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CELL SCIENTISTS TO WATCH

Cell scientist to watch – Christine Faulkner

Christine Faulkner pursued her undergraduate degree at the University of Sydney, Australia. She then joined Robyn Overall's research group at the same institution to obtain her PhD in molecular and cell biology, where she characterised plasmodesmata, which are connection channels between plant cells that allow for communication and molecule transport. In 2005, Christine moved to the UK to continue studying plasmodesmata characterisation and function, as well as trying to understand their link to infection outcomes. Her first postdoctoral position was with Karl Oparka at the University of Edinburgh, followed by a second at the John Innes Centre in Norwich with Professor Andrew Maule. She subsequently joined the lab of Silke Robatzek at The Sainsbury Laboratory, also in Norwich, before starting an independent fellowship at Oxford Brookes University, in Oxford, in 2012. In December 2013, Christine returned to the John Innes Centre to establish her own lab. In 2016, she was awarded an ERC Consolidator grant. Her lab is trying to understand how cell–cell communication occurs in plants, focusing on plasmodesmata, and how this process is crucial for regulation of the plant immune response.

What inspired you to become a scientist?

I'm not sure that I had only one moment of inspiration. When I was a student in high school, I was actually gearing up to go into the humanities. It got to a point where it was becoming almost like an expectation, and I had a strange sense of rebellion. I just decided that I wasn't doing it and went into science. At first I wanted to do something related to ecology, but I quickly realised that was not really for me. Molecular biology and cell biology ended up being much more appealing. At the University of Sydney, they have a special programme where the students who are performing well academically can design their own courses and do research projects in labs. I was working in labs for credit for at least half of my degree and ended up studying plant science and molecular biology. I think what also drove me was my interest in problem solving and diving into the unanswered questions. So I didn't set out from a young age to become a scientist, I just found myself in it and ended up really enjoying it. It was a bit of a serendipitous path, really.

Do you think that this special programme, with more applied courses during your degree, also helped you get more interested in an academic research career path?

I think so. One of the benefits was that it gave me a lot more exposure to what science really is. Universities in Australia are very big organisations, and in the first year there can be several hundred students taking the same class. It's very difficult to get noticed or to have further in-depth conversations with the academic staff because they're just simply overwhelmed. I think the opportunity to enrol in this programme really did allow me to understand that science was a lot more than what was presented in the textbooks. That's what hooked me. There are still a lot of unknowns. And when you get a peek into what the real world is, I think it's intoxicating and exciting. And that just suits me. I thrive in that kind of context, thinking about possibilities and exploring ideas.

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Christine Faulkner

"Never underestimate the impact that a good teacher can have on a class."

How did your interest in plant cell biology start?

It started with a professor during my undergraduate degree who ended up being my PhD supervisor, Robyn Overall. She gave us lectures in plant anatomy in the second year of the course. Sometimes anatomy studies can be quite dull, but she somehow had a way of presenting things in quite an interesting way. Then, by third year, she was also the lecturer in plant science. These classes don't usually have a very huge cohort, so there were only about seven of us taking that class. She sat on the edge of her seat as she was teaching – she was so excited. She would tell us about how the cell wall is formed, and talked about microtubules and microfibrils. But the exciting part was that she presented things in terms of what was still not known. I just got hooked. It was the excitement of a teacher, basically. And then, when I was doing my PhD with her, I remember getting my first significant result. I took it into Robyn's office and showed her the result, and she jumped up going 'Yes, yes, yes!' It keeps you going. It's inspirational. Never underestimate the impact that a good teacher can have on a class.

How was the transition between Australia and the UK?

It was a bigger transition than I expected. Australia is an English-speaking country with a lot of cultural heritage that comes from the UK, in particular, so you don't expect it to be a culture shock. But there were certainly elements of it. It took me a long time to realise it and to understand some of those cultural elements that are critical for day-to-day functions. But, more importantly, it just blew my horizons wide open in the scientific context. Australia has wonderful science but it's a small country on the other side of the

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Christine Faulkner with her lab following her institute's football competition, in which they won the wooden spoon and the spirit prize.

world. From a time zone perspective or the geographical situation when going to conferences, you're very isolated. I think during my PhD, in the four years that I was at the university, there was probably one international plant science speaker that came to give a seminar. We really didn't get a lot of direct exposure to science; it all came through reading. So when I came to the UK, there was so much science at the University of Edinburgh. I just learned so much and realised how big the scientific world could be. And I think that's a big part of why I'm still here [in the UK].

What questions are your lab trying to answer just now?

We work primarily on cell-to-cell communication in plants. One of our early discoveries was finding that plasmodesmata, which are the channels that connect cells, are dynamic in response to the perception of a pathogen. These structures make plant cells quite unique. The cytoplasm is continuous between neighbouring cells, which creates this whole other entity – we call it the symplast or the symplasm – in which molecules can freely move. Now that we know that plasmodesmata can open up or close down in response to different stimuli, we're trying to work out exactly why that is important. We focus particularly on what happens during the execution of immune responses, because we found that if you perturb plasmodesmata during an immune response, you affect how well the plant can fight off a pathogen. But we don't know what molecules might be moving through plasmodesmata, what signals they might be carrying, and we don't really understand why this matters, because the plant immune system is cell autonomous in many respects. So why does it matter if the cells are connected? What's the multicellular context here? We're looking specifically at the mechanisms by which the plasmodesmata open and close, as well as trying to find the signals that are moving through these channels during immune responses. We also look at it from the infection point of view, because we found that pathogens can manipulate the plasmodesmata in these host tissues. You've got the plants trying to shut the plasmodesmata down, and then the pathogens trying to keep them open.

