The research team believes it is how to shrink centralized analytical labs and put their analytical capabilities in people's hands, just like the computing power and communication convenience they enjoy with their laptops and cell phones. At Clemson, the research team is developing radio frequency (RF) lab-on-chip (LOC) science and technology to capture, analyze, and identify single microorganisms, including bacterial cells and viruses in environmental samples. The development involves many aspects of electrical and computer engineering (including software defined radio, measurement system control, and quantum computing), computer science (including machine learning), mechanical engineering (including microfluidics and 3D printing), biology (including metabolism), and bioengineering (including noninvasive cell selection). Therefore, the multidisciplinary RF-LOC platform offers rich opportunities for exploration.

Student Involvement:

The research interns are encouraged to contact the professor and discuss about specific research interests and topics. The interns will work in a group mostly mentored by a graduate student.

Required Skills / Prerequisites:

Students should have exposure or hands on experience that is related to the aspects in project description.

Expected Outcomes:

The team will develop various electrical instruments, new software, 3D printing, etc.

Future Opportunities:

Sucessful students could continue to work with the research team in the Fall.

Research Location:

Main Clemson University Campus

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Project Title: Understanding the Experiences of Neurodivergent Learners in Higher Education
Mentor: Matthew Boyer, Research Associate Professor
Department: Engineering & Science Education

Project Description:

"Neurodivergent individuals are those who have atypical neurological development, including but not limited to autism, ADHD, dyslexia, and other conditions. While the number of neurodivergent students in higher education is increasing, there is a lack of research on how the university environment impacts their experiences. The goal of this project is to develop a deeper understanding of the experiences of neurodivergent learners in higher education by exploring the following research questions:

- What challenges do neurodivergent learners face in higher education, and how do they impact their academic performance?
- What strategies do neurodivergent learners use to overcome these challenges and succeed academically?
- What kind of support do neurodivergent learners receive from the university, and how effective is it in helping them succeed?

The project will use a mixed-methods approach, including quantitative and qualitative data. The research methods will include surveys, interviews, and possibly focus groups. The research team will use surveys to collect quantitative and qualitative data on the challenges that neurodivergent learners face and the support they receive. The team will use interviews and possibly focus groups to collect qualitative evidence on the experiences of neurodivergent learners. This research project will provide a valuable opportunity for the student interns to learn research methods and develop data collection, analysis, and presentation skills."

Student Involvement:

"The research interns will play an essential role in the research project and be involved in various stages of the research process. Specifically, their involvement will include the following.

Literature Review: The research interns will work closely with the project supervisor to comprehensively review the literature on neurodivergent learners in higher education. Creating the review will include searching relevant academic databases, reading and summarizing research articles, and identifying research gaps.

Data Collection: The research interns will assist in the data collection process, which will involve preparing survey questionnaires, conducting interviews, and organizing focus groups. They will also help in the recruitment of participants and scheduling of data collection sessions.
Data Analysis: The research interns will assist in analyzing the quantitative and qualitative data. The analysis will involve organizing and cleaning data, running statistical tests, and exploring the themes and patterns that emerge from the qualitative data.
Poster Presentation: The research interns will work with the project supervisor to develop a poster summarizing the research findings. They will be responsible for designing the poster layout and contributing to developing the content.
The interns will develop research methods, data collection, analysis, and presentation skills. They will receive guidance and support throughout the research process and will be encouraged to participate in regular team meetings to discuss their progress, ask questions, and provide feedback. By the end of the project, the research interns will have gained valuable experience conducting research and presenting findings at the poster forum."

Required Skills / Prerequisites:

"While interns don't need previous research experience, they should be interested in research and willing to learn new skills and techniques throughout the project.
To participate in this research project, the interns should have the following skills, experiences, and knowledge:
- Strong communication skills: The interns should have excellent oral and written communication skills to communicate effectively with research participants, supervisors, and team members.
- Attention to detail: The interns should have excellent attention to detail to ensure that data collection is accurate and complete.
- Organizational skills: The interns should have strong organizational skills to manage and prioritize tasks and meet project deadlines.
- Proficiency in Microsoft Office and/or Google Apps
- Interest in neurodiversity: The interns should have an interest in neurodiversity and a desire to learn more about the experiences of neurodivergent learners in higher education."

