Precision genome editing using prime editors in zebrafish

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CST
Biology

One of the main drawbacks of the CRISPR/Cas9 genome editors is that they introduce double strand breaks. These breaks are repaired by error-prone repair mechanisms, leading to small insertions and deletions. Even in the presence of a template for homology directed repair, only a small fraction of CRISPR/Cas9-induced double strand breaks are repaired in precise manner, introducing the desired mutation. The recently published prime editors rely on reverse transcriptase activity to introduce a precise change into the target site with only one DNA strand broken (nicked), without a double strand break. In this project, we will test if Prime Editors can be used to introduce epitope tags into genes coding for important developmental regulators in zebrafish. Please see Burg et al., 2016 (PMID: 27892520) for a fairly recent reference.

Location: Main; In-person essential
Student Majors Accepted: Biochemistry and Biology
Class Preferences: Sophomores, Juniors
Important Selection Criteria: strong background - or interest in - genetics

Arthropod Biodiversity in Philadelphia's Vacant Lots

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Biology

The study and conservation of urban biodiversity is essential to ensuring our cities are healthy and vibrant places to live. Our goal is to understand the role of vacant lots (empty parcels of land scattered across Philadelphia's poorest neighborhoods) in providing habitat for arthropods (including bees, butterflies, spiders and more!). Arthropod samples were collected in 20 vacant lots in summer 2019 and are ready to be sorted and identified. The undergraduate researcher involved in this project will learn to identify insects and other arthropods using technical guides and laboratory tools. The student will also help design and implement statistical analyses to understand the impacts of habitat management (mowing, vegetation clearing, tree cutting, etc.) on arthropod diversity. This project provides a unique opportunity for a highly-motivated student to develop arthropod identification skills and contribute to a research project with important implications for urban biodiversity and conservation. They will be encouraged to present their work at scientific conferences and submit it for publication in peer-reviewed journals.
Location: Main; In-person essential
Student Majors Accepted: Biology; Environmental Science; Ecology, Evolution and Biodiversity
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Successful undergraduate researchers are curious, detail-oriented, and thoughtful. If that describes you, we'd love for you to join our team!

Urban Fox Niche Dynamics and Caribbean Herp Diversity

Jocelyn Behm
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CST
Biology

The Integrative Ecology Lab (www.iecolab.org) is looking for a research assistant to help with two projects being conducted by researchers in the lab. The first project is investigating the diets of red foxes and feral cats in the Philadelphia area. The research assistant will aid in the collection of samples from forested areas of the city and so that the diet of foxes found in Philadelphia can be determined. The second project is investigated the influence of human activity on large-scale patterns of reptile and amphibian diversity in the Caribbean. When the research assistant is not in the field collecting samples for the first project, they will be in the lab updating a species occurrence database of Caribbean reptiles and amphibians as well as collecting information of ecological trait of these species from the published literature. The option for conducting the Caribbean database work remotely is available.

Location: Main; In-person essential
Student Majors Accepted: Biology; Environmental Science; Ecology, Evolution and Biodiversity
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: All majors and years are encouraged to apply, but the ideal applicants will have an interest in ecology and the environment, good time management skills, and great attention to detail. In addition, a willingness to work both in the field and in the lab on a computer is required.

Temple Forest Observatory

Amy Freestone
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Biology

The Temple Forest Observatory (TFO), a collaboration between the Temple Ambler Field Station and the Smithsonian Forest Global Earth Observatory (ForestGEO; https://www.forestgeo.si.edu/), is a platform for inquiry-based education and long-term forest research. On Sept. 1, 2021, the TFO was substantially impacted by an EF2 tornado, a remnant from Hurricane Ida. This uncommon disturbance event is emblematic of larger changes that are occurring worldwide. Storm frequency and intensity are increasing due to climate change, causing changes to disturbance regimes in natural ecosystems. The TFO now provides an important opportunity to understand forest resilience in the face of these changes. Using detailed data collected before and after the storm, students will engage in outdoor, hands-on research to understand forest recovery, while developing skills in field data collection, data analysis, and more. Additional opportunities for professional development training are also provided. These positions are open to all students who have an interest in gaining field experience in forest science, ecology, and global change. No previous research experience is required. An integral part of our mission is to promote diversity, equity, and inclusion in science, and we encourage applications from students from populations underrepresented in science. The TFO and Ambler Field Station are located on the Temple Ambler Campus, a 50-minute drive from Main Campus. Transportation will be provided.

