FACES OF MASS SPECTROMETRY / Elyssia S. Gallagher

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At the End of the Day, We Are All Just People

Elyssia Gallagher is an associate professor at Baylor University, where she leads a lab group that specializes in developing novel methods to analyze biomolecules such as proteins and glycans using mass spectrometry techniques. She became interested in analytical chemistry during graduate school after joining an interdisciplinary biological chemistry program, which featured lab rotations between three departments. After a postdoc position and transition to academia, Elyssia remains inspired by the countless directions that analytical chemistry has to offer in terms of research objectives and paths to discovery.

As a committed educator, Elyssia devotes time to numerous programs that create new opportunities for a diverse range of students in her community. She is a member of the Baylor Women in the Academy Group, which connects participating mentors with female graduate students from across the university. She also coordinates an on-campus instrumentation workshop offered to undergraduate students enrolled at smaller schools from the surrounding region. In addition, Elyssia contributes to a program that provides continuing education to local high school teachers and offers lesson plan modules designed from a unique professional perspective.

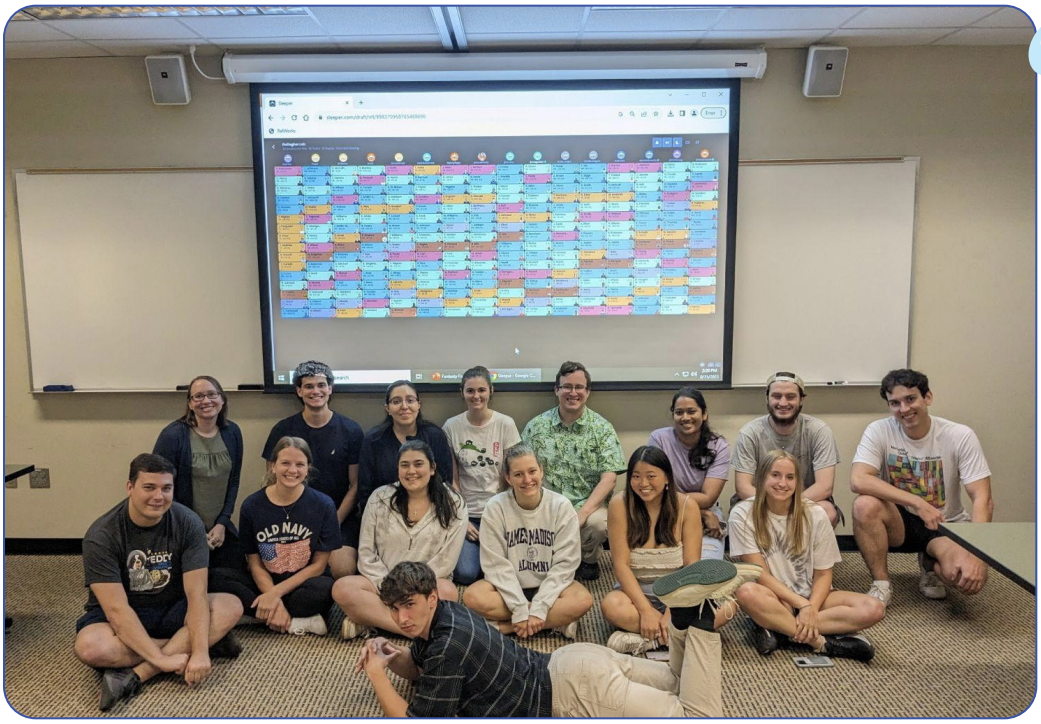
For the students who join her lab, Elyssia wants them to be prepared for whatever career path they may ultimately choose to pursue. To do this, she emphasizes the refinement of soft skills such as writing and oral presentation, in addition to lab-based competencies. She also recognizes the importance of building strong connections and celebrating each other's achievements. In the past, this has taken the form of kickball games, trips to the rodeo, and piñata parties.

How did you get your start in mass spec? What led you to your current position at Baylor?

