An Interview with Trachette Jackson

By Joe Gallian

Trachette Jackson is associate professor of mathematics at the University of Michigan. She received a Ph.D. in Applied Mathematics in 1998 from the University of Washington. Her research focuses on modeling the growth and control of cancer.

Jackson has held post-doctoral positions at Duke University, the Institute of Mathematics and its Applications at the University of Minnesota, and the National Health and Environmental Effects Research Laboratory of the Environmental Protection Agency. She is the recipient of an Alfred P. Sloan Research Fellowship and the Career Enhancement Fellowship from the Woodrow Wilson National Foundation. At the University of Michigan she received the Amoco Faculty Undergraduate Teaching Award. She is currently a co-PI on an NSF grant for a revolutionary program that will allow undergraduate students to develop knowledge and acquire skills in research areas that are at the interface of biology and mathematics. Jackson is a frequent invited lecturer at conferences and universities.

Joe Gallian: Did you start out as a math major in undergraduate school at Arizona State?

Trachette Jackson: No, I didn't. I entered Arizona State as an engineering major. I planned to go into aerospace engineering with hopes of maybe becoming an astronaut or something grand like that. But I had the good fortune to attend several math classes at Arizona State as a high school student, and I caught the interest of several math professors. They asked me what I was going to major in, and I told them engineering. They asked why, and I said because I'm good at math. I thought that that was the natural answer. They said "Why don't you major in math?" So I ended up changing my major in that first semester.

JG: Did you participate in research as an undergraduate?

TJ: I was fortunate enough to participate in an REU with a mathematical biologist while at Arizona State. That was my first experience in mathematical biology. I got to do a little bit of differential equations and see how they played a role in predicting growth of bacterial colonies. It was really great.

JG: Now mathematical biology is about the hottest field in mathematics. When you got started was it considered a hot field?

TJ: I think that it was just coming to the fore. I hadn't heard of mathematical biology and I had no idea that the two subjects could connect. I think that the faculty member whom I worked with was one of the only people doing it at Arizona State. I think that I was lucky to catch the wave at the starting point. I could have easily gone down a different path, so that was very lucky.

JG: So was that undergraduate research program pivotal?

TJ: Yes, it was. Research experience, as well as a particular talk that I happened to go to as an undergraduate, were huge factors in my decision to go into mathematical biology. Going to talks was required as part of the REU program; I would probably never have drifted into a math seminar as an undergraduate if it weren't required. I heard a talk by James Murray on how a leopard gets his spots. I didn't understand why this talk should be in the math department because it didn't seem like it should have anything to do with math. Even though I didn't understand very much of the talk, I saw that there were some exciting possibilities in mathematical biology, and I knew that that was the direction that I wanted to go in when I went on to graduate school.

JG: You and your husband sometimes work together on research projects. Is that harder or easier than working with someone who is just a colleague?

TJ: That's a tough question. In some ways it's easier, because we were trained the same way, we speak the same language as far as math and biology go, and our ideas often complement each other's. It's kind of nice to talk to someone who complements you that way.

Learning to talk math biology to biologists has been a process. It started when I was in graduate school. Luckily, my advisor pushed us out into the sciences. I was interested in cancer, so he made me talk to people who were working on cancer. I think that the fact that I started learning to communicate at that stage in my career has helped me today. That's something that I try to do with my students: to make sure that they're learning to communicate, to understand problems and be able to communicate what they've done mathematically to the audience that it's intended for, which is biologists.

JG: Your research must require you to spend a lot of time learning biology.

TJ: Yes. My experience with biology in high school and as an undergraduate was very minimal, so when I hit graduate school and made a commitment to working on biological problems, I had to really hit the books. I focused mainly on the biology that was relevant to cancer. By no means am I an expert on biology, I don't even have anywhere near a degree in biology, but my strategy has been to focus on the particular aspects that I work on.

What I find really exciting for those who are coming up now is that they don't have to do that, they don't have to be trained as a mathematician and then learn biology or be trained as a biologist and learn some math later. There are many programs now that are trying to get dual training at the very earliest stages in place. I find that prospect really exciting for these students and I try to convey that enthusiasm so they see what an opportunity they have, an opportunity that I wish I had when I was coming up.

