Nadja Cech

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The Unschooled Path to Creative Research

Nadja Cech—Patricia A. Sullivan Distinguished Professor of Chemistry at the University of North Carolina (UNC) Greensboro—never attended high school. In fact, she never entered a public school building until she started community college at the age of 14.

Cech's path to mass spectrometry and academia is lively and adventurous. Her interest in science, the natural world, and plants is rooted in the organic farm where she spent her childhood living in unusual circumstances: a teepee, a cabin without electricity, a 300-square-foot wooden yurt.

"My parents went off the grid in the early 1980s, and they sort of unschooled us," laughs Cech. "I don't actually have a high school diploma, but no one ever asks for it, so it works just fine."

*By the time she finished her undergraduate degree at Southern Oregon University, Cech's focus had narrowed to analytical chemistry. For her Ph.D., she chose the University of New Mexico to work with Chris Enke, whose lab performed the first CID-MS/MS experiments in triple-quadrupole mass spectrometers. She researched the fundamentals of electrospray ionization mass spectrometry, work that culminated in a highly-cited review paper [Cech, N.B. and Enke, C.G., Mass Spectrom. Rev., **20**, 362-287 (2002)].*

Cech was 23 when she joined the faculty at UNC Greensboro, and she has been there for nearly two decades. She is a passionate advocate of undergraduate and graduate education, and has received awards for teaching and mentorship. When a doctoral program was established at UNC Greensboro in 2008, she transitioned her laboratory into an R01-level NIH-funded research group. In recognition of the scientific contributions that the group has made, they received the 2011 Jack L. Beal Award for Best Journal of Natural Products paper by a Young Investigator.

"A theme of my work has been trying to figure out ways to make my work accessible to a broader audience," says Cech after describing life experiences that range from collecting water samples in the wilderness to researching medicinal plants.

How did your background lead you to science?

I think of being a scientist as being curious about the world, asking questions, predicting what is going to happen, and learning to bend nature to our will. Kids go through this process of asking "why, why, why," and that's a good thing. Sometimes curiosity is beaten out of us through an educational process that is knowledge or canonically-based. I'm lucky nobody ever told me I couldn't be a scientist or stopped me from asking questions.

I grew up in an environment where I spent a lot of time running around barefoot, building little huts in the forest, climbing trees, and sending leaf boats down the river. I also had a really great chemistry teacher at Rogue Community College, John Salinas, who empowered students to explore. When a gas chromatograph was donated to our department, he said "Nadja, let's see if you can make this work." I spent weeks tinkering with that instrument. I was hooked.

Working with John, I spent summers in the wilderness collecting samples for hydrology research. There were a lot of magical moments on those trips: spaghetti tasted like the best thing in the entire world because we were starving, and we got to sleep miles from anywhere under the stars. We also learned that it's hard to hold an instrument still when mosquitos are dive-bombing at you. There was a lot of adventure.

When did you start working in mass spectrometry?

I ended up doing this amazing undergraduate research project at Southern Oregon University. I worked in a forensic laboratory with Ed Espinoza identifying species of animals from blood at a crime scene. Ed proposed that we could identify species based on the molecular weight of hemoglobin [Espinoza, E.O., *et al., Anal. Biochem.*, **268**, 252-

The people that make science happen in Cech Lab.

261 (1999)], and I helped create a database of hemoglobin molecular weights with electrospray ionization mass spectrometry.

Do you have a favorite project?

Actually, I have one right now! My favorite projects are always morphing because I get excited and that leads to something else. I also am very influenced by ideas my students have. I learn so much from them! Over the past 20 years, we've shifted our research focus into the realm of natural products research [Caesar, L.K., *et al., J. Nat. Prod*., **82**, 469-484 (2019)]. We're very interested in how molecules from plants, fungi, and bacteria interact with biological systems—particularly how they can treat or prevent disease.

What are you working on now?

We are looking for new ways to treat bacterial infection by studying how bacteria communicate with each other [Paharik, A. E., *et al., Cell Host Microbe*, **22**, 746-756 (2017)]. Bacteria produce chemical signals that shift from a mode in which they're just hanging out to a mode in which they're attacking and producing a load of damaging toxins. It is a density-dependent system that doesn't get activated until there's enough bacteria for it to actually be feasible for the bacteria to mount an attack on the host.

We've also been studying signaling between species of bacteria, how one species can shut down toxin production in another species. Bacteria not only use signaling molecules to mount an attack but also defensively to prevent other types of bacteria from taking over. We're collaborating with other groups to learn how beneficial bacterial living on our skin can prevent pathogenic bacteria from colonizing and causing infections [Williams, M. R., *et al., Sci. Transl. Med*., **11**, pii: eaat8329 (2019)].

Anyways, I'm super-intrigued by the whole system: the role of the microbiome in preventing infection, the signaling within a species and across species of bacteria, and the use of small molecules from natural products like fungi and plants to perturb the system and block the signaling for pathogenic bacteria [Todd, D.A., *et al., Antimicrob. Agents Chemother*., **61**, e00263-17 (2017)].

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What do you like to do outside of the lab?

I have a passion for engaging science in the community and doing cross-disciplinary research. I just helped host a collaborative art exhibit in downtown Greensboro that was centered on a 300-year-old tulip poplar tree. This tree was a marker of the Underground Railroad, and we worked with scientists, artists, and historians to share different perspectives about our local history from a post-disciplinary perspective. The exhibit bridged my hobbies: I like to perform, I like to talk to people, I like to create experiences that make people think about things in a new way, and I love to work with my students.

I'm also an avid gardener. My kids—my son is 14 and my daughter is 10—work with me on the weekends in our community garden. I'm lucky to be married to another academic. My husband is an ethnomusicologist and a great guitarist. Name a song, and he'll play it for you. He's great fun around the camp fire. We both travel a great deal for our work. This summer I'm taking my group on a research trip to the Norwegian Fjords, where we'll talk science with my collaborator Olav Kvalheim, a brilliant chemomatrician descended from some of the first Vikings who set sail from that region.

What challenges have you faced?

What is the challenge for all of us? How can we best spend our time to do the most good, to do the best science to support humanity, to decide which projects are worth pursuing and which projects are not? You know, the same struggles that everybody faces. It is a huge balancing act, but I feel incredibly lucky that I have the career that offers me the flexibility to decide that I'm going to study communication between bacteria or do a crazy community art exhibit that supports students and brings to light stories of the history of the Underground Railroad. It's amazing.