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RYAN LASH/TED

Biomedical engineer Liz Wayne calls for greater inclusivity in academia.

EQUITY

How to break barriers

Social and financial obstacles can complicate the path to success for female researchers.

Women from disadvantaged backgrounds or those who are the first person in their family to attend university (first-generation students) can face multiple struggles when pursuing a career in science or engineering. *Nature* spoke to six researchers about challenges that they have faced, and overcome, to secure opportunities.

LIZ WAYNE
Fight stereotypes

Biomedical engineer at the University of North Carolina at Chapel Hill.

I had wanted to study physics since I was 11 years old. At the age of 14, I moved about 320 kilometres from my family home in Crystal Springs, Mississippi, to attend the Mississippi School for Mathematics and Science in Columbus, one of 14 residential, public high schools in the United States for students who are talented at mathematics and science. At the time, tuition and board were free, which helped economically disadvantaged students such as me.

Suddenly, I was in an environment where it wasn't, "Are you going to college?" but rather, "Which college are you going to?" It was the most diverse place I'd ever been. At the same time, I felt that if I didn't get good grades, it would confirm something negative about my blackness, a feeling that became heightened in college. Without that experience, I don't know whether I would have got into the University of Pennsylvania (Penn) in Philadelphia, where I earned a bachelor's degree in physics.

When I arrived at Penn, an Ivy League university, I realized that I'd had to work hard for a basic education while others had received one without struggling or having to move. Socially, I felt excluded from events because of a lack of money. I had only two dresses to go out in. I was too self-conscious to tell my university friends that my family was struggling to pay the bills, and I couldn't tell my family that I had attended a catered ice-sculpture event on campus.

First-generation students are often from low-income families, a circumstance that can intersect with race and gender. People from disadvantaged backgrounds can be so grateful for what they get that they don't know how to ask for anything more. I didn't understand that I could argue for extra points on a test. I didn't realize that I could ask for help.

By graduation time, I was crawling across the finish line. I was exhausted and didn't think that I wanted to study physics any more because ▶

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I was tired of trying to fit in. But after starting a graduate programme in biology at the University of North Carolina at Chapel Hill, I realized that I wanted to do more physics, and so I started a PhD using multiphoton microscopy to conduct biomedical-engineering research at Cornell University in Ithaca, New York.

I'm a black woman with two Ivy League degrees, in physics and engineering — that's like a unicorn. I have a lot of visibility, which can be uncomfortable. Everyone thinks it's easy for me, that I have an edge in the job market because I'm black, but it's actually harder to get a job. My white male colleagues don't get asked why they are interested in physics. Because I 'made it', I'm expected to give back to my community by giving talks to and mentoring first-generation students. But when I spend time on outreach instead of research, I'm not considered to be a 'real' scientist by my colleagues in research.

To discuss life in academia as a woman of colour, in 2015, I co-founded a podcast series called PhDivas with Christine Yao, a lecturer in American literature at University College London. As hosts, we receive a lot of questions from listeners asking for guidance. We've shared information about how to protect yourself on social media, including how to block trolls and how to report abusive tweets.

I also advise early-career scientists to invest in their colleagues at different levels — from postdoctoral peers to faculty members. It's important to find people who you think do something well and to make them your mentors.

CASSIE SIMS
Harness your strengths

Chemical ecologist at Rothamsted Research in Harpenden and at the University of Nottingham, UK.

Growing up in a rural farming village in Yorkshire, UK, I didn't know that being a scientist was a career option. But teachers encouraged my talent for science and maths. My secondary school didn't provide students the option to do A levels. So, at 16, I started to commute to another school — a three-hour round trip requiring an expensive bus pass that I had to get a job to pay for.

My parents discouraged me from going to university out of fear that I'd get my hopes up but that it wouldn't work out financially. They weren't aware of loans and grants. They also experienced mixed emotions when I left home to attend Keele University, UK, for what became a dual honours degree in biology and chemistry. They had expected me to move out when I was 17, but they were wary of universities. To this day, I don't talk about it much with them because it's not a shared experience.

At university, I fell in love with how the shape of a molecule affects the sense of smell. I'm now doing a PhD at the University of Nottingham, studying insects' sense of smell at Rothamsted Research. I didn't know that completing a PhD would demand so much independence, and I had no idea what happened after a PhD. Students further along in their studies have taken me out for coffee so that I can ask them questions informally. I wish that advisers would ensure that new postgraduate students understand the nuances of the academic process.