Location: Ambler; In-person essential
Student Majors Accepted: All majors
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: All students are welcome to apply.

Building a tree of life with DNA data

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CST
Biology

This project involves working with DNA sequence data of diverse organisms, and software, to help build the tree of life and better understand evolutionary principles. It takes place in the Center for Biodiversity and mostly involves learning and using new computer tools and applications. The center is located in SERC.

Location: Main; In-person essential
Student Majors Accepted: Biology, but could be any major
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Strong academics

Conserving the biodiversity of Haiti

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Biology

This project involves helping efforts in Temple's Center for Biodiversity to learn more about the biodiversity of Haiti, and to protect it. The multi-faceted team efforts include discovery of new species, mainly through DNA sequencing of samples collected in Haiti, ecological and evolutionary studies, and educational and outreach components. The center is located in SERC.

Location: Main; In-person essential
Student Majors Accepted: Biology, but could be any major
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Strong academics

Spotted Lanternfly Invasion Meltdown

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CST
Biology

Temple University's iEcoLab (https://www.iecolab.org/) has several projects on stopping the destructive spread of spotted lanternfly. Projects include biological control, species traits, ecology, data science, computer coding, machine learning. Students will work within a dynamic group of undergraduates, graduate students and postdocs focusing on spotted lanternfly ecological and computational research.

Location: Main; In-person essential
Student Majors Accepted: Biology, CIS, ES, Physics, Engineering, GUS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: We have projects available for a range of skill sets. We have projects that are focused on ecology and projects that are focused on computer coding.

Universal Patterns of Biodiversity

Matthew Helmus
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CST
Biology

Temple University's iEcoLab (https://www.iecolab.org/) has several projects on understanding global patterns of biodiversity and how humans are causing extinctions through pollution, deforestation and climate change. Projects include species traits, ecology, data science, computer coding, machine learning. Students will work within a dynamic group of undergraduates, graduate students and postdocs focusing on biodiversity and its conservation for future generations.

Location: Main; In-person essential
Student Majors Accepted: Biology, CIS, ES, Physics, Math, Engineering, GUS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: We have projects available for a range of skill sets. We have projects that are focused on ecology and projects that are focused on computer coding.

Identifying Gene x Environment (GxE) interactions in exposure-based diseases

Rob Kulathinal
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CST
Biology

Our short-term goal is to create and curate a genomic database of genome-wide studies involved with exposure to air contaminants. To build this database, a student(s) will search the large, growing literature from GWAS, transcriptomic, and epigenomic surveys of humans exposed to a variety of air contaminants. SNPs will be identified in relevant pathways and epigenetic markers related to the specific contaminants associated with air quality extreme events in different global populations. Ultimately, we wish to assess the relationship among various biomarkers such as those related to inflammation and the interacting effects of altitude and adverse air quality on lung function in a population from Medellin, Colombia.
References: http://dx.doi.org/10.1136/thoraxjnl-2013-204949, https://www.iarc.who.int/news-events/exposome-explorer-database-3-0-includes-newly-curated-gut-microbial-metabolites/

Location: Main; Virtual or computational research
Student Majors Accepted: Biology, Biological Data Science, Genomic Medicine
Class Preferences: Juniors, Seniors
Important Selection Criteria: A good understanding of the genomic tools and resources that can help identify SNPs/genes involved in complex human phenotypes. Data mining

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Evolution of compensatory mutations in proteins

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CST
Biology

Within a protein, secondary amino acid substitutions are able to mask deleterious mutations by preserving the protein's overall structure and function. The deleterious mutations, found in a protein-coding exon, are known as "disease" mutations with tens of thousands annotated in humans. The secondary substitutions are known as intramolecular "compensatory" mutations and can prevent deleterious effects by masking functional changes caused by disease mutations. When a human disease mutation is found in another mammalian species (i.e., orthologous site), compensatory substitutions are assumed to have evolved prior to the fixation of the diseased mutation itself. In this project, we would like to identify these compensatory sites in order to understand their mechanism of evolutionary change. These results can be applied to genomic medicine questions such as drug targeting, molecular stability, and viral transmissibility.