My graduate studies were in analytical chemistry. But I did separation science as a grad student. When I was transitioning to my postdoc, I really wanted the opportunity to learn mass spec; so, I specifically targeted opportunities where that would be possible. I talked to faculty who were in mass spec fields with different research applications, and I ended up doing a National Research Council postdoc at NIST. When I started as a postdoc, that's when I really started getting hands-on with mass spec. In terms of what led to my current position at Baylor: I had always been interested in the academic environment, because I think it's fun to have a place where you get to talk about and develop ideas. I also enjoy being surrounded by students who are excited about their research. When I was doing the NIST postdoc, it let me explore research in a national lab—and as much as I enjoyed it, there were still aspects of the academic environment that I missed. So, I made the decision to go back into academia, sending out applications and whatnot. I started as an assistant professor at Baylor in 2015 and went through promotion and tenure. Now, I'm an associate professor.

When did you realize that you wanted to become a scientist?

I liked science all through elementary and high school. But it wasn't until college that I really considered being a scientist as a career. Before that, I was one of those students who thought that if you liked science, it meant you became an "MD" sort of doctor. So, in college, I began on the premed track, and I really liked the classes I was taking. I ended up with a double major in molecular and cellular biology and chemistry. But at the same time, the research I did at the undergraduate level became highly informative in terms of where I wanted my future career to go. It showed me that with science, there really are a lot more opportunities than just as a practicing medical doctor. So, seeing what those opportunities were is what guided me into becoming a scientist, and being involved in research was probably the biggest reason that I am where I am now.



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Fall 2023 Fantasy Football Draft! From left to right: Back row: Elyssia Gallagher, Andrew Pritchard, Ana Quintero, Alexis Edwards, Jacob Hatvany, Irushika Senarathne, Hadden Swanzy, Michael Cordes; Middle row: Darren Gass, Jessica Conforti, Madeline Bannon, Lyssa Garber, Emma-Le Olsen, Amanda Ziegler; Front row: Connor Breus. (Photo courtesy of Jessica Conforti.)

When did you specifically decide to focus on analytical chemistry?

I went to grad school at University of Arizona. One of my two undergrad majors, as I mentioned before, was chemistry, and that's the subject I wanted to focus on in grad school, because I really enjoyed the way chemistry guided biology. So, in starting grad school, I joined an interdisciplinary program, which was the biological chemistry program. It was interdisciplinary between three departments: chemistry, medicinal chemistry (which was part of the College of Pharmacy), and biochemistry. In this particular program, new students were required to do rotations in at least three labs. In my first year, I was exposed to different types of research in inorganic, analytical, and pharmaceutical labs. In my rotation in the analytical chemistry lab, I discovered the many ways that measurements could be applied and how new methods could be developed to address important biological questions. I found that in analytical chemistry, there were so many different directions you could go with your research—that's what really drew me to the field.

Is there a specific advancement in the field of mass spec analysis that has significantly influenced your research?

We do a lot with electrospray ionization, including using it as a reaction chamber. But we're also really interested in how the process of electrospray yields the gas phase structures that we monitor in mass spec. While this isn't a "new" development, it's something that's extremely valuable to us, and so we spend a lot of time thinking about it. One cool story: When I first started at Baylor, my students bought a little beta fish that sat in the window in the student office. We named that fish "John Finn," as a play on John Fenn's name, who was, of course, awarded a Nobel Prize for electrospray ionization. My current grad students all remark that if you join our group, you will have a very thorough understanding of electrospray and every group meeting, seminar, and research talk will contain at least one electrospray slide. The ongoing joke among them is, "Are you really a member of the Gallagher lab until you present detailed electrospray slides in group meeting?" Beyond electrospray, there are a lot of toys that we enjoy using—and by "toys," I mean "instruments"! As an analytical chemist, I think new methods can be enabled by novel instrumentation. I am blessed here at Baylor, because we have a mass spec facility that has many different resources available to us in terms of different instrumentation types. This provides us with more opportunities to take research in new directions.

How has your participation in the Baylor Women in the Academy group helped you to grow as a scientist, in terms of receiving mentorship and also learning how to be a mentor to others?