Although university was a stretch financially, I always had a job to support myself. The real struggles were cultural. It's hard to find friends who are like-minded. People can look down on you when, for example, you go to a restaurant and don't know what something is on the menu.

At first, my background felt as though it were something to overcome, but now I find that it has benefits. I'm self-reliant and have the drive to prove myself. When equipment breaks, I try to fix it before calling a repair person. That's the mindset of someone who has grown up poorer.

LAURA MARTÍNEZ
Keep pushing

Infectious-diseases researcher at the University of California, Los Angeles.

I volunteered while in high school at the county hospital near my home in Los Angeles. It was my first introduction to science and medicine. My parents are from Mexico and had no education beyond primary school.

My mother supported our family of six, and she pushed us to get an education. I was admitted to the University of California, Los Angeles (UCLA). I couldn't be too far away from home because I needed to help my younger brothers and sister. Still, it was challenging. I wanted to pursue a career in medicine but didn't know how to do that. When I started doing research in the laboratory in the fourth year of my undergraduate studies, I was selected for the university's Leadership Excellence through Advanced Degrees programme. I built up research experience and developed good relationships with mentors — each step helped me to gain confidence that I had a place in the lab.

While working in the field of HIV, I moved to the University of California San Diego to attend a postgraduate biomedical-research education programme, which was funded jointly by a fellowship with San Diego State University. I tried to develop my own projects and to build a set of research skills. I took a graduate-exam preparation course and started to attend journal clubs.

Throughout, I struggled with communication and public speaking. Although I grew up speaking English at school, I spoke Spanish at home, and I experienced anxiety when expressing complex concepts in English. I managed to get a second authorship on a methods publication that, with support from a mentor, helped me to apply to a PhD programme. I was not accepted the first time. Instead, I began a master's degree at California State University, Los Angeles. After I received a fellowship through the US National Institutes of Health that was designed to support members of under-represented groups in biomedical research to transition to PhD studies, I applied for a third time and was accepted to nine PhD programmes.

I chose to attend the University of Washington in Seattle. I wanted to continue to do research on infectious diseases, and it also had a programme called GO-MAP to help postgraduate students of colour, which has created a community of students who can share their experiences and build a support network. It felt inclusive and offered a way for me to give something back to other students. My mentors at the university's Society for Advancement of Chicanos/Hispanics and Native Americans in Science also took the time to learn where I came from, and about my passions, weaknesses and strengths, so that they could offer me personalized support and training — steps that more mentors should consider taking.

I took seven years to earn my PhD, after which I joined a lab at Cedars-Sinai Medical Center in Los Angeles, where I worked to uncover how the Zika virus causes congenital eye disease. Even now, as I begin a postdoctoral position at UCLA studying AIDS-related non-Hodgkin's lymphoma, I still struggle with impostor syndrome. I feel as though there is a club that doesn't change — and for the club to be more inclusive of women and people of colour, someone like me has to keep pushing for it.

RACHEAL ADELODUN
Seek a social support network

Clinical-trial coordinator at the Sarah Cannon Research Institute, London.

My parents are from Nigeria and were the first generation of our family to come to the United Kingdom. I grew up in southeast London, receiving more of a 'work hard' ethic than a 'go to school' ethic. At my secondary school, I met representatives of in2scienceUK, an organization that facilitates work experience at universities and companies for students with disadvantaged backgrounds. I applied to the programme and worked during the summer of 2012 at University College London (UCL). I really liked how diverse the campus was and decided that, one day, I'd like to study there.

The most important thing that in2scienceUK gave me was a support system made up of the other programme attendees. We were all from the same age group, working hard towards similar goals. Most of the people that I formed

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LIZA VAN DEVENTER

a bond with are still good friends of mine and are also in science — so we share advice and information about schemes and opportunities.

One thing that is difficult for every first-generation student is explaining the stress of academia to family members who have never been to university. It's hard to communicate the challenges to someone who hasn't gone through that experience.