Location: Main; Virtual or computational research
Student Majors Accepted: Biology, Chemistry, Biochemistry, Physics, Mathematics, Computer Science
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Highly motivated and independent student with knowledge of genetics and evolution. Coding experience will be required.

Molecular identification of Antarctic protists (algae and protozoa)

Robert Sanders
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CST
Biology

The objectives of this project are to (1) confirm the taxonomy of our polar protist culture collection using molecular tools and (2) assess the genetic drift associated with the maintenance of protists under controlled conditions for many generations.

In this project, you will be responsible for identifying the species in our culture collection based on molecular analysis. You will photo-document the cultures, extract their DNA, amplify and Sanger sequence target genes (nuclear small subunit ribosomal gene, mitochondrial cytochrome oxidase I, and in some case the plastid small subunit ribosomal gene).

During this project, you will gain experience in microscopy and molecular techniques including DNA extraction, polymerase chain reaction (PCR), and electrophoresis. You will also learn about bioinformatics used in the lab to analyze DNA sequences and about building phylogenies.

Location: Main; In-person essential
Student Majors Accepted: Biology / EES
Class Preferences: Sophomores & Juniors
Important Selection Criteria: This project requires an in lab time commitment of about 10 h per week.

Bat susceptibility to white-nose syndrome

Brent Sewall
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CST
Biology

White-nose syndrome is an emerging infectious disease of hibernating bats caused by an invasive fungal pathogen. Since its first detection in 2006, it has caused extensive mortality of bats during hibernation, and has spread across much of North America. In this project, we will seek to improve understanding of factors influencing both the impacts and spread of the disease, and means to conserve bat populations in light of this ongoing threat.

Location: Main; In-person essential
Student Majors Accepted: Biology, Environmental Science, Mathematics
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Coursework, training, or experience in ecology, conservation biology, animal behavior, statistics, Geographic Information Systems (GIS), epidemiology, or public health, and a strong motivation for research and interest in the topic

Spotted lanternfly studies at the Temple Ambler Field Station

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CST
Biology

The spotted lanternfly is an invasive insect that poses an emerging threat to native forest ecosystems. In this project, the student will work as part of a team, using field surveys, standardized field experiments, and laboratory work to understand the ecology of spotted lanternflies and the effects they have on tree species. Research will occur primarily at the Temple Ambler Field Station, located on the Temple Ambler Campus, with the potential for some additional work on Main Campus. Transportation from Main Campus to the Field Station is provided via the inter-campus bus during the academic year.

Location: Ambler; In-person essential
Student Majors Accepted: Biology, Environmental Science, or related field
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Background (coursework/experience) in ecology or related field is recommended

The Suppression of Bitter Taste in Oral Medications

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Biology

Bitter taste is aversive to humans, and many oral medications exhibit a bitter taste. Bitter taste can be suppressed by the use of inhibitors, or by masking agents such as sucralose, Monk fruit, or sucrose. One novel approach is to encapsulate bitter tasting compounds in solid lipid microspheres or in solid lipid microparticles. In both cases, the release of a taste stimulus from lipids is delayed as these lipid supports erode in the oral cavity. Bitter taste suppression is achieved by encapsulating bitter taste stimuli in solid lipid microspheres along with masking agents, and then placing these encapsulated stimuli in rapidly dissolving edible films that also contain a variety of bitter taste masking agents. In this approach, masking agents are immediately released as edible films become hydrated by saliva, but before the erosion of encapsulated stimuli. This delivery method also minimizes choking hazards in both the young and the elderly. This project will primarily use techniques that enhance the masking of bitter taste in the oral cavity, and will require a minimum of three hours of lab work per week per academic credit. In summary, this approach is useful for increasing the palatability of oral medications, for delivering micronutrients to the oral cavity, and for enhancing the flavor of food.
Location: Main; In-person essential
Student Majors Accepted: Neuroscience, Biology
Class Preferences: Juniors, Seniors
Important Selection Criteria: Willingness to work a minimum of three hours per week per academic credit; ngagement in the research project; Ability to solve problems associated with the research project; Ability to recruit test subjects for psychophysical studies.

