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Thoughts on Why I Love School

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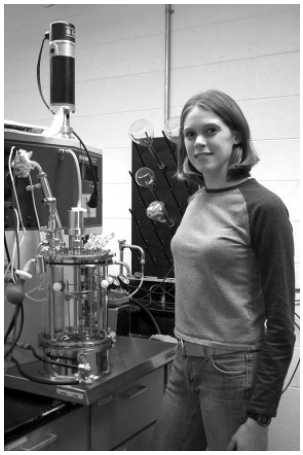
If there is one thing you should know about me, which I will admit to you with pride, it is that I really like school. Oh yes, I was that kid who got so excited to go back to school in August that I couldn't sleep the night before the first day of class. In fact, when I think about the course of my life thus far, other interests seemed to come and go, but my love for learning has remained constant. Now I know that some may question why anyone would think that school-work is fun, so I must explain why it is that I truly enjoy going to class, doing homework, and learning new information (at least most of the time).

Before I go any further, I should mention that all subjects do not share my love equally. While I do find almost any class that I take to be interesting and beneficial in at least some aspect, my passion has always been science and math. Curiosity is part of my nature, and so I am amazed and excited each time I learn something new about how things work.

When I took AP Biology in high school, I realized that it is the existence and workings of living organisms that amaze me more than anything else. I find that this feeling of wonder returns again and again, each time I take a new class and reach a new level of complexity and depth in my knowledge. Biological systems are so incredibly complex that it would be nearly impossible to know everything, or even most things, about most of the systems found in a particular organism. At this point, we can at least come very close to complete understanding of very simple organisms, but when it comes to the elaborate workings of our own bodies, understanding becomes much more difficult. It seems that, as more is learned about biological systems, the levels of complexity deepen and new questions emerge that must be studied.

As a Biology and Chemistry major here at UK, I have had the opportunity to take some very interesting classes that have sparked my curiosity. Yet, I often felt myself wondering what it was that my professors weren't telling me — what else is there to know that has not yet been uncovered? Being able to take part in new scientific discoveries



is one of the main reasons why I wanted to be involved in undergraduate research.

As a sophomore I had begun working as a technician in Dr. Sylvia Daunert's Bioanalytical Chemistry lab. As I learned about the research going on there, I found that it utilized an interesting mixture of concepts from Biology and Chemistry for analytical applications. I already knew that I wanted to be involved in research and Dr. Daunert's lab seemed like an exciting place to get started. Luckily, she always has room for more researchers, so I started working on my own project in the lab the next summer. Dr. Daunert is involved in developing biosensors that can be used for a wide range of analytical applications. Many of these biosensors employ fluorescent and bioluminescent proteins that enable detection of a molecule of interest as a result of the readily measurable light they produce. The methods that are used to couple the light emission of these proteins with the presence or activity of a particular molecule are often quite innovative and fascinating. Really, you are simply taking advantage of a system that nature has already produced, and using it in a clever and applicable way. Sensing systems for markers of heart disease, environmental toxins, and many other important molecules have been developed using biological systems in Dr. Daunert's lab.

On my Research Project

The main project that I have worked on in the lab involves the use of a fluorescent protein, GFPuv, for arsenic detection. This project is exciting because it incorporates aspects of molecular biology, mechanical engineering, and analytical chemistry for the creation of an optimized biosensor. This sensor makes use of a natural resistance that some bacteria have to arsenic. The genes that confer resistance on the cell are grouped together in the *ars* operon and are only transcribed when arsenite (an arsenic ion) is present in the environment.

We can make use of these genes for sensing purposes by engineering the gene for the fluorescent protein GFPuv into the DNA of the operon, so that it will also be expressed when arsenite enters the cell. Because the ars operon is transcribed more often when a greater amount of arsenite is present in the cell environment, the amount of fluorescence produced by GFP should be related to the concentration of arsenite in the environment. Using bacterial cells as sensors may actually provide useful information about the concentrations of arsenic that would be harmful to humans and other animals. The bacteria will only 'sense' arsenite ions that pass through their cell membrane and, in effect, they help us to quantify the bioavailablilty of this toxic compound.

We are working toward making this type of whole-cell biosensor a completely portable system that could be taken directly to a contaminated site. The ability to test environmental samples quickly and simply could provide tremendous advantages over current testing methods, which often require expensive equipment and skilled technicians. The basis for our portable sensor is a centrifugal microfluidics platform that needs only a minimal number of samples and amount of reagents, and has a

built in mixing system. We have found that we are able to detect levels of arsenite more rapidly in these miniaturized samples than with larger volumes of samples and reagents. In the future, this system could be automated, so that someone with minimal training could simply inject a water sample into the device and receive a readout indicating the level of arsenic in that sample.