Expected Outcomes:

"The expected outcomes of this research project are as follows:

A deeper understanding of the experiences of neurodivergent learners in higher education: The research findings will contribute to our understanding of the challenges that neurodivergent learners face in higher education and the strategies they use to overcome them. Additionally, the research will provide insight into the kind of support universities can provide to better meet the needs of neurodivergent learners.
A poster presentation: The research interns will be able to develop skills in presenting research findings by creating a poster that summarizes the project's key findings. They can present the poster at the poster forum, where they can share their work with other researchers and university community members.
Experience in research methods: The research interns will have the opportunity to gain experience in research methods, including literature reviews, data collection, data analysis, and presentation development. They will also gain exposure to various research techniques, such as surveys, interviews, and focus groups.
Collaboration skills: The research interns will be able to work collaboratively with their supervisor and other team members, allowing them to develop teamwork and collaboration skills.
Knowledge of neurodiversity: The research interns will gain knowledge and understanding of neurodiversity and the challenges that neurodivergent learners face in higher education. This knowledge will be helpful for anyone who plans to work with neurodivergent individuals in the future, whether in an academic or non-academic setting.
Additionally, the research findings may be published in academic journals, allowing the interns to be recognized as contributors to academic research."

Future Opportunities:

"Completing this research experience can open up several opportunities for students, including:
Continuing this work: Future opportunities for collaboration with Dr. Boyer and fellow student researchers in the ongoing Creative Inquiry project #2293 on this line of research and development.
Enhancing their resume: Participating in a research experience is an impressive addition to any resume, demonstrating the student's dedication to their field and ability to conduct independent research.
Networking: Research experiences allow students to network with other researchers, professors, and professionals. These connections can be valuable for career development and may lead to future research opportunities.
Opportunities for publications and presentations: If the research findings are significant, students may have opportunities to publish their work in academic journals or present at conferences. Publications and presentations can be valuable additions to their resume and help them establish themselves as emerging experts in their field.

Improved critical thinking and problem-solving skills: Research experiences require students to analyze complex data and draw conclusions based on evidence. Research experience can help students develop valuable critical thinking and problem-solving skills in any career path.
Engaging in a research experience can provide students with various opportunities that can be valuable for career development and personal growth. By participating in this research project, students can gain experience in research methods, develop teamwork and collaboration skills, and gain knowledge of neurodiversity, which can open up a range of future opportunities."

Research Location:

Main Clemson University Campus

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Project Title: Understanding of Retort Processing for Food Safety and Shelf Life of Food Products

Mentor: Sneh Bangar, Post-doctoral fellow

Department: Food, Nutrition and Packaging Sciences

Project Description:

Retort (Thermal) processing is a method for preserving food products by subjecting them to heat (240-250°F or 115-121°C) and pressure (around 15-20 psi or 1-1.4 bar), to ensure that the food remains safe while preserving its quality and value. The main purpose of this treatment is to eliminate microorganisms like Clostridium botulinum to achieve a "Commercially sterile" status for the food. With the increasing demand for lasting and high-quality food items, retort processing has gained importance in the food industry. This preservation technique significantly prolongs the shelf life of fresh produce, enabling longer storage periods without refrigeration, which is particularly beneficial for distribution and retail purposes. While retort processing may slightly affect texture, flavor, and color, it generally preserves the nutritional content of the produce, making it a versatile and effective method for ensuring food safety and quality throughout the supply chain.

Student Involvement:

This project specifically concentrates on the retort processing of low-acid foods. For those engaging in the proposed initiative online, a comprehensive series of PowerPoint presentations, literature reviews, and interactive discussions will be orchestrated to impart to students a thorough understanding of food safety principles and the application of retort processing to enhance the shelf life of low acid foods. Those participating in the proposed project in person will work with graduate students to learn and gain hands-on experience in the retort processing of fresh produce, alongside engaging in packaging techniques and conducting shelf life studies.