Personalized medicine and evolutionary link between DNA and disease

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CST
Biology and iGEM

We all have many DNA differences from others. Which of these personal differences cause disease? We use computers to study disease variation in humans and compare it to differences humans show with other species. We also build predictive methods and tools.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Freshmen & Sophomores
Important Selection Criteria: Interest in the field and interest in discovering patterns and solving problems.

Software development and Bioinformatics

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Biology and iGEM

We develop software (including smartphone apps) for analyzing biological data in the fields of Genomics, Evolution, and Medicine.

Location: Main; Virtual or computational research
Student Majors Accepted: All Majors
Class Preferences: Freshmen, Sophomores & Juniors
Important Selection Criteria: Knowledge of computer programming and/or app development.

Combining Photons, Electrons and Nanoparticles for Plasmonic Sensing and Catalysis

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CST
Chemistry

Students will develop and use nanoscale plasmonic materials for rapid, high sensitivity detection of biological and chemical agents, as well as catalytic conversion. They will learn to use a variety of analytical techniques such as spectroscopy, Atomic Force Microscopy.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Physics
Class Preferences: Sophomore & Junior
Important Selection Criteria: Curiosity and persistence - Interest in research - Aptitude for careful laboratory research - - Undergraduate researchers in my group typically present at local, regional and even national conferences. Many have been co-authors on publications.

Laser Vibrational Spectroscopy and Dynamics of Molecular Species at Bio and Geochemical Interfaces

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CST
Chemistry

Research involves learning to use ultrafast lasers (we make some of the shortest infrared pulses in the world) to perform vibrational Sum Frequency Generation (SFG) a technique that provides sensitivity to single molecular layers. Students will investigate water, arguably the most important molecule on the planet at interfaces of biological and geochemical relevance. Students will learn about surface chemistry, biointerfaces, geochemistry and laser spectroscopy.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Physics
Class Preferences: Sophomore & Junior
Important Selection Criteria: Curiosity and persistence - Interest in research - Aptitude for careful laboratory research - - Undergraduate researchers in my group typically present at local, regional and even national conferences. Many have been co-authors on publications.

Treasure from trash: using discarded plastics to clean up pollutants in waterways

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Chemistry

The project will leverage the intrinsic chemical properties of waste plastics to collect persistent organic pollutants for the environmental remediation of waterways, through an interdisciplinary program that aligns with the research and geographical strengths of Temple University. To achieve this objective, the project team will physically and chemically modify waste plastics, explore how micronized/porous plastic waste adsorbs organic contaminants, like PCBs and PFAS, demonstrate adsorption of contaminants from waterways, and divert disposal of plastics/contaminants in landfills by exploring gasification alternatives.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Biochemistry, Materials Science
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: At least general chemistry and associated laboratory. Preference given to those who have completed organic chemistry and associated laboratory.

Chemical Education - Design of teaching tools for organic chemistry

Steven A Fleming
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CST
Chemistry

Dr. Fleming (professor of instruction) does research in chemical education. In particular, he is developing a teaching tool for organic chemistry called “Interactive Organic Reaction Animations” (iORA). This tool will assist student learning by providing a 3D perspective of organic reactions. The animations that are included in the program are based calculated data so that the representations are as accurate as possible. The iORA software will run on a smartphone as an app and it will be free for any user. We are also have a project that involves converting PDB files into UnityMol (or a similar system) and then exploring the 3D image using Oculus Rift. The ultimate goal would be to generate a virtual reality teaching tool for organic chemistry.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry, Biochemistry, CIS
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Students working on this project would need to have a basic knowledge of computer languages and an interest in learning virtual reality. A good foundation in organic chemistry would be helpful.

