ISB Systems Education Experiences

BOEING

SYSTEMS THINKERS IN STEM

A CONVERSATION WITH:

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Which systems thinking skills do you use?

#1: Explore Multiple Perspectives
Systems biology is inherently interdisciplinary, being able to provide different perspectives helps solve complex biological questions. We often work with engineers, biologists, mathematicians, and computer scientists, all providing unique skills and opinions.

#9: Identify Relationships
When one analyzes a system, there are connections (direct or indirect) that require clear analysis or a keen eye to identify patterns. For example, our team of researchers identified a set of genes from a set of 27,000 that may confer resilience in corals based on their unique expression patterns between habitats.

#14: Predict Future System Behavior
Using preliminary data we were able to predict and hypothesize that diatoms will be more resilient in acidified oceans. Eventually, we were able to test this behavior with a unique experimental design and a systems biology approach to validate this prediction, which eventually became a publication.

1. **What is your role within the STEM community?**
   As a research scientist, my role is to drive research that answers complex biological questions. In particular, I am interested in how microbes will manage the trade-offs between stress and the effects of climate change. This work involves writing grants, designing experiments, data analysis, and writing publications. In addition, a large portion of my work includes developing STEM curriculum and tools to help students understand critical STEM concepts. I also spend time mentoring for high school and undergraduate students throughout the year.
2. **What complex problem do you address in your work?**
   As anthropogenic practices continue to change the climate and particularly cause the ocean's pH to drop and temperatures to rise, there is a need to understand how organisms will respond and recovery to stress in their new environments. For instance, I am studying how diatoms, a keystone marine phytoplankton in coastal regions, will be impacted by ocean acidification. A significant change in their resilience could impact marine food webs across the globe. Additionally, coral reefs are extremely sensitive to rises in ocean temperatures and are at risk of extinction. Using a systems biology approach, we are trying to identify global transcriptomic signatures of coral resilience that can help prevent coral bleaching.
3. **What elements do you need to consider when addressing this problem?**
   When considering how to address complex problems, you need to design an experiment that captures the multifactorial environmental influences that organisms constantly face. This often times creating new reactor systems that can simulate and control various environmental factors like pH, light, temperature, CO_2, and many others. In doing so, you can simulate the various contexts you want to test. Another important aspect to consider is how to capture the dynamics of an organism's response. Often times organisms respond non-linearly to environmental factors, thus high resolution monitoring of their physiology is an important way to capture dynamic responses.
4. **How did you get to where you are today?**
   My research path started when I gathered the courage to ask a professor to work in his proteomic laboratory when I was an undergraduate student. I was a good student, but shy and didn't know what research really entailed. I started as a dish washer and eventually received my own research project which turned into a publication. This led to a research fellowship at Montana State University where I studied biofuel production in diatoms. Graduate school opened up a lot of opportunities for research, from thermophilic archaea in Yellowstone National Park to building photo-bioreactors to grow algae. This led me to a postdoctoral fellowship at ISB and currently a research scientist appointment. My career would not be the same without the support of professors and administrators that encouraged and gave me confidence along the way.
5. **What advice do you have for becoming a systems thinker?**
   My advice is to think of the inputs and outputs of a system. Ask yourself how one influences the other. Systems are all around us, and identifying how one factor impacts another is crucial to predicting future outcomes. Nothing happens in isolation, so identify the connections that explain what you see.