There are financial schemes to help low-income students, but they often come with a catch. For example, the University of Essex, UK, where I did my undergraduate degree in biomedical sciences, has offered certain bursaries to students who select the university as their first choice. Other schemes can provide support if you have evidence that you have no money left. But if the university doesn't approve someone's application, the student will be in a difficult situation. For spending money, I started a catering business that sells spicy Nigerian jollof rice, as well as other dishes, at university events and to people that I know. I do it for fun, but to get income, too.

I chose to go to UCL for my master's degree, in part, because everybody I met there was lovely and it was so diverse. I had been to other universities, but didn't feel like I fit in.

Ndoni Mcunu founded Black Women in Science, a support and training network in South Africa.

NDONI MCUNU
Unify voices

Agricultural researcher at the University of the Witwatersrand, Johannesburg, South Africa.

I grew up in Durban, South Africa. Post-apartheid, there were not a lot of black people in academia. There was also a lot of division, in terms of housing and access to schools. I was fortunate to grow up in a middle-class family in the suburbs. I was exposed to a life of privilege, but it's so hard to touch that privilege when you are not from the same background as your peers.

My brother and I were two of only three black people at our school. He and I spoke Zulu at home, which contributed to my struggles to learn mathematics and science in English. My parents saw my interest in science and were able to pay for private tutors, but most South Africans don't have the income to fund that kind of support. As I work on my PhD in food production, I will be the first person in my family to get that degree. My family members continue to ask me whether I will ever be done with university.

When I was pursuing my master's degree, I felt so lonely and was overwhelmed by the responsibility to produce independent research. In 2015, I started an organization called Black Women in Science, because I didn't see anyone in my image in research that I could turn to for advice. I also wanted to make it easier for others like me to enter academia.

The organization now offers a fellowship to roughly 150 participants each year. We meet three or four times a year and bring in experts to provide training sessions. For example, our first ever workshop was on data analysis, scientific writing and publishing. An editor gave a talk on common mistakes that scientists make when writing an article. We also offer a network of support for students in their third year of undergraduate studies that they can lean on until the end of their PhD.

Our participants value the network perhaps more than they do the workshops. It's so important to unify our voices — to help each other to get through this stressful time.

EMMA MORRIS
Balance finances with passion

Geologist at University College Dublin.

As I was growing up on the border between Northern Ireland, UK, and the Republic of Ireland, armed police vehicles escorted us to school for two years. Subconsciously, I wanted to leave, and I realize now that I probably chose a field of study that would require me to move.

I had always loved rocks, but there was nowhere to study geology at university in Northern Ireland. I ended up at the University of St Andrews in Scotland, UK. During the summer holidays of my undergraduate degree, I got to dig up dinosaurs for three months in Garfield County, Montana. I realized that I loved fieldwork and research. Even though I wasn't hugely comfortable with academia, I decided to do a field-based PhD at the University of Liverpool, UK. But it was so hard. I was the only one who didn't have a master's degree.

I noticed the biggest difference between me and my fellow students at the end of my PhD. When it was time to look for jobs, I panicked. I applied for a job that I didn't really want and took it when it was offered. None of my peers experienced that panic. They knew that their parents would cover financially whatever they needed. I didn't have that kind of security blanket. I had to get a job immediately.

The job was in the petroleum industry in Houston, Texas, for three years. I enjoyed having my weekends again, but I hated that I never went outside. Then, in 2015, the price of oil crashed. Work became tough. My visa was tied to sponsorship from the company. If nobody was drilling, there would be no work. I was filled with anxiety and worry — if I were made redundant suddenly, what would happen to me?

In 2016, I decided to return to academia and moved back to Northern Ireland. I wrote a grant proposal for a postdoctoral fellowship with my present boss at University College Dublin. I have been working there for almost two years now, in a position that enables me to pursue my passion for rocks. I'll probably have to complete another two such postdocs to get a permanent job.

My extended family thinks that I was foolish to leave a job that paid me almost three times as much as I make now. But I'm much happier, and that's worth more to me than money. ■

INTERVIEWS BY VIRGINIA GEWIN

These interviews have been edited for clarity and length.

CORRECTION

The Careers Feature 'Plug into industry' (*Nature* **565**, 665–667; 2019) misdescribed physicist Mirko Zimic as a biologist. Also, Sankara Subramanian is in the engineering and design department, not the engineering department, at the Indian Institute of Technology Madras.

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