Synthetic Organic Chemistry: Harnessing Light for New Chemical Reactions

Daniel Kim
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CST
Chemistry

The Kim Lab is interested in developing new chemical transformations. While these transformations are would be useful to a wide variety of industries such as agricultural, energy, biological systems, and new materials. However, our focus is to develop transformations that are specifically relevant to medicinal chemists and pharmaceutical sector. The student will help to develop new protocols, synthesize, and purify new organic compounds. Along the way, the student will learn and use a wide variety of tools such as mass spectrometry, NMR, IR, column chromatography, TLC, air-free techniques, and learn more about our lab research. Productive students will have the opportunity to earn authorship on published papers and attend local or national meetings to present their work.

Location: Main; In-person essential
Student Majors Accepted: Chemistry and Biochemistry
Class Preferences: Sophomore & Juniors
Important Selection Criteria: We are looking for motivated students who intend to commit significant research hours. We teach the necessary skills, but the student needs to be adaptable, enthusiastic, and conscientious.

Modeling photophysical and photochemical properties of molecules

Spiridoula Matsika
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CST
Chemistry

Computational chemistry is applied to study the fate of molecules after absorption of light. Theoretical methods based on both quantum mechanics and classical mechanics are used to model the excited states of molecules and their reactivity, leading to our understanding of photophysics and photochemistry of chemical and biologically relevant systems. We focus on a variety of applications: (i) photostability of DNA subject to radiation, (ii) development of fluorescent probes used in biomolecular detection; (iii) absorption and fluorescent spectra of organic chromophores; (iv) formation and stability of prebiotic molecules; (v) modeling and interpreting pump probe spectroscopies of gas phase molecules. Motivated undergraduate students can make contributions to any of these topics.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Biochemistry, Physics, CIS
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Interest in physical chemistry, math, computational science

Making high accuracy affordable through DFT

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Chemistry

The coupled-cluster singles and doubles with perturbative triples complete basis set limit, CCSD(T)/CBS limit [J. Chem. Phys., 138, 144104 (2013), J. Chem. Phys. 143, 214110 (2015)] offers very high accuracy for much of thermochemistry, but these calculations are very expensive. If we limit the CCSD(T) calculations to the valence electron correlation energy, the remaining small corrections can be treated by DFT with little loss of accuracy at dramatically reduced cost. For example, we recently published [J. Chem. Phys. 143, 214111 (2015)] a core-valence density functional that requires less time than a single SCF iteration, but reproduces the CCSD(T)/CBS core-valence correlation energy to within ±0.27 kcal/mol rms error. We are now developing density functional methods covering the elements H through Kr for the geometry (±0.011 Å which corresponds to ±0.065 kcal/mol rms error in the energy)["Three Body Dispersion Corrections to the Spherical Atom Model: the PFD-3B Density Functional" George A. Petersson, Michael J. Frisch, Frank Dobek, and Barbaro Zulueta*, J. Phys. Chem. 124, 10296 (2020)]. These errors compare favorably with the inherent error in CCSD(T) energies (±0.56 kcal/mol rms error) with respect to Full CI energies for these species. This work will include extending core-valence density functional to the third-row including the transition metals, and improving on the generalized Douglas-Kroll-Hess relativistic DFT calculations of the spin-orbit coupling interactions. The undergraduate research participant's background in Chemistry is not important, but some knowledge of quantum mechanics and an aptitude for writing computer code are essential. The departmental major or class year are unimportant.
* Temple B.S. 2019, currently Ph.D. student, University of Pittsburgh.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry, Physics, Math, Computer Science
Class Preferences: Sophomores
Important Selection Criteria: The undergraduate research participant's background in Chemistry is not important, but some knowledge of quantum mechanics and an aptitude for writing computer code are essential. The departmental major or class year are unimportant.

Machine Learning Optimized Molecular Energy Surfaces

Jonathan Smith
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CST
Chemistry

Accurate molecular properties can now be computed using quantum mechanical computations for moderate sized molecular systems. In the case of reactive systems of astrophysical and atmospheric significance and their spectroscopy, molecular dynamics can extend these studies but requires many computationally expensive steps. These steps can be sped up by >10,000 fold by trained machine learning molecular potential energy surface models.

