Julia Balog

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Speaking the Language of Science

Julia Balog speaks in a lively, direct tone, projecting a sense of calm that is noteworthy given her busy career, which combines multiple expertise in analytical chemistry, biology, math, and computer science. For her, it is the end of a day filled with meetings, but Julia is relaxed and clear-eyed.

Entering academic science with the unique perspective of a biologist and a mathematician, Balog has been able to help bridge the perspectives of colleagues from across diverse research teams, making her a valuable interpreter and communicator for the language of science. Fluency in math, chemistry, and biology is also instrumental in Julia's role as principal consultant research scientist at the Waters Research Center in Budapest, which is a bellwether for the use of analytical technologies to enhance human health. She manages research partnerships with numerous collaborator sites that value her experience with mass spectrometry applications and user software.

Some of Julia's postdoc work has grown with her for the duration of her career. One of her long-term projects has been contributing to the innovation of a tool called the intelligent knife (iKnife), which combines rapid evaporative ionization mass spectrometry with an electrosurgical knife to detect cancerous tissue. The work has been immersive, placing Julia right alongside surgeons in the operating room. Her focus on mass spectrometry technology led to a startup company that was acquired by the Waters Corporation and has contributed to its growth.

Finding symmetry in her work–life balance is important to Julia. We learn that early morning horseback rides are part of her secret to staying rejuvenated. Workdays are paired with time spent in the openness of nature, and time often finds Julia enjoying the expansiveness of the open road.

At what point in your life did you realize that science was in your future?

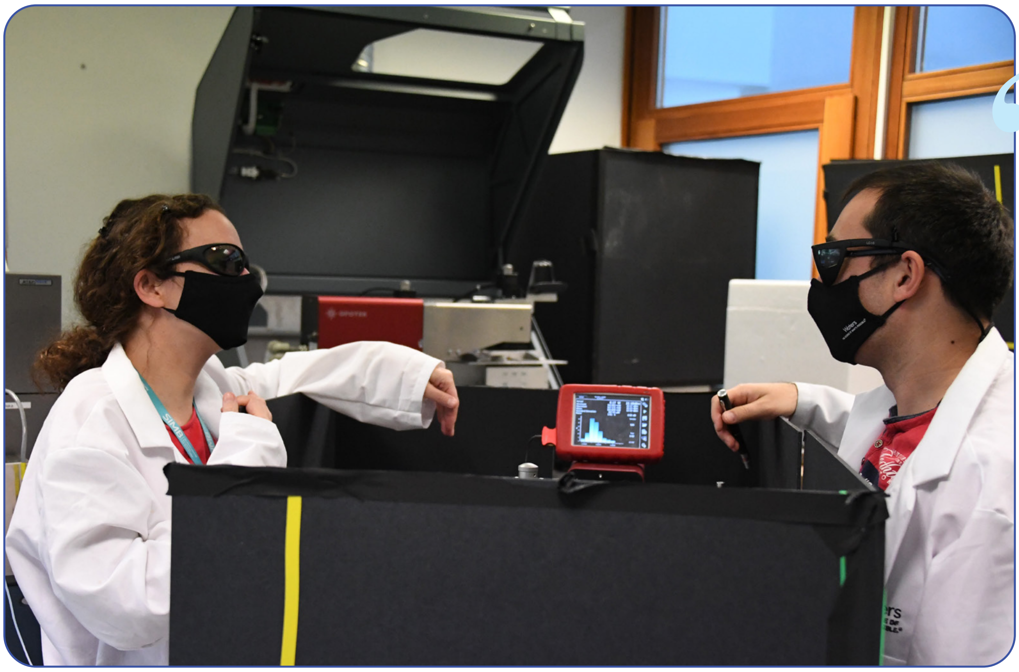
I have a mathematician father and a physician mother. When I went to school, I had no idea what I wanted to do with my life, but I really liked my biology teacher. She convinced me that I should be a biologist. That is when I realized I lacked mathematics. So, I started studying computer science and math. Then, somehow, I got into the science field. My motto was always, "Either don't do something or do it right," and at some point, I said, "Some weekends, you need to do something else other than work." I kind of brought that mindset to a startup company, which would eventually become Waters Research Center, where work was my hobby, and it is still my hobby. But I have other hobbies besides working. I realized there needs to be a balance, and it is good that way.

How did you get your start in mass spectrometry?

Initially, I was not trained in anything related to analytical chemistry or mass spectrometry. First, I had a master's degree in biology - actually, neuroscience. I was fascinated by the brain. Meanwhile, I started to study computer science and mathematics. I think that was inherited from my mathematician father. I started my Ph.D., first still in neuroscience. When I was still studying at the university, that is when I met Professor Zoltan Takats and he offered me a job developing the iKnife. I really loved that idea, so I joined them. So, I got inside mass spectrometry during my graduate years and finished my PhD on the "iKnife".

