

CSBC Investigator Highlight

Dr. Douglas Lauffenburger Investigates Cancer Biology from an Engineering Perspective

Doug Lauffenburger, Ph.D., a CSBC Investigator at the Massachusetts Institute of Technology (MIT), has been integrating engineering and computation with biology throughout his long career. When describing his research journey, he said, “Systems biology was established and coined around 2000, but I didn’t see it as anything different from what I had already been doing for 20 years.”



As an undergraduate, he trained in chemical engineering and learned how to analyze systems using mathematics. However, he chose to apply his engineering mindset to biology in graduate school. When he started his academic career, he remained interested in understanding cell biology from an engineering perspective.

In this interview, he discusses his views and research related to cancer systems biology.

- **Why do you integrate systems biology and engineering to study cancer?**

Like most of biology, cancer is complicated. My lab characterizes it as multivariate, meaning there are multiple things all working together to yield an outcome.

To understand the multiple interactions of the many different components in a multivariate cancer system, we have to bring in engineering. Systems biology is grounded in the engineering mindset of predictively understanding multivariate systems.

Engineering allows us to predictively understand the effects of altering the individual properties of cancer. In other words, we can study how a change in one property affects other components and interactions within the system.

- **How do trainees from your lab use cancer systems biology in their scientific careers?**

Mentoring has been the most rewarding part of my career. The most gratifying thing of an academic career is the chance to interact with students and post-docs. I love that I can have a positive influence on their careers and lives.

Many of my former trainees are building their own careers in cancer systems biology. Some of them are currently involved in the CSBC in different ways. [Shannon Hughes](#) currently works as the director of the CSBC. [Aaron Meyer](#), [Kevin Janes](#), [Melissa Kemp](#), and [Pamela Kreeger](#), are a few of my former trainees who are currently investigators with different CSBC research projects.

It was a privilege to have these scientists in my lab and I couldn’t be prouder of what they are doing in own careers.

- **What recent technologies have contributed to your cancer systems biology studies?**

I wouldn't focus on or particularly emphasize tools, which often come and go. Some old tools get forgotten because of the hype of new tools, even though they may be just as effective. There's no particular tool that works best for every study.

The most important aspect of systems biology is the field's way of thinking. Investigating cause and effect in cancer requires multivariate analyses by computational models that are built on experimental measurements. The tools you use for making measurements or developing computational algorithms aren't the main point. The important part is the way that you think about the problem.

- **What challenge do you hope will be overcome by cancer systems biology?**

A crucial challenge in cancer is resistance to any therapeutic. It's hard to envision any single cancer treatment that would work for all patients and carry no risk of relapse.

There's always a fraction of the patient population that doesn't initially respond to a cancer treatment. Additionally, a patient often only partially responds to a therapy due to the heterogeneity and adaptation of cancer cells. There isn't a single, stand-alone cancer treatment that can eradicate an entire tumor.

We're always going to need combinations of cancer treatments. To understand the best combinations of therapies, either all at one time or in sequence, is a challenge that requires systems biology. Multivariate analysis through cancer systems biology is the only way to understand therapeutic resistance, and will help us determine ways to overcome it.

- **Can you describe your MIT CSBC center research?**

The current MIT CSBC center focuses on single-cell functional characterization of responses to cancer therapeutics. We are studying relationships between molecular measurements of cancer cells and drug responses to understand treatment resistance.

[Alex Shalek](#) and [Scott Manalis](#) are working on the technical platform side of this project. They are addressing the question, "What is a good single cell phenotypic response assay that can be directly related to single-cell molecular measurements?"

Collaborators at Dana Faber are helping us collect clinical samples from cancer patients undergoing drug treatments.

We work with [Chris Love](#) to examine single tumor cell responses to treatments within the context of the microenvironment.

This research will help us determine mechanisms of therapeutic resistance in cancer and approaches to combat this challenging clinical problem.

Links

[MIT Biological Engineering Profile of Doug Lauffenburger](#)

[Lauffenburger Lab Website](#)