Location: Main; Virtual or computational research
Student Majors Accepted: Chemistry
Class Preferences: Juniors & Seniors
Important Selection Criteria: An aptitude in coding (or interest in learning) to automate and analyze computations.

Optimization of Extremophilic Photolyase Protein Folding

Robert Stanley
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Chemistry

Enzymes found in extremophilic organisms that thrive in high and low temperature face challenges to stability that mesophilic proteins (like ours) don't face. Mimicing the cytosolic contents of extremophiles to stabilize their intracellular constituents is a formidable but necessary task. You will explore a wide range of solvent additive conditions to find regions of protein-folding stability for the DAN repair enzyme, DNA photolyase.

Location: Main; In-person essential
Student Majors Accepted: All majors
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Biochemistry, Organic, analytical skills all are important. Evidence of discipline and enthusiasm are important.

Bioinorganic Titanium Chemistry

Ann Valentine
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CST
Chemistry

The Valentine Lab is interested in hydrolysis-prone metal ions of biological relevance. The student will investigate possible ligand systems for stabilization of titanium(IV) in a water environment, will make and characterize new inorganic coordination compounds, and will evaluate their interactions with biomolecules.

Location: Main; In-person essential
Student Majors Accepted: Chemistry, Biochemistry
Class Preferences: Sophomores & Juniors
Important Selection Criteria: intelligence enthusiasm conscientiousness - will teach skills necessary

Research at the Interface of Chemistry, Materials, and Energy

Mike Zdilla
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CST
Chemistry

The Zdilla lab conducts research in inorganic chemistry, materials, crystallography, and energy science. Our projects include 1) efforts to design molecules and materials inspired by nature that split water into hydrogen and oxygen, 2) synthesis of novel energy-rich molecules with new realms of energy density, 3) design of electrolytes for safer batteries, and 4) development of new methods in X-ray diffraction and crystallography. Depending on project assignment, students may have the opportunity to learn chemical synthesis, air-sensitive handling (glove box and schlenk line techniques) spectroscopy, magnetometry, electrochemistry, and crystallography. Motivated and productive students will earn (co)authorships on published papers and attend local and/or national meetings to present their work.

Location: Main; In-person essential
Student Majors Accepted: Chemistry and Biochemistry
Class Preferences: Freshmen & Sophomores
Important Selection Criteria: We are looking for students with a passion for chemistry who intend to commit significant time. Research cannot be done as a side hustle. A significant fraction of weekly hours over multiple years is needed for undergraduate researchers to be successful, and students should apply with the intent to meet these expectations.

How do Individuals develop Mental Models and Mitigation Strategies for AI Systems?

Stephen MacNeil &
Richard Souvenir
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CST
CIS

People will increasingly interact with AI systems to commute to work, recommend music and news, and help them to perform their work. This raises important new questions about how people understand AI systems and how they adapt when these systems break down. This summer, we will be conducting experiments to better understand how people develop an understanding of the AI systems that they use.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Psychology
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Interest in explainable AI systems (XAI)

Scene Analysis for Large Image Collections

Richard Souvenir
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CST
CIS

The student will apply and adapt recent techniques from computer vision and machine learning to identify attributes from images of indoor scenes. This work is part of an ongoing project to (http://traffickcam.org/about) to combat human trafficking by identifying hotel room features from images.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science
Class Preferences: Sophomores & Juniors
Important Selection Criteria: Strong programming skills (preferably Python), interest or experience in image processing, data science, or machine learning.

Security of mobile payment apps

Chiu Tan
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CST
CIS

Mobile payments have become increasingly popular, and with that popularity, has led to a rise in frauds. The objective of this project is to collect and analyze mobile apps to determine the causes and design new solutions to defend against these new attacks.

Location: Main; Virtual or computational research
Student Majors Accepted: CIS, criminal justice, psychology
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Background in UX or criminal justice or psychology, will be helpful.

