

Some of the Not-So-Scientific Discoveries ...That I made as an Undergraduate Researcher Celine Santiago, '09

I was walking across campus one day when a guy with a voice recording device stopped me and asked if I'd be willing to talk for thirty seconds about Rice student life. I must not have seemed very enthusiastic because he insisted I could talk about "anything that mattered to me." I accepted. When he asked, "What has been the most memorable part of your undergraduate experience?" I started talking about zebrafish and fluorescently labeled embryos, hands-on experience and great mentors, and – "Um, is there anything other than research that you'd like to mention?" I blinked. "Well, yeah, there's the college system and classes, all that, but – " "Yeah, that'd be great, can you talk about that, please?"

So for everyone who already knows about the college system and classes, or for anyone who wants to know what it's like to try research as an undergrad, here is my story. Naturally, there is no single 'Undergraduate Research Experience at Rice.' It will depend both on the lab and on the student. Many undergrads probably find it difficult to balance lab with classes, college life, sports, and other hobbies. In the end, though, it all comes down to a conscious decision. We distribute our time according to what matters to us. If you ask any undergraduate researcher what his or her experience is like, the specifics will change, but all of them will agree that they get out as much as they put in. So I can only speak for myself when I say that joining my lab was probably the best academic decision I made while in

college. It's been a lot of fun, and it's helped me figure out what to do after I graduate, but what I really want to talk about here are the ways in which I have been challenged, and the things that I have learned. Research is hard, but all of the things that make it hard are the things that make it worth it.

I joined Dan Wagner's lab at the beginning of the second semester of my freshman year. He and Mary Ellen Lane are the two Rice faculty members who work with the zebrafish as a model organism for embryonic development. I started looking for a lab with the idea that I wanted to work on development, a topic that strongly appealed to me even though I knew very little about it. All I knew was that every cell in my body contained the same DNA, and the process by which all of these cells came to be different seemed like a huge, exciting mystery.

From the beginning, I found my research topic fascinating. We try to identify genes that are important for cell and tissue movements during development. I've worked on several different projects over the last two years, and I've learned more than I ever would have expected. I learned a handful of technical skills, sure, like how to inject embryos at various stages with RNA, how to navigate the compound microscope, or how to tell adult male and female zebrafish apart. I developed more intellectual skills, like how to think of ways to answer a specific question by using the tools available, how to succinctly summarize my data for a group, or how to fit what I was doing into the bigger picture. I

also learned a fair amount of developmental biology itself, just by exposure through background reading and lab meetings. But honestly, the biggest revelation, for me, was discovering what science is



Above: Celine Santiago's lab group in Dr. Daniel S. Wagner's Zebrafish Lab at Rice University. Right: Celine Santiago. (Both photos courtesy of Santiago)

truly like.

I'd had no prior research experience, and even though I loved biology, I wasn't initially convinced that I would actually enjoy research. I had always been slightly dysfunctional with school-related labs. They seemed boring and pointless, and I'd always end up knocking a beaker over or forgetting to add HCl at some critical point. But I soon realized that research was nothing like any prior educational experience I'd had. It is a very different way of learning; it has a different final goal. In many introductory science classes, we spend a lot of time taking in massive amounts of very detailed information. This is fine, since in the end we manage to avoid nervous breakdowns and we retain a sense of the bigger picture. In teaching labs, most of us are just doing the work so that we can get the expected result and get out of there (go eat dinner, pass the course, get on with our lives). That's fine too, since those classes still provide a structured, straightforward introduction to basic experimental procedures and theory.

But when we do research, we're a part of something much bigger. We can have various motivations for doing the work: 1) it's a much more entertaining way to spend the afternoon than studying, 2) it will help us learn new skills that will open up doors for the future, 3) we're so engrossed by the research question that we lose sleep over failed experiments and we want to know if it works this time, 4) we feel valued by a team that we have somehow become a part of, and contributing to something bigger than ourselves gives us a sense of purpose, or 5) all of the above. In any case, the nature of the investment is very different than for schoolwork, and perhaps this is why it comes as a bit of a shock when things don't run smoothly.

Science is slow, and failure is normal. I was surprised, at first, by how often my experiments didn't work, but after a while I realized that I'd get there in the end. I just had to keep trying. Patience and perseverance are almost always rewarded. True, luck will come into play, but it's like everything else in life: there are so many things outside of our control, but we can't focus on those. We'll go crazy if we do. We need to focus on what's in our power. Analyze our options, pick one, and keep going. Sooner or later we run into that beautiful day when everything goes right and we get so much done and something really exciting happens, and then it's all worth it.

Another major thing that surprised me was the extent to which research is based on human interactions. It is an amazing feeling to be surrounded by people who are eager to share their

Things Every Undergraduate Researcher Should Know

- Science is slow, and experiments usually don't work
- The trick is to keep trying: it makes success that much more rewarding
- The human interactions are what make research what it is
- It feels really good to realize you are a part of something bigger than yourself

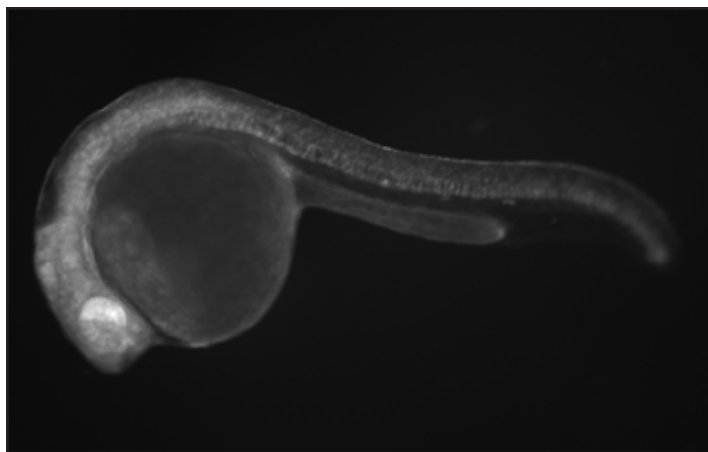
passion, to answer my questions, to listen to ideas – it is difficult to explain the extent to which this has transformed my academic life. Without the others to guide me and make me think deeper, go farther, push my own intellectual limits, I wouldn't have grown or learned nearly as much.

I have decided to go to graduate school, because I cannot

imagine not being able to do this after I graduate from Rice next year. I know that my experience is not everyone's, but I think that many types of students can get a lot out of research. I have heard pre-meds comment that it has helped them learn "how to think", as well as how to keep trying. And it's good for any science major to get a glimpse into how the process of knowledge actually happens. Again, I can only speak for myself when I say that I don't regret the time and energy I've committed to research. I think

that people from any discipline can relate to the importance of finding one's passion. It doesn't have to be your career—I know a friend who lives for music even though she is a Bioengineer—but somehow, I stumbled upon mine here.

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A one-day-old zebrafish embryo expressing a fluorescent protein. (Image courtesy of Celine Santiago)