This biosensing system could perhaps be utilized in areas of the world, such as Bangladesh, that continue to have problems with arsenic contamination in groundwater. The advantages of the centrifugal microfluidics platform used in this system could also serve as a model for the development of biosensing systems for molecules that require frequent testing in a hospital, such as markers of disease or infection.

On Being a Beckman Scholar

I must say that being named a Beckman Scholar at the University of Kentucky has been vital in shaping both my last year and a half as an undergraduate and my future goals and aspirations. The resources that the Beckman Foundation has generously put within my reach have allowed me to truly experience the life of a researcher as an undergraduate. In the past year I have had the opportunity to travel to several scientific meetings, at which I presented my research to other scientists and students. I will also be traveling to an international conference in Spain this summer. These presentations have been a wonderful learning experience for me because they required me to explain the ideas and impacts of my research to other people from a broad range of scientific backgrounds. I realized that I developed a better understanding of the scope of my research after each presentation.

Beyond the valuable learning opportunities provided by research and presentations, it is quite exciting to know that I am now an integral part of the worldwide scientific community. There is definite personal satisfaction to be had from seeing your name in print attached to something that you worked hard to accomplish. Just for fun, I recently typed my name into the "Google" search engine and found several hits related to the research I have done in Dr. Daunert's lab. Being a Beckman Scholar has helped me to get my name out into the world of science and also to make a clear decision about my future as a scientist.

Before I began doing research, I was unsure of my future career plans. I had no idea what life as a graduate student was like and, frankly, the thought of getting a doctoral degree sounded a bit daunting. However, just a short time working in the lab erased any fears or uncertainties I may have had about graduate school. Being able to interact with and learn from current graduate students and post-doc's has been an invaluable experience for me. These students treat me as their equal, and I now find that I am answering questions almost as often as I am asking them. My time doing research as an undergraduate helped to finalize my decision to attend graduate school next year. I now feel confident that I know what to expect from a graduate program, as well as what will be expected of me.

The opportunities I have had here at the University of Kentucky are an excellent preparation for what lies ahead of me. In the fall, I will be leaving for the University of Wisconsin-Madison where I will pursue a Ph.D. in Nutritional Sciences. I really like the idea of studying this subject because its applications are so obvious and practical. I think that most people do not have an appreciation for how profoundly nutrition affects every aspect of their lives. When you consider it for a moment, you realize that what you are putting into your body is becoming a part of you and will affect you in countless ways. There are obvious needs in all parts of the world for a clearer understanding of the complex ways in which our bodies are affected by nutrition. I hope that my future research in graduate school and beyond will make a significant contribution to this effort.

The following is a list of the presentations that I have made at the conferences I was able to attend thanks to the Arnold and Mabel Beckman Foundation. I have included those presentations to which I made a significant contribution, as well as the publications that I have co-authored.

Jessika Feliciano, **Anna Rothert**, Sapna Deo, Libby Puckett, Lori Millner, Jan Roelof Van der Meer, Marc Madou, and Sylvia Daunert. "Bacterial Biosensing Systems for Arsenic Detection: From the Laboratory to the Field**."** 2003 Superfund Basic Research Program, Hanover, NH, November 9, 2003.

Anna Rothert, Sapna Deo, Libby Puckett, Lori Millner, Marc Madou, and Sylvia Daunert. "Adaptation of a whole-cell based reporter gene assay for arsenite and antimonite to a compact disc centrifugal microfluidics platform." 55th Southeast Regional Meeting of the American Chemical Society (SERMACS), Atlanta, GA, November 16-19, 2003.

Received 2nd place award for presentation of this poster at the undergraduate poster session at the SERMACS conference.

Received an honorable mention award for presentation of this poster at the Regional Undergraduate Chemistry Poster Competition at UK, April 23, 2004.

Delegate to the 8th World Congress on Biosensors, Granada, Spain, May 24-26, 2004.

Anna Rothert, Sapna K. Deo, Lori Millner, Libby Puckett, Marc J. Madou, and Sylvia Daunert. "Whole Cell Reporter Gene-Based Biosensing Systems on a Compact Disc Microfluidics Platform," submitted for publication in *Analytical Biochemistry,* 2004.

Urvee Desai, **Anna Rothert**, Sapna K. Deo, and Sylvia Daunert. "Bioluminescence Properties of Obelin Mutants: Influence of the Native Cysteines in the Generation of Biolum-inescence," *in preparation*, 2004.