Creating tools for civic designathons and hackathons

Stephen MacNeil
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CST
Computer and Information Sciences

Our research team has hosted a few hackathons and designathons---such as Design for San Diego (D4SD), ScaleSD, and San Diego Design Week (SDDW).
For these events, our team has developed a technology platform that visualizes the ideas that emerge across teams and matches similar teams across an event in real-time for feedback and collaboration. This summer we are focusing on ways to dynamically speed-up and slow-down teams so that we can create opportunities for synchronized collaboration.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Management, Psychology
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Candidates should be excited to build technology that is deployed in the real-world

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Expert Goggles: Teaching Data Literacy with an AI Tutoring System

Stephen MacNeil
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CST
Computer and Information Sciences

People form opinions (e.g.: is climate change real?) and make decisions (e.g.: should I get vaccinated?) based on data visualizations. However, extensive research has demonstrated that visualizations are often misunderstood. Our project, Expert Goggles, helps people with limited data literacy skills see visualizations through the eyes of an expert by automatically annotating visualizations with key insights and scaffolding for interpretation.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer Science, Psychology, or Design Fields
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Students should be excited to work in a multi-disciplinary team

AI-supported human-computer interfaces

Slobodan Vucetic
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CST
Computer and Information Sciences

Students will be engaged in development of software that supports cooperation between humans and machines through innovative uses of artificial intelligence (AI) technology. The particular focus will be on design of a user interface and integrating it with an AI-supported backend. Students will be involved in all stages of software development, including ideation, design, implementation, and evaluation through user studies.

Location: Main; Virtual or computational research
Student Majors Accepted: Computer science majors
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Strong software development skills, some experience with user interfaces and frontend development, interest in AI technology.

Modeling crowd behavior in physical spaces using machine learning

Slobodan Vucetic
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CST
Computer and Information Sciences

This project seeks to understand and mathematically model behavior of humans in physical spaces. Examples are behaviors of pedestrians on crowded streets, behaviors of drivers on roads, and behaviors of players in team sports. The project involves collection and processing of moving trajectory data, application of machine learning algorithms, and observational studies aided by visual analytics tools.

Location: Main; Virtual or computational research
Student Majors Accepted: Data science, computer science, applied math, physics
Class Preferences: Juniors, Seniors
Important Selection Criteria: Solid background in data science, machine learning, and programming. Background in mathematical modeling and modeling of physical systems is a plus. Previous research experience is a plus.

Auto-detection of geologic features through citizen science

Alexandra Davatzes
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CST
Earth and Environmental Science

I am looking for a student to work with me and a few graduate students on a project where we are developing a citizen science activity to annotate images for the purposes of machine learning.

Location: Main; Virtual or computational research
Student Majors Accepted: EES, CIS
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Students must have some geologic background, preferably completion of physical geology and Sedimentary Environments.

Urban stormwater monitoring

Laura Toran
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CST
EES

We know urbanization increases stormwater runoff as we pave over land in cities. We further amplify stormwater runoff through human-induced climate change. My research team uses monitoring equipment to collect large data sets with unprecedented temporal and spatial resolution. Students are needed to maintain field equipment and analyze data; also expected to assist graduate students in collecting data. The field work is storm dependent, but there are several existing data sets that can be analyzed when the weather doesn't cooperate.

Location: Main; In-person essential
Student Majors Accepted: EES
Class Preferences: Juniors, Seniors
Important Selection Criteria: Strong preference for students who have taken Groundwater Hydrology or Physical Hydrology and are willing to make a multi-semester commitment. Need to enjoy using computers for data analysis.

Investigating antiviral drug targets

Michael L. Klein
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CST
ICMS

Investigating antiviral drug targets via computation.

Location: Main; In-person essential
Student Majors Accepted: Biophysics, Bioinfomatics & Chemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Working in a team environment with Faculty, Post Doc and Staff.

GT-shadows and their action on child's drawings

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CST
Mathematics

GT-shadows are tantalizing objects which may be thought of as approximations to elements of the mysterious Grothendieck-Teichmueller group. GT-shadows are connected to many interesting areas of mathematics. Exploration of GT-shadow and their action on Grothendieck's child's drawings will shed light on very hard questions related to the absolute Galois group of rational numbers.

Students who choose this project will work with presentations of group, covering spaces, learn some advanced mathematics and will get some programming experience with the computer algebra system "Magma".

