I grew up during the personal computer revolution and spent a lot of time programming computers and building things that interfaced with them. That led me naturally into science. My high school had very good teachers in biology, physics, and math who sparked my interest in those fields. In graduate school, I made a conscious choice to migrate from mainstream physics and into biology. Physics is an interesting and beautiful field, but it’s also a mature science. I had the sense that the frontiers were closer in biology, and it was an area in which knowledge was expanding much more rapidly in all directions. I tried to make a career at the interface of the two fields.

For a number of years, my group has been developing new tools for biological automation. Now we are using those tools to do systems biology, and we are trying to bring some of the philosophies and ideas from physics into biology. We are also trying to use quantitative models and physics to describe life. Part of it is making physical measurements on molecules like transcription factors and predicting their biology. At that level, we don’t work with an organism, we work just with the molecules and ask if we can predict what the organism is going to do if we know something about the physics of these molecules and we know the genome. Is that enough to predict some biology? In some cases, yes.

We are also trying to use the tools of physics to look at biological dark matter. Most environmental microbes can’t be cultured; much of what is out there is dark matter, because it doesn’t admit to study by the most common tools of microbiology. We have been developing ways to isolate and sequence genomes from individual organisms to avoid the need for culture. Sequencing 16S ribosomal RNA gives you a sense of the diversity, but you’re missing all the details, and there’s so much to be filled in. It’s going to be an advancing frontier in science that will be unlocked in the near future.

Another area we’ve been focusing on is stem cell biology in the blood and in cancer. This again becomes a measurement issue—can you develop the tools to make genetic and biochemical measurements on small numbers of cells, or even single cells? Stanford is a fantastic place to do this work because there’s an enormous commitment here to stem cell biology; some of the senior faculty were involved in creating the California Institute for Regenerative Medicine (CIRM) initiative. I see the ability to develop new diagnostics and therapeutics coming from being able to dissect cancer stem cells.

I have also been involved in ultra high-throughput DNA sequencing. In 2003, we demonstrated the first single-molecule DNA sequencing technology, and it has now been commercialized. The $1000 genome is just around the corner, and when everybody will be able to have their genome sequenced, what’s that going to mean for privacy, health insurance, and decisions about human health? The technology is not going to let people escape these ethics and policy questions. Are we going to require people, based on their genetic inheritance, to modify their behavior, or just suggest it? Your insurance company could ask you to have a certain diet or they’re not going to cover you. Is that what we want? On the other hand, another consequence of the $1000 genome is people will start sequencing tumors, and that will enable customized therapies based on the genetic profile of each individual’s unique tumor. As has always been the case in human history, technology is not inherently good or bad—it’s simply a question of what use we collectively decide to put it to.

Robin Stinchcombe, my thesis advisor at Oxford, and Steve Chu, my undergraduate and postdoctoral mentor, were both very influential and shaped the way I do science. They led by example and by their style of doing science and I try to do the same.

In the coming years it will be hard to go into biology without having a quantitative background. My advice to young people is, if you want to become a biologist, you should major in physics or bioengineering as an undergraduate and move into biology as a graduate student.

I don’t think I could have predicted five years ago what I’m doing now. One thing leads to another in a way in which every step seems logical, but when I look back over a period of years, I’m a long way from where I started. I love doing science and I try to pass that on to people who join my laboratory. It’s a privilege to be part of the scientific community.

--As told to Lynne Lederman, a medical writer based in Mamaroneck, NY.