Jake Brunkard

Jake Brunkard is an Assistant Professor in the Laboratory of Genetics at the University of Wisconsin–Madison, USA. The Brunkard Lab investigates the evolution and regulation of metabolism in plants, focusing on the TARGET OF RAPAMYCIN signaling network. Jake is a Fellow of *The Plant Journal*.

Tell us about your background. How did you first become interested in plant science and metabolic research?

My path into plant science started early: I grew up in rural Pennsylvania, in an ecologically-diverse forested region called the Poconos. I spent a lot of time outside exploring cranberry bogs, pine barrens, hemlock groves, rhododendron forests, and so on, and I always marveled at the incredible diversity of plants. My parents gardened extensively, and they have a botanical bent, so I learned all the genus and species names for perennials (a little bit like collecting all the Pokémon—I wanted to collect all the genera).

That initial interest in plants kept redirecting me towards plant science later on. I took detours pursuing history, music, French literature, and math, but when it came time to decide on a career, I knew that I would always be happy as long as I was working with plants.

My focus on metabolism was much more fortuitous. As a Ph.D. student investigating cell-cell communication in plants in Pat Zambryski's lab, I was encouraged to pursue the science wherever it led me, and by the end of my Ph.D. studies, I had discovered that cell-cell communication is deeply intertwined with a metabolic signaling network coordinated by the TARGET OF RAPAMYCIN (TOR) protein kinase. That unintended discovery led me to my current studies of plant metabolism.

What is your lab working on currently?

My lab's investigations orbit around the TOR signaling network. In almost all eukaryotic cells, TOR senses nutrient availability and then shapes metabolism to ensure that physiology and development stay within certain "guardrails", not growing too fast, but also not leaving nutrients unused. TOR evolved in the last eukaryotic common ancestor and has remained evolutionarily static since then (the human and plant versions of TOR are incredibly similar to each other), but the mechanisms used by TOR to sense nutrients and regulate metabolism have evolved much more diversity.

Methodologically, I always strive to be experimentally brave, so we use a range of approaches in the lab. Our most common approaches are functional genomics and genetics; nothing is more exciting to me than a mutant with a bizarre, unexpected phenotype.

What does a typical day look like for you?

I start my mornings going through e-mails and reading some papers from home while I have breakfast, drink my coffee, and maybe go for a walk with our dog. I don't get into the lab until 10 or 11am most days; I'm not a

Left: A *Nicotiana benthamiana* leaf infected with virus to silence a gene involved in pigment biosynthesis in cells surrounding the leaf veins. *Above:* A pleiotropic maize mutant defective in the growth-defense metabolic tradeoff (see Abraham-Juárez *et al.* 2022).

morning person, nothing productive happens for me in the office until after 10am, and no one in my lab wants to see me until then! I usually check in with everyone in the lab at least once a day, just to see how things are going; sometimes those quick meetings turn into long discussions about future directions or troubleshooting experimental methods, sometimes my lab shoos me away back into the office. I also check on our plants as often as I can—we have plants growing all over campus, in growth chambers, greenhouses, and fields (in the summer), and I try to keep a close eye on them for any unpredicted phenotypes. Otherwise, most of my time is spent writing or reviewing manuscripts and grant proposals.

What do you most enjoy about your work?

I've always been drawn to academia for two major reasons: independence and social interactions. I am at my most creative and fulfilled when I feel self-motivated, rather than having someone else ask me to work on something, and academic research gives me that freedom to explore and to set my own schedule and expectations. That's not for everyone, but I always knew I wanted as much independence in my work as possible. I also do best when I am in a positive, collegial social environment. I love working with students, postdocs, and faculty who are excited about learning and discovery, it's inspiring and helps to keep me motivated and engaged. If anything, I have to keep myself from chatting the day away with students—it's easy to get lost in a fun conversation!

> "Keep your options open and stay focused on what matters to you... the precise topic you're investigating doesn't matter as much as finding a path that will leverage your strengths and push you to grow"

What do you find most challenging?

Like most faculty I know, I'm always struggling with the bureaucratic side of things: deadlines, grant administration, keeping up with e-mails, etc. I also think that science has an unpredictability factor: sometimes you're making rapid strides and accumulating exciting data to analyze, but sometimes there's a lull, and it can be challenging to keep focused on the long-term goals when there isn't much short-term return. This is especially an issue in plant genetics, since we often have to wait two or three years until a mutant is fully back-crossed to determine its phenotype, for instance.

What is your lab hoping to work on in the future?

I chose to center my lab's investigations around TOR because of the flexibility that affords. TOR is in every eukaryote, and touches on a wide range of biological processes, so we have the opportunity to move from TOR in any direction we find exciting. Currently, I'm most excited about better understanding how plants sense nutrients at a molecular level and how TOR signaling networks may have diversified across plant species.

What advice would you give to aspiring scientists in this area?

Keep your options open and stay focused on what matters to you, not what someone else thinks should matter for you. We're in a time when scientists can find careers in so many different directions—the precise topic you're investigating doesn't matter as much, in my view, as finding a path that will leverage your strengths and push you to grow.

Who are your scientific heroes?

I have many scientific heroes in my personal life, mentors and friends who have inspired me along the way. I'm also inspired by scientists who have engaged with public discourse in constructive ways, like Stephen Jay Gould and Richard Lewontin. More broadly, I would emphasize that science is collaborative: like an orchestra, we might put the conductor's name up front, but the performance is a collaboration that involves each musician. The hero is the orchestra.

Left: Some of the Brunkard lab, 2022. Left to right: Michael Busche, Ryan Martinez, Katie Klimpel, Erin Alberts, Jake Brunkard.

Selected Publications from SEB Journals

Abraham-Juárez MJ, Busche M, Anderson AA, Lunde C, Winders J, Christensen SA, Hunter CT, Hake S, Brunkard JO. 2022. *Liguleless narrow* and *narrow odd dwarf* act in overlapping pathways to regulate maize development and metabolism. The Plant Journal 112, 881-896.

Scarpin MR, Simmons CH, Brunkard JO. 2022. Translating across kingdoms: target of rapamycin promotes protein synthesis through conserved and divergent pathways in plants. Journal of Experimental Botany 73, 7016–7025.