Location: Main; Virtual or computational research
Student Majors Accepted: Mathematics and/or computer science
Class Preferences: Juniors & Seniors
Important Selection Criteria: Math 2111 and Math 3098 are prerequisites for working on this project. Most of all, I expect a student to be passionate about mathematics!

Neuro-VISOR: VR-based neuroscience modeling and simulation

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CST
Mathematics

The student's research project will advance the tool Neuro-VISOR, which immerses the user in a virtual lab world where brain cells can be visualized, interacted with, and stimulated. Real-time simulations of neuronal activity can be analyzed and interacted with, making Neuro-VISOR a unique tool in the area of computational neuroscience, used in an instructional and scientific context.

The project revolves around the development of novel virtual reality-based computational tools, applied to neuroscientific modeling and simulation, and is co-advised by Dr. Seibold and Dr. Queisser. Students will have the opportunity to work in a team that covers a broad range of research, from mathematical modeling, numerical and visualization methods, to optimizing computational scalability for large problems.

Location: Main; Virtual or computational research
Student Majors Accepted: Mathematics, Computer Science, Physics
Class Preferences: Sophomores, Juniors, Seniors
Important Selection Criteria: Knowledge of programming languages (e.g., C#, C++, Java) are critical. Experience with Unity3D is a plus, but not a must.

Understanding the Impact of Vehicle Automation on Traffic Flow

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CST
Mathematics

The broader goal of this research is a better understanding the impact of vehicle automation on traffic flow and its impacts on health and safety. This specific project focuses on developing mathematical models, simulations, and small-scale virtual experimentation that can provide new insights into heterogeneous traffic flow in which a few vehicles are automated and the rest are human-driven. Two particularly important research directions are: (a) the development of better models for traffic waves, smart vehicle controllers that smooth traffic waves, and models that quality the energy impact and accident risk; and (b) the incorporation of models for traffic waves into 3D virtual reality simulators that can then be used for studies on human reactions to automated vehicles. No specific course or technical background is required; but the projects require a keen interest in mathematical models, simulations, data, programming, and hardware (all or some of the above). Students will work virtually or in the Center for Computational Mathematics and Modeling.

Location: Main; Virtual or computational research
Student Majors Accepted: Mathematics, Computer Science, Physics
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Experience in numerical methods, data processing, and/or programming (particularly Unity) is very welcome.

Fixed Point Theory and Applications

Jeromy Sivek
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CST
Mathematics

Fixed point theory refers to a collection of mathematical results guaranteeing that T(x)=x must have a solution. In most applications, T is an operator consisting of many terms and reflects the specifics of the application. Students will explore the rich foundation of this area and be shown a few applications. Students will then be encouraged to take a deep dive into any one application and possibly pursue more abstract and open problems about fixed points and minimal invariant sets that have already proven somewhat accessible at the undergraduate level.

Location: Main; Virtual or computational research
Student Majors Accepted: Mathematics, Physics, Computing
Class Preferences: Sophomores, Juniors & Seniors
Important Selection Criteria: Students should have some background in proof-based mathematics. A course like Math 3137 or 3141 would be an appropriate pre-req or co-req for starting the project.

Design of advanced materials for strategic applications including body armor.

Michael L. Klein
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CST
TMI/ICMS

The project involves the computational design of advanced materials for strategic applications including body armor. The materials currently under investigation are aromatic polyamides such as Kevlar® and ultra-high molecular weight polyethylene. Researchers at Temple Material Institute (TMI) are using computational methods to explore the molecular structure and properties of these materials with main objective of enhancing their performance.

The student's research primary focus will be use of computational methods (modeling, simulation, machine learning) for improving predicting capabilities in designing new polymeric structures for strategic applications.

Secondarily, as appropriate, the student's activity will involve also assessing some properties of polymer samples in the form of powders, fibers, or films, using thermal analysis (Differential Scanning Calorimetry), and nanoindentation.

Location: Main; In-person essential
Student Majors Accepted: Physics, Chemistry
Class Preferences: Freshmen, Sophomores, Juniors & Seniors
Important Selection Criteria: Working in a team environment with Faculty, Post Doc and Staff