The students participating in the project online will read and discuss related research papers on different food processing techniques (thermal and non-thermal), retort processing, food microbiology, and food safety. They will participate in all the online presentations and discussions and actively interact with our graduate students to become familiar with the basics of scientific research on food types and their preservation techniques. The students participating in the proposed project in person will work with graduate students to learn and gain hands-on experience

in the retort processing of fresh produce, alongside engaging in packaging techniques and conducting shelf life studies.

Required Skills / Prerequisites:

No specific skills are required for the students to be involved in this project. Knowledge learned from high school sciences courses will be enough to participate in the project.

Expected Outcomes:

The project would allow students to become familiar with the basics of various food processing techniques, retort processing, food microbiology, and food safety through hands-on experiments, the review and discussion of research papers, and participation in presentations and discussions. They will also be trained to read scientific literature as well as to prepare, present, communicate, and discuss scientific data with their peers and the general public.

Future Opportunities:

Following the EUREKA! Internship, the students could continue their research in the lab, gain more hands-on research experience, and have opportunities to present research data in professional meetings and publish their discoveries.

Research Location:

Main Clemson University Campus

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Project Title: AI in Biomedicine: Prediction of Novel Human Disease Genes by Genomic Data Mining

Mentor: LJ Wang, Associate Professor

Department: Genetics and Biochemistry

Project Description:

"In the human genome, most genes actually do not encode proteins; they are non-coding RNA genes. The largest class of non-coding genes is known as long non-coding RNAs (lncRNAs), which are transcripts greater in length than 200 nucleotides, but with no protein-coding capacity. While some lncRNAs have been demonstrated to be key regulators of gene expression and 3D genome organization, most lncRNAs are still uncharacterized. We have thus been developing artificial intelligence (AI) and machine learning approaches for the functional annotation of human lncRNAs through mining the vast amount of genetic and genomic data (""biological big data""). The team's recent studies demonstrate that genomic data mining can give insights into RNA functions and provide valuable information for experimental studies of candidate lncRNAs.

This research project will focus on the identification and functional analysis of novel candidate lncRNAs associated with human diseases, including autism spectrum disorders (ASD) and intellectual disability (ID). ASD and ID are clinically and genetically heterogeneous complex disorders, affecting up to 1% and 3% of the human population, respectively. ASD is characterized by impaired social communications and restrictive or repetitive behavior, whereas ID is recognized by diminished intellectual capacity and adaptive reasoning. Both disorders originate in early childhood, and involve a large number of genes essential for normal brain development and function. However, in most cases of ASD or ID, the specific genetic factors of the disorders are still unable to be determined. Until recently, only protein-coding genes were studied for their involvement in ASD and ID. It is thus likely that many of these disease-causing genetic factors may reside in lncRNAs, which are enriched in the brain. The research interns will learn how to build machine learning models for candidate disease gene prediction, and then utilize publicly available genetic and genomic data to further characterize and prioritize the candidate lncRNAs. The high-priority candidates identified in this project can not only provide new insight into the roles of lncRNAs in genetic brain disorders, but may also be further developed as biomarkers."

Student Involvement:

Research interns will be directly involved in the project. Each intern student, under the supervision of a graduate student, will learn how to build a machine learning model for candidate disease gene prediction and prioritization. They will also contribute to the further evaluation and curation of novel candidate lncRNAs associated with genetic brain disorders.

Required Skills / Prerequisites:

Research interns are expected to have good computer skills and understand the basic concepts of genetics. Although prior experience with computational research is not required, the interns are expected to be willing to learn basic AI/machine learning concepts and computer programming skills for genomic data mining.

Expected Outcomes:

The project will generate a prioritized list of candidate lncRNAs associated with genetic brain disorders. The findings can be used for presentations and publications. The intern students will also learn large-scale genomic data analysis and use of AI/machine learning techniques in biomedical research.

Future Opportunities:

The data analysis skills learned through this project can be useful for future careers in biomedical data science, bioinformatics, genomics, human genetics, and precision medicine.

