



Biophysicist in Profile

MERRITT MADUKE

“Biophysicists tend to be very independent-minded and self-sufficient,” says Merritt Maduke, Associate Professor of Molecular & Cellular Physiology at Stanford University, “nevertheless, it is a valuable proverb that ‘two are better than one, and that a three-stranded cord is not easily broken.’ It is important to always learn from and support one another.”

Maduke cultivates such an environment in her own lab, one that encourages collective learning and finding creative solutions to biophysical problems—an environment not unlike the one Maduke’s parents provided for her. They made sure actively seeking and acquiring knowledge was an ever-present part of her life. Her mother,

trained as a nurse, encouraged delving into biological questions. Her father, a commodities futures trader, came at learning from an inherent fascination with the knowledge out there for the taking. “From the time I was three years old, he

spent time every night with me after dinner, giving me math problems and telling stories about great discoveries in chemistry and physics of the 20th century,” says Maduke. “Both of my parents read extensively, and together they created an environment in my childhood that inspired the love of learning.”

As an undergraduate, Maduke started on the pre-med track. “I didn’t really think about it, but it seemed to be a default pathway for students who were good at science,” she says. Her love of using math to solve problems determined her choice of major—chemistry—but one of her teachers, *Brian Miller*, taught her to enjoy lab work. “Dr. Miller was a master at teaching us how to connect theory with experiment, was open to trying any new experiment in the lab, and allowed us to call him at home

with questions any time except between the hours of 2:00 AM and 6:00 AM,” she says.

Though not swaying her from her medical aspirations, Miller’s classes did prompt Maduke to try a summer research program. She joined *David Lynn’s* lab at the University of Chicago the summer before her senior year, studying plant metabolism using ¹³C NMR. Lynn’s lab showed Maduke what Miller’s class alone could not. “He exemplified the wonder of a career in academics—continually asking questions, learning, and discovering new things,” she says. “It was an excellent introduction to biophysics, applying physical approaches to studying a biological problem.” By the end of the summer, she had shifted her focus to graduate school and applied immediately, retracting her already-submitted medical school applications.

Once accepted to the University of California, San Diego’s (UCSD) Chemistry Department, selected for its biology-infused approach to chemistry and its proximity to the beach for pre- and post-experiment jogs, Maduke got to work in *David Roise’s* lab. She applied what she calls Roise’s “rigorous approach” to her own project, developing fluorescence-based methods to study the binding of mitochondrial presequences to membranes as well as to assess their translocation kinetics. In the meantime, she read ceaselessly. *Chris Miller’s* published work on the *Torpedo* chloride channel told her she had found the next step in her career. Even after her application for a postdoc in Miller’s full lab was rejected, Maduke was so fascinated by his work that she took off for Brandeis University to meet Miller in person.

“It’s an incredible experience to design and conduct experiments that increase our knowledge of the world.”

—MERRITT MADUKE



Merritt Maduke’s son Max in the lab.

“After an hour of talking with her, I realized that a postdoc position had just opened up,” Miller says. “Lucky for me, she accepted it.”

Pioneering work by Miller had established CLC-type chloride channels as fundamentally different in both structure and mechanism from the cation-selective families of ion channels. Seeking to further understand the molecular mechanisms of these chloride channels, Maduke and a team led by fellow postdoc *Joe Mindell* discovered a prokaryotic CLC protein, and published the first direct structural data on a CLC, a projection structure solved using electron microscopy on two-dimensional crystals. As more data were published, including an X-ray crystallographic structure by *Dutzler* and *MacKinnon* and a surprising discovery concerning CLC function by *Accardi* and *Miller*, Maduke saw the need to integrate understanding of structure and function more than ever. “The discovery by Accardi and Miller that the CLC family encodes both channels and secondary active transporters challenged the existing paradigm that these two types of proteins operate by fundamentally different mechanisms and suggests instead that their mechanisms are subtle variations on a single central theme,” she says. “Research in my laboratory has been focused on determining the molecular details of these mechanisms.”

Maduke found more at UCSD than her life’s work. She met her husband, *Eric Lanzendorf*, in a molecular spectroscopy class, and they hit it off when they both ran the La Jolla Half-Marathon. “Ever since then we have been thinking about science and running together,” says Maduke. The couple also bike and hike together, along with their four-year-old son, Max. Of Maduke’s memorable qualities, a few stand out to Lanzendorf, including “her honesty and integrity coupled with a sense of childlike wonder—the ‘hey, this is neat’ factor,” he says.

Considering Maduke’s adventuresome approach to research, these qualities are evident in her lab as well as outside it. “As a researcher, I’m impressed by how many tools she is willing to use to address a particular problem,” says *Justin*

Du Bois, one of Maduke’s frequent collaborators. Her lab seems to have their collective hands in everything, from NMR structural biology, electrophysiology, crystallography, biochemistry, molecular biology, to pharmacology.” Using what you know and teaching yourself new tricks when you need to is a philosophy Maduke reinforces in her students. “Merritt taught me never to be satisfied with incomplete answers,” says *Gilbert Martinez*, a former student of Maduke’s, “and if you can’t find a complete answer with a technique you are comfortable and familiar with then you should learn a new technique to answer the question right.” Such an approach can occasionally require a friend to lend a hand, or an ear. “I am fortunate to have many friends and collaborators in biophysics to advise us in areas in which I am still gaining expertise,” says Maduke. “I have met many people at the Biophysical Society Annual Meetings who have helped me in my thinking and research directions. No one connection stands out, but the sum of all the connections is amazing.”

Amidst her work and family commitments, Maduke finds time to give back in other ways. She’s a member of the BPS Committee for Professional Opportunities for Women (CPOW) and was recently elected to the BPS Council. She volunteers with a local organization called “Science is Elementary,” helping to teach primary school children in underprivileged communities about the process of discovery and the scientific method. She has also volunteered to judge high school science fair projects at the California State Science Fair. “We are extremely lucky to live in a society that supports scientific research,” she says. “I think we owe it to society to work very hard in gratitude and to provide a good return on this investment in us.”



Merritt Maduke (left) backpacking with friends and family (son Max, center; husband Eric, right) in the Desolation Wilderness, Eldorado National Forest.