What is the iKnife, and what does it do?

When surgeons are operating on people and basically cutting around a tumor, there's smoke generated while they're cutting. So this "iKnife" is an electrical knife, I would say. We draw away the smoke into a mass spectrometer, and we can immediately tell, within a second, whether the material came from healthy or cancerous tissue. The idea was to build an instrument that would feed information back to the surgeons during the surgery. In that way, as they cut through cancerous tissue, the



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Julia Balog in the lab with colleague, Richard Schäffer.

instrument would inform them, "Go back, you left some cancer in there." I actually started doing this work during my university years. I talked to the surgeons, I went into the operating room, and I tested the whole system with those surgeons. I wrote the algorithms behind it to analyze the data. It was a company of five people - so there were not very many of us. This went on until 2014, when Waters Corporation bought us. That is how I started working for them, and that is where I've stayed ever since. Coming out from the university, I started working on the technology that I'm still working on right now. My dream is still to help surgeons save lives.

Who does the Waters Research Center collaborate with, in terms of universities or medical centers?

Professor Takats became my supervisor, and when he moved to Imperial College, London I also moved there to do a postdoc for a couple of years. So that became one of our main collaborations. We have another main collaborator in the "iKnife Team" in Kingston, Ontario, Canada, at Queen's University. They're very much engaged and very enthusiastic about the technology. And in The Netherlands, we have M4I, the Division of Imaging Mass Spectrometry, in Maastricht University with another group of surgeons, with whom we have been working on a lot of different technologies. Besides them, we collaborate all across the globe with multiple groups to improve the technology and show people how useful it can be.

What are some of the microorganisms that you have been studying, and why is the research important?

This was mainly done at Imperial College, on clinical microbiology samples. It is based on a laser technology where we shoot the colonies and then can tell immediately what type of bacterial colony it was. It helps ID the bacteria right after culturing, so it is a simpler method than what they use currently. The idea was first to check if we could have a species type of ID. Afterward, we checked if we could see antibiotic resistance or subspecies. In some cases, it is very important which particular subspecies we're talking about, because they can shut down a whole ward if the infection ends up being one of the nasty ones. This technology is very promising because it works very quickly with high sensitivity.

Has your background in computer engineering been helpful for your work in the medical field?

I've learned two different perspectives of the world. One was from the perspective of biology, where everything is a complex living organism, which is really hard to model with mathematics. The other is from the mathematical perspective. Using these different viewpoints has always helped me. For example, I've also been a translator between the software team, the algorithm team, and the biological or chemistry team because I am able to understand their point of view. Understanding the logic of these different fields has constantly helped me with my work.

How can mass spectrometry be applied to solve problems in food fraud?

The main driver for that is another collaborator in Belfast, Northern Ireland, at Queens University in the Institute for Global Food Security. They are devoted to the fight against food fraud; that is, cheating with food. For example, with fish, the question might be whether they're actually giving you the species they claim. We were building the reference database. For example, there were a couple of haddocks, which always were classified as cod or the other way around. These samples were coming from trusted suppliers, so we first thought the technology just was not sensitive enough. When they sent it for DNA analysis, we found that our technology was correct, and the labeling must have been mixed up. That is when everyone started to believe in the technology. My big dream was to be able to go in a restaurant with a backpack mass spectrometer and test whether they give you what they claim. Maybe it is better not to know, but my principle is that if they say it is salmon, it should be salmon. So, I'm still dreaming of something like that, where people honestly put on the plate what they claim.

How has your work in mass spectrometry contributed to our understanding of cervical cancer?

We did another study on this topic. The idea was if we could quickly tell if someone was in a precancer state, and what kind of precancer state that was, it would be helpful for the patient. You would immediately know whether surgery is necessary. In order to actually use this technology in the hospitals, we need to go through regulatory processes, which is tough. We are still right at the beginning.

What are some of your interests outside the lab?

I'm the type of person who believes that when you work, you should be working. But you still need an outside life. I do not believe people can work 24/7 for long without burning out. I really believe in sports, so I do a lot of exercise. At seven o'clock every morning I meet my father at the stables for horseback riding. And then around 8:30 or 9 am I'm at work. That is one of my main hobbies besides jogging and playing basketball. I've been riding nearly every day since I was 7 years old. Before COVID-19 I was also going outside with a 4 × 4. I have a Land Cruiser, and I really love that car. It can take you anywhere! I've been to road rallies in Africa with it five times, and the car went down all the way to Mali. I've also been in the Sahara on the sand dunes many times in Tunisia, Morocco, and Mauritania, and I really enjoyed it. In the beginning I used to navigate in the rallies but then I started driving also. It is scary, but it is fascinating! And it definitely makes you rethink your entire work and life and paves the road toward new and great ideas!

Off-roading in the Land Cruiser.

> *"Some weekends, you need to do something else other than work."*

Most mornings, Julia meets her father for an hour of horseback riding.