Research Location:

Main Clemson University Campus

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Project Title: Plant Biotechnology for Enhanced Agricultural Production

Mentor: Hong Luo, Professor

Department: Genetics and Biochemistry

Project Description:

Environmental stress is one of the most important factors impacting agriculture production. Plant genetic engineering using molecular cloning and transgenic approaches has been playing an increasingly important role in modern agriculture. Development of novel molecular strategies to genetically engineer important crops will lead to new cultivars with beneficial new traits, enhancing crop yield. This project focuses on manipulation of expression of several stress-related candidate genes in transgenic rice and turfgrass plants to achieve enhanced plant performance under adverse environmental conditions such as drought and salt stress, improving agriculture production and economy.

Student Involvement:

The students participating in the project online will read and discuss related research papers on plant molecular biology, plant genetic engineering and molecular mechanisms of plant-environment interaction. They will participate in all the online presentations and discussions, and actively interact with Dr. Luo, graduate students and post-doc researcher to become familiar with the basics about scientific research, gene cloning, gene functional characterization and chimeric gene construction as well as plant genetic transformation and transgenic analysis. The students participating in the proposed project in-person will work with graduate students to learn and gain hands-on experience in gene cloning, chimeric gene construction, plant genetic transformation and transgenic analysis.

Required Skills / Prerequisites:

No specific skills are required for the students to be involved in this project. Knowledge learnt from high school biology courses will be good enough to participate in the project. The students will be trained to learn basic molecular and cell biology techniques including DNA and RNA extraction, DNA cloning, plasmid construction, PCR, plant tissue culture and plant genetic transformation.

Expected Outcomes:

The project would allow students to become familiar with the basics about scientific research, gene cloning, gene functional characterization and chimeric gene construction as well as plant genetic transformation and transgenic

analysis. They will also be trained to read scientific literature, to prepare, present, communicate and discuss scientific data to their peers and general public.

Future Opportunities:

The students could continue their research in the lab and gain more hands-on research experience and have opportunities to present research data in professional meetings and publish their discoveries. This experience has been very helpful for many students in their application for graduate school, medical school and other professional opportunities.

Research Location:

Main Clemson University Campus

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Project Title: DNA Repair and Genome Instability
Mentor: Michael Sehorn, Associate Professor
Department: Genetics and Biochemistry

Project Description:

The overall aim of the project is to understand the biochemical mechanism by which DNA repair proteins function in genome stability. This involves cloning of DNA repair genes and using PCR to introduce mutations into these DNA repair genes. The
mutations that the research team inserts into these genes provide a way to understand how the mutation affects the activity of the DNA repair protein. The intern will also express the protein in order to purify it. Once the protein is purified, the intern will biochemically
characterize the protein for DNA binding activity, protein-protein interactions and functional DNA repair assays. This project will provide valuable insight into the role these DNA repair genes play in maintaining genome stability.

Student Involvement:

The intern will perform the actual experiments (PCR, agarose gel electrophoresis, SDS-PAGE gel electrophoresis, protein expression, etc.). The student will be guided by graduate students, undergraduate students and the professor. Each person
in the lab has their own projects but they recruit other students and interns to help them complete the work for the project. Therefore, the individual activities performed by each person serve to help the collective of the lab to be successful.

Required Skills / Prerequisites:

The intern is not required to have any skills, experiences or knowledge of this project. The research team will train the intern to do the experiments they will conduct for their project. They find this helps build confidence for the intern in their newfound abilities.

Expected Outcomes:

Within the time frame of the EUREKA! program, the intern will be able to generate data that is appropriate for the poster session. The eventual goal of the project is to produce data that would be published in a peer-reviewed journal.

Future Opportunities:

At the end of the EUREKA! program, the intern will have the opportunity to continue in the lab for the duration of their time at Clemson should that be something they want to do.

Research Location:

Main Clemson University Campus

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Project Title: Exploring Microbial Interactions During Human Infection
Mentor: Stephen Dolan, Assistant Professor
Department: Genetics and Biochemistry

Project Description:

The research group studies microbial interactions in human infections, specifically complex communities formed by multiple species, resulting in polymicrobial infections. The current research is focused on understanding the mechanistic basis of polymicrobial interactions between fungi and bacteria during cystic fibrosis (CF) infection. Using clinical isolates, the research team is interested in how the physiology of both partners is altered upon co-culture in a recapitulated CF environment, when compared to monoculture. The research team's aim is to leverage their unique cross-kingdom insight to unravel how fungi respond to bacteria (and vice-versa) and other cues found in polymicrobial environments. This approach will be instrumental in developing new therapeutic interventions.

