Biophysicist develops nanoscale measurement approaches to understand growth properties of cancer

March 10 2014, by Sathya Achia Abraham

Jason Reed, Ph.D.

Jason Reed, Ph.D., is a sort of research jack-of-all-trades. He has a broad base of knowledge to pull from – an undergraduate and master's degrees in physics and a Ph.D. in physical chemistry. While in his doctoral program, he focused on genome analysis of single DNA molecules. Since then, he has focused his research on biological systems – applying imaging approaches that look at how cancer cells grow or how they respond to treatment.

Along the way, he had a six-year stint in finance, gaining knowledge of the biotech and pharmaceutical industries, before jumping back into research at the California Nanosystems Institute at UCLA for 10 years. His work has been supported by the National Institutes of Health for the past several years.

Last fall, Reed joined the Department of Physics in the VCU College of Humanities and Sciences, where he applies his multidisciplinary talent to the development of nanoscale measurement approaches related to biological systems.

With an enterprising mindset, his sights are set on ultimately fostering commercialization of his applied technologies once they mature.

Below Reed discusses his ongoing research, where he sees his field headed, and his advice for rising young researchers.

Your research is a mix of physics, chemistry and biology – how does that come together to make your research possible?

Broadly, I look at measurement approaches on the nanoscale as they apply to biological systems. The focus is on small structures, such as single living cells and even individual DNA molecules. The techniques of measurement I use most frequently are optical interference microscopy and scanning probe microscopy, both of which are sensitive down to the sub-nanometer scale.

While those techniques were primarily developed and are used in materials science, we're adapting that to use in biological problems.

What biological problems/systems do you investigate?

One of my main projects is to develop ways to determine which genes are turned on within single cells. This is an important problem in many biomedical areas, but especially in the cancer field. For example, recent research has shown that even in early-stage cancers there are circulating tumor cells in the bloodstream that can be isolated in different ways. Researchers really want to be able to characterize those more deeply, but the material is limited in quantity and size, and traditional techniques are tough to apply. So, we need to develop a very sensitive technique of measurement in order to carry this work out.

I am just starting collaboration with Lynne Elmore, [Ph.D., associate professor of pathology] at the VCU Medical Center Department of Pathology. We hope to use scanning probe microscopy to analyze small numbers of cells present in the blood of patients who have been treated with chemotherapy. In this case, we will take pictures of molecules present inside the isolated cells. There is a lot of technology development involved with making this approach work.

In another project, in its very early stages, I am working with VCU and UCLA colleagues to use technology known as interference microscopy to measure the way light interacts with materials in a very precise and quantitative way. We are using it to measure the mass of individual cells to a very high precision – to the point where we can observe how cells grow over a matter of minutes. So instead of having to incubate the cells for days and count them, we can actually measure how they accumulate their mass over minutes in a cell culture. We can watch the cells and see which are growing faster, or which are growing slower.

We have applied this technique to drug response characterization and hope to use it as a rapid method of determining therapeutic response in certain cancers.

In breast cancer cells, we have shown that it is possible to quickly

measure the response of a growth-inhibiting drug such as Herceptin. We have also tested it on multiple myeloma using drugs that disrupt protein production and we can detect growth inhibition very quickly. Normally this type of analysis would take several days.

How could this work one day impact patient lives?

Both technologies we've discussed can be applied to medical diagnostics, in addition to basic research.

In the therapeutic response screening project, the idea is to actually test patient material directly to determine which classes of drugs are active and to also understand cellular heterogeneity in the patient's tumor. Because it's an automated microscopy method, we can measure individual cells rapidly and do not require a lot of sample material.

The same thing would apply to the AFM technique – it's a way to determine the phenotype of the individual cell. In other words, we want to characterize where these cells come from and their current biological state. Traditional histological techniques are only minimally informative at the single cell level, but if we can use genomic techniques, we can learn a lot more. By using tools of nanotechnology to perform the analysis, we hope to have a sensitive enough method.

Moving forward, where do you see the field headed?

During the past 10 years, there's been a push to measure smaller and smaller amounts of material. In the next 5 years, I think we will start moving some of these measurement techniques from the lab and apply them in biomedicine. This is possible in part because much more computational power is available today versus, say, 20 years ago, and much of the recent progress in quantitative imaging is attributable to

sophisticated signal processing.

You work with undergraduate students to postdoctoral researchers in your lab. What advice do you have for students looking to enter the research field?

Everything is very competitive, so it's a matter of hard work to distinguish oneself. Students today need to work hard and be focused.

Generally speaking, students interested in this field should be prepared with computer science skills and have a keen understanding of technology. In my lab, we focus on becoming familiar with the nuts and bolts of that kind of stuff.

If students are interested in pursuing research in measurement, nanotechniques or biotechnology, working in my lab may offer a broad range of opportunities. Due to the nature of my research, they would have a good chance of having exposure to things they wouldn't ordinarily be exposed to if they were traditional chemistry, physics, or biology students for that matter.

Provided by Virginia Commonwealth University