Time of day shapes plant responses to environmental cues

Organisms across the kingdoms of life rely on circadian oscillators to anticipate daily and seasonal environmental change. For sessile plants, coordinating physiology with daily shifts in light and temperature maximizes energy-use efficiency and stress resilience. My lab integrates temporal transcriptomics, metabolomics, and physiology, with computational modeling to reveal how internal timekeeping coordinates plant responses from natural variation in crops to cell-type-specific regulation within organs. In this talk, I will present two examples illustrating how we approach temporal regulation at different biological scales. First, I will show how intraspecific variation in *Brassica rapa* uncovers genotype-specific cold acclimation while revealing conserved temporal regulatory programs hidden by gene duplication. Second, I will present our single-nucleus and spatial transcriptomic datasets in the *Arabidopsis* leaf that reveal cell-type-specific circadian regulation and provide a framework for studying temporal communication among neighboring cell types. Together, this work reveals temporal gene regulation as an organizing principle from cells to tissues to whole-plant physiology and is informing future efforts to tune synthetic time-of-day gene expression with tissue-level precision.