Student Involvement:

Research interns will be directly involved in generating gene deletions in pathogenic fungi and bacteria using CRISPR and other gene editing technologies. Interns will also be involved in screening mutant strains for a variety of clinically important phenotypes (growth, virulence, stress tolerance, etc.).

Required Skills / Prerequisites:

Interns will be shown the techniques required to succeed at this project. A strong understanding of statistical analysis methods, excellent note taking and observation skills would be a distinct advantage.

Expected Outcomes:

The expected outcomes of the team's work is always to publish high quality research in peer-reviewed journals. This process can take many years of experimental research and looking at the data in different ways. It is difficult for new students to attain this goal over a short research visit. Students will be encouraged to understand how their data fits into a gap in the literature.

Future Opportunities:

Students who complete their research experience would be in a competitive position to enter Dr. Dolan's laboratory as a undergraduate student (or other research laboratories at Clemson), where they can build on their research and move towards developing their own project.

Research Location:

Main Clemson University Campus

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Project Title: Thomas Green Clemson in Paris: 1826-1831

Mentor: Eric Touya, Professor

Department: Languages and Interdisciplinary Studies

Project Description:

"In 1826, supported by his father's trust fund, 20-year-old Thomas Green Clemson went on a grand tour of Europe. Clemson spoke French fluently and, while living abroad, studied at the Paris School of the Mines. He attended lectures of noted chemists Louis Jacques Thenard, Joseph-Louis Gay-Lussac and Pierre-Louis Dulong at the Sorbonne Royal College of France in Paris, one of the oldest institutions of higher education. He later studied at the chemical laboratory at Robiquet, completing his studies at the Royal School of Mines in Paris.

In June 1831, Clemson received his formal diploma as an assayer of mines from the French Royal Mint in Paris. With this degree in hand, he was internationally certified as a mining engineer. In addition to his studies, Clemson became interested in politics. As a student in Paris, he took part in the Revolution of 1830, which replaced Charles X with Louis-Philippe as king."

Student Involvement:

The student will do research on how Thomas Green Clemson's studies in Paris from 1826-1831 impacted his life and thinking. What did he study? Where? How did his studies impact his knowledge and research? How did living abroad and experiencing a different culture for five years shaped his academic, cultural and political thought? How did it shape his thinking on education? How did it possibly impact his future life as founder of Clemson University. The student will work with Dr. Touya exploring these questions and seeking answers in Paris via phone and email and at the Strom Thurmond Institute.

Required Skills / Prerequisites:

No specific skills are required to participate in this project.

Expected Outcomes:

In addition to the poster presentation, the student may continue to work on this research project beyond the summer.

Future Opportunities:

The student will work with Dr. Touya exploring the topic and seeking answers in Paris via phone, email and at the Strom Thurmond Institute.

Research Location:

Main Clemson University Campus

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Project Title: Using Machine Learning to Automate the Assessment of Creative and Entrepreneurial Personality

Mentor: Andrew Wang, Senior Lecturer

Department: Marketing

Project Description:

This study attempts to develop a machine learning model to automatically assess people's creative and entrepreneurial personalities (e.g., innovativeness, risk-taking propensity) by analyzing digital trace data. Students will assist the instructor in collecting, cleaning, and analyzing the data (e.g., social media posts, interviews, and startup pitch videos).

Student Involvement:

Students will be assigned different tasks based on their skills and academic background. In the first step, the instructor and students will work on data collection and cleaning. In the next stage, the instructor will split students into two teams. For students with computer programming and analytics skills, they will help the instructor develop machine-learning models and analyze the data. For students without computer programming skills, they will work with the instructor to conduct qualitative analysis and help draft an academic paper.