The biggest part of this program is faculty mentorship toward female graduate students. But the program has also provided more insight into mentoring as a whole—different ways you might think about mentoring, along with how to approach the different challenges that come with it. What I really enjoy about the program is getting to mentor graduate students from across campus, whether at the PhD or the master's level, who are not necessarily specific to my department—actually, they occasionally aren't even studying the sciences! It has been fun to be in an environment where I get to learn about different types of research across campus and hear about graduate students' experiences

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After the Rage Room. From left to right: Jessica Conforti, Michael Cordes, Elyssia Gallagher, Amanda Ziegler, Ana Quintero, Jacob Hatvany, Darren Gass, and Alexis Edwards. (Photo courtesy of Jessica Conforti.)

outside of a chemistry lab. It's also very rewarding to be able to present ideas to students or provide support in different ways. A lot of times, the mentoring is not so much focused on research, but rather focused on how to develop skills that could be valuable in future jobs or in advocating for oneself. This semester, we're talking a lot about writing and presentation skills, which are both important for students as they think about their future career paths.

Tell us about some of your efforts at Baylor to promote diversity and inclusion. What has this entailed?

I am currently a member of the DEI Committee for the Department of Arts and Sciences. There is a representative from every department, and the committee is subdivided into different areas. I serve as the chair of the DEI Subcommittee for Faculty, and we try to think about how we can recruit and retain a diverse set of faculty members that are not only representing the student body more accurately, but also providing different viewpoints. Because these committees have faculty members from across all the departments in the College of Arts and Sciences, it has been insightful to see how different people think about diversity and inclusion. The concept of diversity itself can be very different depending on the field. In chemistry, for example, we may think about diversity in terms of the types of people doing the research, which may affect the types of research to some extent. But in English, they might view diversity as bringing in researchers with very specific research interests that provide diverse perspectives. Beyond that, though, I also want to work with a diverse group of students who are comfortable talking about different life experiences and/or sharing their different perspectives. So, I'm trying to make sure there's an inclusive, respectful environment for the students who are present in my lab, the department, and around campus.

How has working on the Baylor annual Advanced Instrumentation Workshop helped you grow as a scientist, in terms of working toward a diverse and inclusive environment?

As background to what this event is: It's a two-day workshop that our Department (the Department of Chemistry and Biochemistry) has hosted at Baylor. This has been the 16th year we have hosted this event. During those two days, we invite undergraduate students and faculty from small schools in Texas, and the surrounding region, to Baylor's campus. Over the two days, the visiting students and faculty attend three instrument workshops.

The goal is for the visiting students and faculty to be exposed to research instrumentation that might not be present at their home institution, particularly if they're at smaller schools. In each workshop, students get to learn about the instruments and run an experiment where they collect their own data. In the mass spec workshop that my lab hosts, the visiting students perform a tandem MS experiment to sequence a peptide, showing both the analytical capability of mass spec and its relevance to biochemistry research. Over the two days, we also offer information sessions. For the visiting faculty members, for example, we offer grant writing workshops, and for the visiting students, we offer a discussion panel on graduate schools and what might be done with a graduate degree. This workshop is designed to be an opportunity for students to not only see instrumentation, but also get more information on future scientific careers.

Since starting my position at Baylor, I've hosted a workshop each year, but last year, I actually co-organized the event on campus. Every year, I have incorporated my own graduate students in running the workshops—that way, they get the chance to teach undergrads and answer questions about their research and graduate school. We have now had 52 schools and almost

500 students participate in this workshop, and it's just such a great chance for students who don't have as many resources for research on their own campuses—it lets them know that they, too, have career opportunities in analytical chemistry and other fields of science.

Tell us about the achievements that led to your receiving the CAREER Award from the National Science Foundation.

My CAREER Award, like all CAREER Awards, had two different parts: A research component and an educational plan. In terms of the research component, this particular award has supported the work in my lab where we have developed methods to utilize hydrogen/deuterium exchange-mass spectrometry to label carbohydrates. In particular, as I mentioned before, we do these exchange reactions during electrospray. In terms of the educational plan, I wanted to focus on high school students. I discovered the value of chemistry and the opportunities that exist for scientific careers when I got to college. So, in a lot of ways, I think it would be great to have high school students get to see not only what you can do with science, but also different scientific fields and how science can be applied to aid society.

