1. **Project:** Effects of periodic flooding on *Miscanthus x giganteus* soil priming
   Mentor: Chuck Hyde | **Faculty member:** Wendy Yang
   Location: University of Illinois Urbana-Champaign

Miscanthus x giganteus is a large perennial grass and a prime culprit for biofuel production. There is recent evidence that soil moisture is a possible control on the magnitude of the rhizosphere priming effect, and thus this project aims to assess the effects of seasonal floods on carbon cycling in these soils. The student will assist in taking soil cores at field sites near campus. The student will flood these soil cores in the laboratory and collect greenhouse gas emission data to determine the changes in C cycling throughout the season. There are no requirements for the mentee, but experience with laboratory techniques, programming in R, or completed of an introductory ecology course will be helpful.

2. **Project:** Water use efficiency and stomatal density
   Mentor: Daniel Tejeda-Lunn | **Faculty member:** Andrew Leakey
   Location: University of Illinois Urbana-Champaign

This project focuses on increasing water use efficiency by reducing stomatal density. More specifically, the project involves identifying and genetic characterization of stomatal density in transgenic or naturally varying Sorghum populations. The student will use optical tomography to image Sorghum populations and determine the number of stomata per unit area using machine learning. The student will also characterize the genetic makeup of these lines through genotyping a transcription abundance. The results of this project will help identify exciting lines for further analysis.

3. **Project:** Quantifying greenhouse gas emissions from bioenergy crops
   Mentor: Christy Gibson | **Faculty member:** Carl Bernacchi
   Location: University of Illinois Urbana-Champaign

In this project, laser spectrometers will be used to measure greenhouse gas emissions over bioenergy maize and bioenergy sorghum plots at the University of Illinois Urbana-Champaign Energy Farm. We will use the emissions data gathered from the spectrometers and convert them to fluxes (think of fluxes as the measure of something leaving/flowing into or out of a room or box; our box is the bioenergy plot) which we can then use to generate a clear picture of the greenhouse gas budgets of our bioenergy crops. The student will learn how to use and monitor laser spectrometers, perform daily checks while gaining basic knowledge of IR spectroscopy. The student will also learn how to determine quality data output, identify basic problems with data, and process data. There are no prerequisites for the mentee, but basic chemistry and biology coursework will be helpful.

4. **Project:** Effects of arbuscular mycorrhizal fungi (AMF) on nitrous oxide emissions from soils
   Mentor: Kevin Ziliang Zhang | **Faculty member:** Wendy Yang
   Location: University of Illinois Urbana-Champaign

Arbuscular mycorrhizal fungi (AMF), which form associations with roots of more than 80% of terrestrial plant species, have been demonstrated to reduce soil nitrous oxide (N_2O, an important greenhouse gas having threat to climate warming, food production and human health) emissions. However, the conclusion on whether AMF have a N_2O reduction effect remains inconsistent, which may be largely attributed to the confounding effectiveness and function of AMF in different soil types. Thus, this project will investigate how AMF influences N_2O emission from soils with different textures. The student

will help set up the experiment in the greenhouse, take necessary measurements, and be involved in processing data. There are no prerequisites for the mentee, but basic knowledge of soil science or plant science will be helpful.

5. **Project:** Investigating the role of Sorghum Rca-α in heat stress
   Mentor: Nikita Bhatnagar | **Faculty member:** Donald Ort
   Location: University of Illinois Urbana-Champaign

Heat-induced inhibition of photosynthesis results in crop yield reductions as the global climate warms. Impairment usually occurs due to inhibition of the enzyme Rubisco activase (Rca), however, in energy grasses a unique form of Rca with unknown function is expressed only under high temperatures (Rca-α) and is proposed to be important for thermo-tolerance. This project will study the function of this heat induced Rca in Sorghum. The student will participate in genotyping Sorghum Rca-α CRISPR knockout plants, followed assessment of photosynthesis under normal and heat stress conditions. These data will be used to determine the role of Rca-α with potential implications for producing climate resilient crops. Knowledge of plant molecular biology and physiology will be useful.

6. **Project:** Standardization of assumptions for modeling biorefinery feedstocks
   Mentor: Yoel Cortes-Peña | **Faculty member:** Jeremy Guest
   Location: University of Illinois Urbana-Champaign

Biorefineries play a central role in transitioning to a sustainable bioeconomy, yet modeling assumptions on the components of biomass feedstocks vary widely across studies, with no clear standard. This project seeks to understand the uncertainties and importance of assumptions concerning the properties of lignocellulosic components and to generate recommendations for modeling these components. The student will review literature to understand common assumptions in modeling biomass components, then — with the mentor's help — will leverage the BioSTEAM software to characterize how economic and environmental sustainability indicators are affected by these assumptions. Finally, the student will create a set of recommendations based on the results. There are no prerequisites for the mentee, but students studying chemical or environmental engineering will be well-prepared for this project.