Required Skills / Prerequisites:

All students are welcome. A basic RStudio or Python skill is preferable, but it is not required. Students should be hard-working and strong motivation in research.

Expected Outcomes:

The research team plans to present the result at a marketing or management conference and publish our findings in an academic journal.

Future Opportunities:

Students would be welcome to continue participating in this research after EUREKA!

Research Location:

Main Clemson University Campus

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Project Title: Synthesis and Characterization of Magnetic Particles for Biomedical Applications

Mentor: Thompson Mefford, Associate Professor

Department: Materials Science and Engineering

Project Description:

The research team is focused on using magnetic particles for biomedical applications. Specifically, they are synthesizing particles for medical imaging (e.g., magnetic resonance imaging, MRI), targeted drug delivery, and removal of diseased tissue. Students will be producing particles with the correct physical attributes, biocompatible surface chemistry, and suitable surface functionality. Students characterize their materials with electron microscopy and magnetometry.

Student Involvement:

The laboratory works on a team effort approach. The students involved in this project will be integrated into existing work. For example, the student will be trained on the proper synthesis and characterization of nanoparticles. Following training the participants will be given a unique challenge within the project for them to solve. In the past this has been developing new techniques for non-destructive characterization of materials.

Required Skills / Prerequisites:

A successful student will have a strong background in chemistry and an eagerness to learn. In addition, the student must be willing to work individually as well as in a team. Good communication skills (both speaking and writing) are also important.

Expected Outcomes:

The results of this summer will be included in several developing publications focused on the dimensionality of materials and their interactions. This new information will also be presented at several national and international meetings.

Future Opportunities:

Based on performance, students will be given the opportunity to continue on their projects during the school year for either credit or salary. Previous participants have used their EUREKA! experience in Dr. Mefford's lab as a springboard toward other REU programs.

Research Location:

This project is located at the Clemson University Advanced Materials Research Lab (AMRL) (https://www.clemson.edu/ocpsi/cuicat.html) in the Research Park in Anderson, SC. Tiger Transit (https://www.clemson.edu/campus-life/parking/transit/campus-services/research-park.html) is available to transport students from the main Clemson campus to AMRL.

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Project Title: Bioinspired Structural Materials by Design

Mentor: Zhaoxu Meng, Assistant Professor
Department: Mechanical Engineering

Project Description:

Nature contains an arsenal of materials with excellent properties. These emergent superior properties are encoded in the intricate and sophisticated hierarchical structures, which offer unparalleled solutions for high-performance structural material designs.

The research project aims to develop and design advanced structural materials by drawing inspiration from various biological materials. EUREKA! research interns will participate in the group's research project of establishing computational models of materials systems (nanocomposites, nanofibrillar films, etc.) with bioinspired structures and understanding their mechanical properties through computational simulations. The research activities include reading scientific journal papers, learning essential skills to develop computational models for bioinspired material systems, conducting computational simulations on Clemson's high-performance computing cluster to study the mechanical properties of the material systems, and summarizing results.

Student Involvement:

The research interns can form a team and participate in the team's ongoing research projects. They will also learn how to construct computational models, conduct simulations, and analyze results from Dr. Meng and graduate student mentors. The research interns will have weekly meetings with Dr. Meng and more frequent communications with graduate students to discuss their questions and update results. They are also welcome to join biweekly group meetings to learn about research projects conducted by the graduate students.

Required Skills / Prerequisites:

Prior MATLAB or Python experience is preferred but not required. Students will also need to setup their Clemson VPN.

Expected Outcomes:

The research interns will learn critical skills for conducting computational materials science, which has a strong potential for revolutionizing materials design and development. They will also learn about research frontiers and develop a broader knowledge base and scientific perspectives. They can also publish journal articles as co-authors

with our group in reputable journals, which may give them the unique advantage for Fellowship or graduate school applications. Dr. Meng's prior undergraduate mentees are currently enrolling in graduate schools at Stanford, Northwestern University, UT Austin, etc.

Future Opportunities:

The research interns will have the opportunity to continue doing research with Dr. Meng's group and work on their Honors research thesis. With potential significant contributions to research projects, they will be included as co-authors for journal publications.

