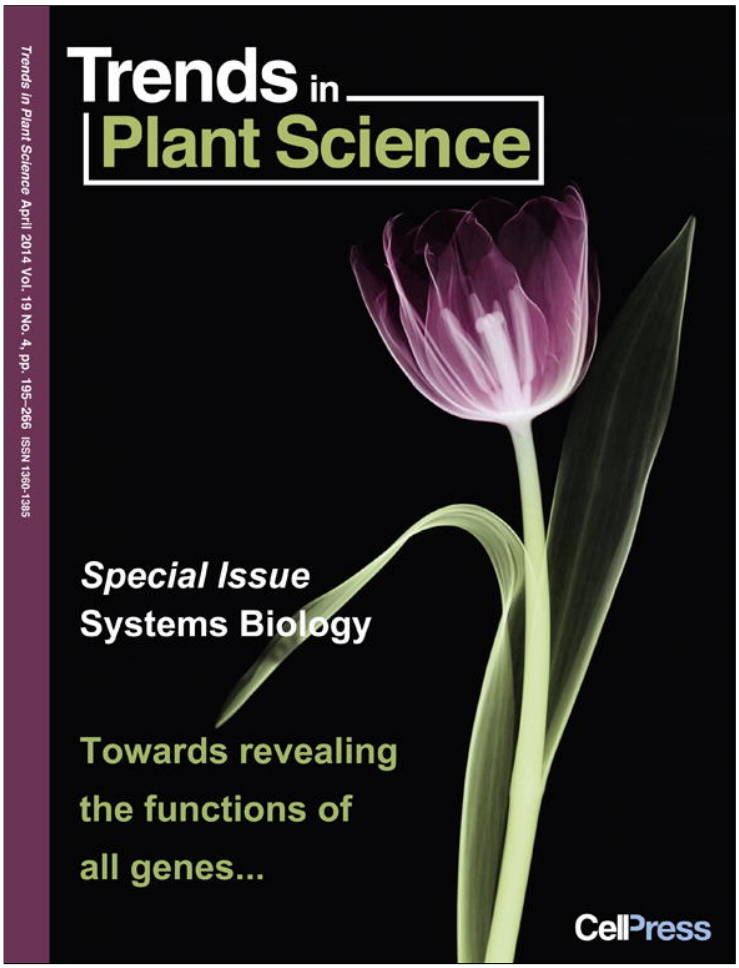

the inner drive that comes from doing something you love, it can be hard to get through the rough patches. I encourage students to try something new; for your PhD, work on a different topic from your undergraduate research, and do not be afraid to switch fields between graduate school and your post-doc. You will bring a new perspective to your new field and, in most cases, the change in topic will be invigorating.

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Interview with Daniel Kliebenstein

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Daniel Kliebenstein was born at Champaign-Urbana, IL while his father was a graduate student at the University of Illinois. He studied Genetics and Chemistry as an undergraduate at Iowa State University (BSc 1993) and Genetics as a graduate student at Cornell University (PhD 1999) where he worked on superoxide dismutase proteins and collaborated to clone the UVR8 photoreceptor. He then went to Jena, Germany to the Max Planck Institute for Chemical Ecology to learn quantitative genomics, ecology, evolution, and secondary metabolism by developing some of the first quantitative trait locus (QTL) cloning approaches to study variation in the *Arabidopsis* glucosinolate system. After 2 years, he started his own research group at the University of California, Davis in 2001 where he is currently a full professor. His biological research interests have largely focused on the interplay of plant metabolism and biotic interactions. This is a focused model system of his larger interest to understand how an organism functions in an unfathomably complex environment.

What influenced your path into plant biology?

While growing up, I spent a number of summers on the extended families dairy farm in south-western Wisconsin near a tiny hamlet called Truman. Besides the physical work, this also gave me lots of time to think, walk through fields, and work with calves. While spending quiet afternoons watching thunderstorms pass in the distance from an Alfalfa field on a hill, I gradually realized I wanted to understand how this whole thing worked. I always loved maths and biology so genetics and chemistry were a natural extension to work towards this understanding. The choice of plant biology was quite simply the fact that I can't see microbes and I can look into the eyes of an animal, thus ruling out both as something I could enjoy studying. Throw in the diversity of smells and tastes of plants and the use of quantitative genetics to study metabolism in plants to me seemed like a natural career path even in high school.

What is the biggest hindrance to science?

Numerous other individuals have already discussed external hindrances to science like funding, education, etc., all of which are important. However, I feel that it could be argued that the biggest hindrance to science as a long-term exercise comes from us, the scientists. When you read the Victorian scientists like Darwin, Bose, etc., they were focused on working to describe and study new biology and not simply prove the known. In contrast, modern biologists like to imagine that we know the vast majority of what is to be known and frame our research in terms of proving known hypothesis to get funding and acceptance. This focused validation of the known however may not be the most efficient way to expand our understanding of biology. One anecdote in support of this comes from the vast number of times someone has told me the following (paraphrased) 'You know I had this experiment that suggested what Dr Brilliant found and it was years before she found it. I just never followed up because it didn't fit what I expected and thus I always thought it was an error'. This invariable follows a talk about new biological phenomena like regulatory RNAs, potential role of methylation in maternal effects, etc. This shows that for various social and economic reasons that scientists tend to prove what is known seems at the cost of studying what is either contrary to existing thought or even outside of existing thought. It is in these dark neither worlds of scientific nescience that lies the greatest potential benefits to rapid scientific advances. It would seem that we need to devise a way to allow and encourage scientists to take greater chances in their research. Although these chances may lead to dead ends, they will also lead to more frequent leaps.

What big questions interest you in the long term?

I think that the big questions that interest me in the long term are also what I feel are the essential future challenges to making advances in biology and plant science. While attempting to compartmentalize my thoughts I think the majority of what fits as a big question for me is how we study an organism in the factorial and complex manner in which it really exists. For example, in

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my own research, the real question is not how this transcription factor controls that enzyme to mediate resistance to a specific insect. That is how we have chosen to parse the system and make the question seem askable. In fact, the real question is how an organism regulates its entire metabolism to control resistance to all of the biotic organisms that attack it throughout its life cycle. This question has multiple dimensions (plant age, metabolite, biotic organism, and abiotic environment) and it is the interaction across all these dimensions that the plant must solve to maximize its fitness (for ecologists or evolutionary biologists) or yield (for plant breeders and agronomists). In spite of this importance, we largely only focus on one of these dimensions and often using presence or absence of dimension (i.e., presence or absence of a pathogen) rather than using a quantitative spectrum of that dimension. We will have to move into studying systems not necessarily in their real world setting but at the very least making our model environment space bigger.

Moving from the current present/absent studies of a single dimension to quantitative studies of interactions across multiple dimensions is not a simple step as every included dimension begins to expand the experiment factorially. This will require developing the ability to routinely phenotype thousands to tens of thousands of plants in even the smallest of laboratories and potentially millions of plants per year in the larger laboratories. Moving to these studies of how plants respond to changes across multiple dimensions of their environment will be essential if we really want to be able to predict how a plant will respond to changes in the real environment where everything is changing, not just a single component.