7. **Project:** Study of two-staged pretreatment method for effective recovery of color from feedstocks
   Mentor: Shivali Banerjee | **Faculty member:** Vijay Singh
   Location: University of Illinois Urbana-Champaign

The increased awareness for eco-friendliness and sustainability has shifted the interest of stakeholders from synthetic colors to natural plant-based pigments for industrial applications. Color-producing engineered bioenergy crops could be sustainable feedstocks for recovery of natural colors. The two-staged pretreatment of these engineered bioenergy crops will allow the recovery of colors while making the feedstock more suitable for enzymatic saccharification. The student will review the literature to understand various methods for extraction of color from plant tissues. The student will then be trained to run experiments on two-staged pretreatment method for recovering color from CABBI feedstocks. The student will further assist the mentor in estimating the total color content recovered via the two-staged pretreatment. Students studying bioprocess engineering, chemical engineering, or environmental engineering will be well-prepared for the project.

8. **Project:** Automated Process Synthesis for Integrated Biorefineries
   Mentor: Sarang Bhagwat | **Faculty member:** Jeremy Guest
   Location: University of Illinois Urbana-Champaign

This project focuses on the development of a software tool to explore the bioproducts opportunity space by automating key aspects of biorefinery process design by leveraging BioSTEAM and the biorefineries made using it. The proposed tools will search for biorefinery configurations across the qualitative and quantitative design space using loss functions that are indicators of biorefinery economics and environmental impacts and recommend designs for the production and upgrading of a portfolio of bioproducts. The student will assist in the survey and review of literature on the techno-economic analysis and life cycle assessment of bioproducts of interest, and the key process design decisions made in those works. The student will also be advised on process design heuristics and collaborative programming in Python. Students studying chemical engineering or technology will be well-prepared for the project.

9. **Project:** Optimizing fermentation conditions for oleaginous yeasts
   Mentor: Christopher Rao | **Faculty member:** Christopher Rao
   Location: University of Illinois Urbana-Champaign

Oleaginous yeasts can produce oils from sugars, creating a more valuable bioproduct. The student will work to optimize fermentation conditions during growth on plant-based sugars derived from CABBI feedstocks. There are no prerequisites for the mentee, but background knowledge in chemistry and biology will be helpful.

10. **Project:** Conversion of biologically derived intermediates to bio-based chemicals
    Mentor: Marco Nazareno Dell'Anna | **Faculty member:** George Huber
    Location: University of Wisconsin at Madison

Triacetic acid lactone (TAL) and linear alpha olefins (LAOs) are important chemical intermediates that can be converted into a variety of products such as preservatives, surfactants, and fuel additives. Both TAL and LAOs can be synthesized by engineered bacteria through fermentation of glucose. This project will focus on the further upgrading of these compounds to the final products with the use of heterogenous catalysis. The student will focus on the study of bio-derived chemicals production through catalytic conversion. The student will learn the basic concepts of catalysis, reaction kinetics, and how to use a batch and flow reactor. In addition, the student will perform sample analysis and extract yield, selectivity, and conversion for the reactions performed. The ideal student will have basic knowledge of reaction engineering, chemical reaction kinetics, and organic chemistry.

11. **Project:** Modeling yeast metabolism to design strategies of biofuel and bioproduct production
    Mentor: Wheaton Schroeder | **Faculty member:** Costas Maranas
    Location: Penn State University

The project focuses on the modeling of yeast species to predict metabolic interventions for the production of biofuels and bioproducts of interest. The student will aid in the reconstruction, curation, and analysis of genome-scale models of metabolism (GSMMs). Further, the student will use tools and methods to analyze these models with the goal of designing strategies for the production of biofuels and bioproducts of interest. Coursework in basic biology, linear algebra, differential equations, and

programming are required. Coursework related to mathematical thinking, set theory, and bioinformatics will be useful, but necessary skills in this area can be learned during the internship.

12. **Project:** Multi-omics exploration of acetate co-utilization to improve organic acid production
    Mentor: Yihui Shen | **Faculty member:** Joshua Rabinowitz
    Location: Princeton University

This project focuses on engineering yeast strains to produce a polymer precursor and exploring acetate as a cheap co-supplemented nutrient source. The student will use multi-omics techniques to characterize their metabolism, based on which the student and mentor will propose new engineering targets for further improvement in performance. The student will learn yeast culture, fermentation, sample preparation, and data analysis for multi-omics measurement. The student will also identify bottlenecks in organic acid production in an engineered yeast strain and suggest next-round engineering. Coursework in biochemistry and general chemistry lab is required.

13. **Project:** Transcriptomic analysis of the multistress-tolerant yeast species *Issatchenkia orientalis*
    Mentor: Ping-Hung Hsieh | **Faculty member:** Yasuo Yoshikuni
    Location: Lawrence Berkeley National Laboratory (Joint Genome Institute)

Issatchenkia orientalis has been known for its tolerance of the low pH, high concentration of organic acids as well as some other stresses (e.g. high salt, high temperature, etc.). However, the underlying molecular mechanisms of its stress tolerance remain unknown. The project will focus on using transcriptomic analysis to discover potential genes involved in the stress tolerance of *I. orientalis.* The student will learn yeast culture, RNA extraction, and basic transcriptomic data analysis. There are no prerequisites for the student, but experience with molecular biology techniques and command-line interface will be helpful.