Research Location:

Main Clemson University Campus

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Project Title: Experimental and Computational Cardiovascular Research

Mentor: Ethan Kung, Associate Professor

Department: Mechanical Engineering / Bioengineering

Project Description:

In this project students will calibrate, prototype, and test devices that can improve the capabilities of a benchtop experiment which generates realistic pressure and flow waveforms mimicking human cardiovascular system. The ultimate purpose of such experiments is to provide a realistic benchtop environment that can be used to test cardiovascular medical devices and surgeries. The project may extend to computational modeling of the cardiovascular system and related medical devices.

Student Involvement:

In-person students will learn about how to conduct benchtop flow experiments and carry out technical work relating to obtaining accurate flow and pressure measurements, and prototyping solutions for how to generate proper pressure and flow in experiments. They will implement a combination of actuators and sensors to realize the design solution in a physical construction of the device prototype. Remote participants may perform computational modeling, simulations, and data analyses to answer scientific or clinical questions. The computational models that the research group employs include low-order circuits models and high-order 3D finite element models.

Required Skills / Prerequisites:

Students must have the ability to learn to use new engineering software and hardware, and be able to learn basic data processing and coding in Python or Matlab. The ability to grasp new scientific concepts is also helpful.

Expected Outcomes:

The program should result in the participants gaining the knowledge for how to conduct a cardiovascular related flow experiment or computational modeling. Products may include completed device calibration, advancements in device prototype development, new scientific findings, or computer simulation results that can aid clinical understanding of cardiovascular diseases.

Future Opportunities:

After EUREKA!, students may continue related research in Creative Inquiry or summer research.

Research Location:

Main Clemson University Campus

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Project Title: Alternative Therapeutics for Anti-Carcinogenic Assessment in Zebrafish Models of Human Breast Cancer

Mentor: Diana Ivankovic, Professor

Department: Nursing

Project Description:

The research group is assessing plant extract doses that will not kill the zebrafish embryos. They inject human breast cancer cells in the chest of the fish (near the heart) and allow for breast cancer to develop. They then expose the fish to the various plant extracts and, thanks to fluorescence, are able to see if the tumor shrunk and whether the blood vessels "feeding" the tumors have shrunk.

Student Involvement:

Students will be able to do toxicity assessments. They will observe how microinjections are done. They will learn how to do confocal and fluorescent microscopy. They will analyze collected data.

Required Skills / Prerequisites:

No previous skills are required.

Expected Outcomes:

Students will learn how to analyze data, familiarize themselves with confocal and fluorescent microscopy, as well as how to handle zebra embryos.

Future Opportunities:

After EUREKA!, students could join the healthcare genetics and genomics laboratory.

Research Location:

Main Clemson University Campus

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Project Title: Climate Resilient Crops for Food Security

Mentor: Sruthi Narayanan, Associate Professor

Department: Plant and Environmental Sciences

Project Description:

The research group's dynamic crop-ecophysiological research program focuses on unraveling the resilience mechanisms of agronomic crops under abiotic stresses. The team leverages this knowledge not just to understand, but to actively develop crop varieties that excel in performance. Their overarching goal is crafting climate-resilient production systems that strike a balance between economic viability and environmental sustainability. They integrate molecular physiology with production agronomy, addressing the monumental challenges posed by climate change and food insecurity.

Student Involvement:

"Research intern(s) will involve in the following projects:

1. Improving soybean's efficiency for heat tolerance with an integrated metabolic and genetic approach - The goals of this project are to identify soybean genes associated with lipid metabolic changes and with physiological mechanisms contributing to heat tolerance and to develop molecular markers for high-throughput screening of large germplasm collections for heat tolerance.
2. Identification of molecular markers associated with root traits that improve performance in cotton - Objectives of this project are to (a) Characterize the US Upland Cotton Core Set of allelic richness for root traits, water use efficiency, and yield and (b) Correlate the root phenotypic information with the existing genotypic information of the Core Set to identify molecular markers associated with root traits that improve water use efficiency and yield of cotton.
3. Cover crop inter-seeding in organic corn production to reduce resource inputs and soil disturbance and enhance pest control and farm profitability - The objective of this project is to evaluate different cover crops (white clover, buck wheat, pigeon pea, and their mixture) inter-seeded with corn at multiple seeding rates and under conventionally tilled or no-tilled conditions to identify cover crops and their management practices that alleviate soil compaction, suppress weed infestation, and enhance microbial communities that improve nutrient availability and soil health."