So, for the educational plan of my Career Award, my goal has been to host teacher training workshops, particularly focusing on high school teachers. I work with a group here in Waco that supports 12 different counties and their school districts, and we provide continuing education opportunities for high school teachers. I have developed lesson plans that these teachers can drag-and-drop into their regular curriculum. Oftentimes, these are lab-based activities, as well as activities focusing on making connections between chemistry and bioanalytical concepts. It's been really fun to interact with these teachers, and to see how these materials can provide high school students with different ways of thinking about what they are learning.

What excites you about your current work? Are there any new topics or questions you hope to explore in the future?

As I mentioned before, my CAREER Award uses electrospray as a reaction chamber in the instrument. So, we're actually doing chemical labeling reactions in electrospray droplets. This has led us to think deeply about what's occurring to analytes during the electrospray process. Recently, my lab has taken a deeper dive into the fundamentals of electrospray, analyte charging, and thinking about the gas phase ion structures that are formed. We are trying to delve into how electrospray impacts our gas phase measurements, and how we can use that information to inform our understanding of the analytes in biological, solvated systems.

In addition to lab-based skills, what are some other strengths you aim to develop for students who join your team and why?

In my lab, I really want students to become professionals—not only in terms of designing experiments, but also in terms of speaking and writing. Presenting and writing are extremely important skills, regardless of career path—whether students stay in academia, go into industry, go into consulting, or take a path that moves away from the research environment entirely.

So, in terms of soft skills development, those are the skills that are emphasized most in my lab. I have observed that with most of my students, practicing giving a talk or presenting a poster makes them more proficient and confident. But one big challenge is that listeners ask questions; and you can't always predict what the questions will be to prepare for them. So, in my group meetings, I try to prepare students for this by doing follow-up presentations. If students get questions in group meeting that they cannot answer, the following week, they are expected to come back to group meeting and present the answer. Some of my more senior students said that they hated doing these presentations when they first started in the group, but they came to appreciate it later, because it made them start thinking about their project in different ways—they tried to anticipate potential questions that they might be asked, which was valuable for preparing to attend conferences.

What are some of your interests outside of the lab?

I really enjoy cooking, probably because I like eating! I also have a mini zoo at home, with a dog and two cats who entertain me greatly. Reading is another activity that I love—I have a very long "to be read" list that I add books to frequently, so it never really gets any shorter. I grew up in a desert—Arizona primarily, although I lived in LA for a while—so when I moved here to Waco and found out that they had rivers and lakes, unlike where I grew up, I really got into water activities such as kayaking and paddleboarding. My other big hobby is yoga—I've come to appreciate both the physical aspects and the mental ones, such as being in the moment and not stressing about the future or the past. In academia, we have a lot of deadlines, so that practice can be very valuable!

What are some activities you organize for your team outside the lab? What are some positive effects you've observed from devoting time to these exercises and events?

Before COVID hit, I used to meet regularly with my students in person to check in and see how research was progressing. During COVID, many things went online, and a lot of that in-person interaction was lost. As a result, many of my students would be spending significant amounts of time by themselves. So, in the post-COVID world, my goal has been to create ways for my students to feel connected to both each other and to the larger community. For instance, this semester, we did a Fantasy Football League, and we also hosted a kickball game with some of the other groups in our department. Last year, my group went to the rodeo, because many of my students had never been to one. After candidacy exams were over last summer, we celebrated with piñatas! We've also taken a trip to the Waco Rage Room. These types of activities benefit everyone, but particularly students far from home and international students. If there isn't a huge international presence in the department, they can still know that they have a community here, even if the cultural aspects are different. These events, for me, really help with the human nature part of being an educator. Of course, I want my students to be great scientists, but it is equally important to recognize that they have value by just being themselves. Hopefully, being a part of the community makes them feel appreciated and welcome in my group and at Baylor!