JG: Do you attend biology colloquia and seminars?

TJ: Yes, I do, even when the thrust isn't mathematical. I think that those are sometimes the most exciting. I always do that when I am looking for a new project. That's the best place to find a new project, at a biological seminar. You see all kinds of experiments, and the wheels start turning about what kind of quantitative things you can do to help address the questions they're interested in, and often that leads to collaborations.

JG: I know someone who got interested in mathematical biology and started attending weekly biology seminars. He was surprised by the amount of arguing and criticism that went on. Have you been to biology seminars like that?

TJ: I have been to a few of those. At journal clubs where a paper is assigned, people rip it apart. It's a different culture over there. The students in biology seem to learn early that it's okay to critique published works. In math and even in applied math, when you read a paper, you believe everything that's in it. The biologists are on the other end of the spectrum. They go really, really deeply into what's been done before. I think that that's good, because they can then see how to advance science by doing things differently.

JG: In math we have proofs, and once something has been proven it's very difficult to overturn it. So maybe there is more room for speculation in biology.

TJ: Yes, there definitely is. And in math, if you read a proof that's really elegant and beautiful, that's the end point, and people don't ask themselves "Could I have done this differently?"

JG: Your NSF SUBMERGE grant seems like a very exciting project.

TJ: It's brand new, and we're going to start it this summer. SUBMERGE stands for Supplying Undergraduate Biology and Mathematics Education and Research Group Experiences. The goal is to bring teams of undergraduates together to work for an extended period of time on projects at the interface of math and biology. The way we plan to do it is to have two students who are concentrating in math working with two students who are concentrating in biology to form a four-person team co-mentored by a faculty member from the mathematical sciences and a faculty member from the biological sciences. They'll begin this summer with some intensive training to get everyone up to speed and on the same page and then they'll work on research projects during the year and take a specialized set of courses.

The goal really is to get them to do something that is cutting edge. The research projects, which I think is really the most exciting part of this, are coming from labs right there on campus, and in some cases are extending existing collaborations, but what I think is really exciting is that new collaborations will be forming between the students and the two faculty members.

JG: That's another significant difference between math and biology. Biologists seem to tend to work in fairly large teams.

TJ: Yes, they work in large labs and in large groups, and that is very different from the way mathematicians tend to work. I think that it's good for students who are concentrating in math to see how biologists run labs and it's also good for the biologists to see how mathematicians normally work. They need to find a happy medium if their goal is to be a scientist who works on problems that lie right at the middle of the two.

JG: Tell me about the mathematical biology research group at Michigan.

TJ: There are only about four serious math biologists in the department, plus a few others who dabble in math biology around the periphery of the subject. The four of us make up the core, but the group also includes faculty from biology and from the medical school. When you look at Michigan, it might not be easy to see from the outside how much mathematical biology is being done there. This group is trying to bring all those people together, at least for short periods of time. There's a seminar series, a distinguished lecture series, graduate students do a brown bag lunch where they talk about their own research to their peers. I currently have four graduate students and two post-docs and one undergraduate working with me.

JG: Do you a have special interest in getting students from underrepresented groups involved in undergraduate research?

TJ: Yes, I do. I have an interest in that at the undergraduate and at the graduate level. At Michigan, it's hard to find underrepresented minorities who are majoring in math. So what I do is spend time as an undergraduate advisor, so that I get to see a wide variety of students, some of whom may be thinking about math, and I get to give my input and maybe mentor and nurture the underrepresented minorities who I see in that way.

Teaching introductory courses has also helped me to find students who might want to major in math. Many students from underrepresented groups come in without testing out of calculus, so they're taking calculus or maybe a course before calculus. That's where I find a lot of students who just need a little encouragement to do well in math, and then they can go on and declare a math major and actually succeed in it. So it's not easy to find them, but once you find them it only takes a little encouragement and for someone to show a little interest for them to realize this could actually be a possibility for them.

JG: A major problem that math has is that when students come out of high school, they don't think of math as a career, even if they're good at math.