Required Skills / Prerequisites:

Students should posses a passion for plant science, ability to work as a team, and basic computer and software skills.

Expected Outcomes:

The student will learn research methods common to any crop science research program. This will prepare them for future undergraduate research and graduate school. If the student continues to work on the research project in the Fall, they might get an opportunity to present their research in the Crop Science Society of America annual meeting. Depending upon the contributions, the student may get a co-authorship in the publication.

Future Opportunities:

Students will have an opportunity to continue research in the lab (depending upon their performance in the summer). In the long run, there is a potential opportunity for a graduate research assistantship, if the student demonstrates potential for a researcher.

Research Location:

Main Clemson University Campus

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Project Title: Imparting Drought Tolerance to Crops via Rhizosphere Microbiome
Mentor: Vidya Suseela, Associate Professor
Department: Plant and Environmental Sciences

Project Description:

The aim of this project is to understand the bacterial and fungal community (microbiome) of a drought-tolerant native plant species and the ability of this microbiome to impart drought tolerance to crop plants. The research group will assess the performance of plants with and without this microbiome when exposed to drought.

Student Involvement:

The students will receive hands on experience in assessing soil, plant and microbial parameters using analytical chemistry instruments.

Required Skills / Prerequisites:

All necessary training on the background, analytical techniques, instrumentation, data analysis and effective oral and written communication will be provided. Students can work individually or in groups.

Expected Outcomes:

The intern has the opportunity to present their research in National Meetings and also can be a co-author in publications based on the research conducted.

Future Opportunities:

The interns can continue in the lab for paid research assistant positions.

Research Location:

Main Clemson University Campus

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Project Title: Understanding the Effect of Arbuscular Mycorrhizal Fungi (AMF) in Obtaining Soil Phosphorus

Mentor: Vidya Suseela, Associate Professor
Department: Plant and Environmental Sciences

Project Description:

The aim of this project is to understand the chemical communication between diverse crop genotypes and AMF species that vary in their functional traits. The project involves assessing the plant growth parameters and AMF fungal colonization that help in obtaining higher yield in crops.

Student Involvement:

The students will receive hands on experience in assessing soil, plant and microbial parameters using analytical chemistry instruments.

Required Skills / Prerequisites:

All necessary training on the background, analytical techniques, instrumentation, data analysis and effective oral and written communication will be provided. Students can work individually or in groups.

Expected Outcomes:

The intern has the opportunity to present their research in National Meetings and also can be a co-author in publications based on the research conducted.

Future Opportunities:

The interns can continue in the lab for paid research assistant positions.

Research Location:

Main Clemson University Campus

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Project Title: Understanding Soil Organic Carbon (SOC) Sequestration and Persistence in Agroecosystems

Mentor: Vidya Suseela, Associate Professor

Department: Plant and Environmental Sciences

Project Description:

The aim of this project is to understand how various plant species with different chemical composition of tissues facilitate the sequestration of SOC. The reserach group also seeks to understand where this newly formed carbon is stored to predict the persistence and function of SOC under global changes. The research gropu utilizes monocultures and diverse mixtures of cover crops belonging to various plant functional types as a model system, to predict the accrual and chemical composition of SOC.

Student Involvement:

The students will receive hands on experience in assessing soil, plant and microbial parameters using analytical chemistry instruments.

Required Skills / Prerequisites:

All necessary training on the background, analytical techniques, instrumentation, data analysis and effective oral and written communication will be provided. Students can work individually or in groups.

Expected Outcomes:

The intern has the opportunity to present their research in National Meetings and also can be a co-author in publications based on the research conducted.

Future Opportunities:

The interns can continue in the lab for paid research assistant positions.

Research Location:

Main Clemson University Campus

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