Title: Defining the Influence of Environmental Stress on Bioenergy Feedstocks at Single-Cell Resolution

Authors: Margot Bezrutczyk[1], Danielle Goudeau[1], Rex Malmstrom[1], **Benjamin Cole[1]***

Institutions: [1]DOE-Joint Genome Institute, Lawrence Berkeley National Laboratory, Berkeley, CA

Project Goals: This Early Career Research Project aims to build comprehensive single-cell resources for bioenergy grasses, characterizing sorghum, switchgrass, and Brachypodium cell types at unprecedented scale and resolution. These resources will be used to investigate cell type-specific environmental stress responses under agriculturally relevant conditions. In addition, we aim to understand how microorganism influence these responses. These efforts will ultimately lead to enhanced understanding of the multifaceted ways that plants react to changing conditions.

Abstract Text: Biomass from plants is an important resource that enhances energy independence and promotes good environmental stewardship. Poor growing conditions (such as drought or low soil nutrient composition) hinders optimal performance of these bioenergy crops. Therefore, the development of new strategies to improve plant biomass production will require a better understanding of how plants respond to (and cope with) stress imposed by the environment. Plant responses to drought are complex and involve the coordinated action of many different types of cells with specialized functions (cell types). For example, cells that compose stomata (pores in the leaf that open and close to exchange carbon dioxide and oxygen, potentially leading to water loss) will respond very differently to drought than cells of the plant vasculature.

This project aims to use cutting-edge single-cell characterization technologies to measure how individual cells and cell types respond to drought and nutrient limitation in two prominent bioenergy crops, sorghum and switchgrass. This will require the construction of large curated datasets detailing the regulation of genes in hundreds of thousands of individual plant cells. In addition, we will quantify how genes are turned on or off under drought and nutrient stress when grown under conditions very similar to those in agricultural plots using sophisticated plant growth chambers. Lastly, the we will investigate the impact of beneficial microorganisms in the soil to plant growth under stress. The results of this project will significantly advance our foundational knowledge of how plants coordinate responses to environmental stress, and will ultimately enable us to target genes in specific cell types for crop improvement. Here, we will present our experimental design, expected outcomes, and preliminary data from our single-cell atlas construction efforts.

Funding Statement: The work conducted by the U.S. Department of Energy Joint Genome Institute, a DOE Office of Science User Facility, is supported under Contract No. DE-AC02-05CH11231. This program is supported by the U. S. Department of Energy, Office of Science, through the Genomic Science Program, Office of Biological and Environmental Research, under FWP ERKP123.