TJ: Our web site has a link that addresses that question. It shows some career choices for mathematicians. It shows where some of our undergraduates have gone, and what career paths some of our graduates have taken so that undergraduates can see some of their options and that there is a wide variety of opportunities.

JG: Have you written joint papers with biologists? Where might these be published?

TJ: Yes, I often write joint papers with biologists. In fact, the first papers that I did when I was a graduate student were with biologists, and I have continued to work with biologists. My most exciting work is hopefully still to come, and I will definitely have biological co-authors.

There are math biology journals that focus on publishing mathematical biology papers, and I publish in those. I really strive to publish in the biological journals of my fields. My field is cancer research, and the very top journals in this field are *Cancer Research* and *The British Journal of Cancer*. When I was starting out, it was very uncommon to see a mathematical modeling paper in one of those journals. Now it is becoming a little more commonplace. But it's still very difficult to get a mathematical modeling paper in the top biological journals.

JG: Some major research universities are making mathematical biology an area of special focus by putting a lot of resources into it. Is that true at Michigan?

TJ: Yes, Michigan is very interested in promoting math biology, and they are putting their money where their mouth is, so to speak. We had a college-wide theme semester in mathematical biology that got a lot of recognition for our group and for the subject.

JG: I noticed that you received a faculty award for teaching. Was there some particular facet of teaching that was a major factor in your getting it?

TJ: When I first got to Michigan, the only math biologist they had left, so I could come in and start developing courses. I started with the undergraduate courses in math biology, and they sort of took off. It's been a great experience.

JG: Does Michigan have a separate calculus course for biology students?

TJ: No, we don't yet. But as part of the SUBMERGE, that's something that could definitely happen. We're talking about getting calculus modules put into intro biology courses and putting biology modules into a calculus course. At the later levels, such as in differential equations, we're trying to do something similar. We're trying to get some experimental components put into the modeling courses, where part of the course will be to do some simple experiments to collect data and then model and analyze it.

JG: You said that there might be calculus modules put in biology courses. Does that mean that biology students take calculus before biology?

TJ: No, not right now, and that's a problem. One of the biggest problems we have is that students who are majoring in biology often wait until the very end to take their math requirements. We want to get that turned around a little bit, and maybe pilot something where math is incorporated gently into one of the biology courses.

JG: It seems that everything you do uses differential equations. Do you use any discrete mathematics?

TJ: It's true that most of my work uses continuous methods. But now there's a big buzz in the field for combining the two, looking at both continuous and discrete methods. For some things it makes sense to use continuous models, but for other things, like individual cells, it makes sense to treat them as discrete entities. I have a student right now who is building a model of blood vessel formation, and we are using discrete components for cells and continuous components for chemicals and things that govern how they move. This is really my first venture into discrete modeling, and I'm finding it very interesting and very applicable to the work I do.

JG: Have you used any combinatorics?

TJ: No, I haven't, but I have sat on a dissertation committee for several students who were interested in bioinformatics and used combinatorial techniques. But I haven't used it in my own research. I do think that that is a way to bridge more pure approaches and the biological sciences. People sometimes ask me if I always have to use differential equations. The answer is no, biology is so immense that there are questions that can be answered with almost any type of mathematics.

JG: What goals do you have for yourself 5 to 10 years down the line?

TJ: Hopefully I will be a full professor! I hope to still be doing research at the level that I'm doing it now, but at the same time I want to start switching gears to really focus on the issue of minority graduate education. I really would like to see the university that I'm associated with have significant numbers. Right now we're not there, but I think that there are a handful of us who are committed to working on that. Being still relatively junior, there has to be a trade-off between research and the other activities that you want to do. I see myself in a few years being able to handle switching gears a little bit better.

JG: Is there anything else you would like to point out?

TJ: It really does seem that luck has followed me throughout my career. I went to the University of Washington in hopes of working with a person I saw give a talk, and it worked out, I ended up getting my dissertation under Jim Murray. I also had the good fortune of being mentored as a post-doc by another leading figure in math biology, Mike Reed at Duke. I think I really have had these angels on my shoulder throughout my career, and I hope to be the angel on someone's shoulder as they come along.