Do you think there is a mechanical component to this interaction between the plasmodesmata and the pathogen or is it purely biochemical?

The plasmodesmata are quite complex structures. In plant cells, the plasma membrane goes all the way around the cell but it also forms tubes to cross the cell wall and connect neighbouring cells. These tubes are plasmodesmata. The way we think that they close is through the synthesis of callose, which is a β(1,3)-glucan in the cell wall that is around the plasmodesmata, and this pushes the membrane inwards and constricts the aperture of the pore. So there's a structural element to it. But then, of course, there are the signalling molecules and the biochemistry that triggers that production of callose. So it's multi-level. We found that there are specific receptors and signalling machinery that sit in the plasma membrane of the plasmodesmata, where the process of callose synthesis appears to initiate in a very localised way. Andy Maule's lab was quite successful in establishing some methods to purify plasmodesmata, which is not an easy task. This gave us a list of proteins, which led to a basis of machinery to work with. So I feel like we've built a solid little stepping stone on which we can stand. And now we can hopefully try some more ambitious things. We are very hypothesis-driven, which some days feels quite risky but is also a lot of fun. I think it's safe to work on the assumption that plasmodesmata are essential, since no mutant plants have ever been found that have no plasmodesmata.

What challenges did you face when starting your own lab that you didn't expect?

Hiring. I had never really thought about how important hiring is or how considered you need to be in hiring people for the first time. So that was a major challenge and a really steep learning curve. I got lucky in that respect. Also, for me, the transition to being a boss was a challenging aspect. In some ways it is an ongoing challenge, because it is not in my nature. I guess the process of learning to be comfortable with taking the lead and finding my own leadership style is an important step. I think I have kind of grown into that more now. Also, when I got my ERC grant, the lab essentially doubled in size. It wasn't as big as the challenge of starting the lab from scratch, but it was very much the transition from a group leader who was still in the lab, rolling my sleeves up and doing experiments, to somebody who really didn't have very much time to do that. That was not the problem per se; the problem was seeing myself in that role and realising that I did have that responsibility and that it was okay. You know, 'imposter syndrome'. It was difficult to change my own understanding of what my role was.

How are the challenges you are facing now different?

The challenges of starting the lab are about getting all the balls in the air. And the challenges I face now are keeping the balls in the air [laughs]. I feel that a big part of it is putting out one fire and turning around to see there's another one right behind you. There is just a lot more of everything – more science, more people – but I think the most important thing is to keep everybody going. Knowing how to partition my time and my energy in the most effective way. I obviously want to give everybody good opportunities, but sometimes that means abandoning a project, which I find quite hard. You need to find that middle ground of communicating and establishing respect for the work people are doing but also guide them in a way that will get them to the highest point they can reach. Sometimes that is counterintuitive and involves difficult conversations. I find that hard.

What was the biggest experimental roadblock that you faced and how did you deal with it?

It's probably one that we're facing right now. We made some assumptions about plasmodesmata and the output of immune responses that would be directly related to very specific immune components. Unfortunately, we found it very technically challenging to analyse this. And I started to realise that we were not obtaining the

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results that we expected, possibly because the hypothesis was wrong. We have spent a number of years pursuing this in a very directed way, and having to wind that back is quite difficult. It is still exciting, because I think it's actually pointing us in a different direction. And I do really want to see where that will lead. But when you look at all the work that has gone into it, which is in no way wasted effort, it is still difficult to keep the motivation high. I have a phrase that I find myself saying quite a lot: the data is the data. And if our hypothesis is wrong, it's wrong. So hopefully, we are now trying to build excitement for a different direction rather than disappointment about abandoning an old one. It's a work in progress.

"I think the key to my success has actually been failure."

What was the best science-related advice you ever received?

The John Innes Centre is a wonderful place because we have so many plant scientists and microbial scientists on site, and many of them are very successful. There's a lot of wisdom on site. I was having a conversation with a very successful senior colleague about a talk we'd heard, and he said essentially 'Why should I care about this?' It was brutal. I have gone to this person on several occasions, because if I can't give him an answer for why he should care about my work, I'm not framing my question very well, or I'm pursuing the wrong one. It's a reminder to ask the big questions. And once you start framing what you're doing in that context, it helps you write grants and papers. But it also helps you design your experiments. We are trained to really be critical and attentive to our data, but when you transition to being a group leader, you have to learn how to present your questions in the bigger picture. It is a marketing aspect and also reminds you what it is that you're pursuing.

What is the most important advice you would give to someone about to start their own lab?

It comes back to a considered approach to hiring and how you want to form your team. When you've never hired anybody before, it is a very daunting process. My advice would be to get more senior people who you respect to help guide you. The first interview that I held for a postdoc position, I had two senior colleagues present with me; I learned a lot by watching them, listening to the questions that they asked and how they asked them, and understanding why they were important. When you go into hiring blind, it takes a long time to distil out exactly what you need to do and where you need to be going. Some advice from people who you respect can be very helpful.

What do you feel were the elements inside or outside of the lab that have been key to your success so far?

I think the key to my success has actually been failure. It's not an easy road, and I've learned an awful lot from the mistakes that I've made. The proposals that I wrote that weren't good enough, or the ideas that I put forward that nobody cared about. That definitely trained me as a scientist. I just had to learn. And failing certainly gave me the opportunity to learn. That and a resilience that as scientists we all need. I think I have benefited from having moved around and meeting a lot of people along the way that have turned into very good friends. When seeking advice, they're the people that I go to most frequently. And I think in recent years at the John Innes Centre, I've had a number of quite good friends amongst my colleagues. That friendship element provides me a safe space to share my struggles or problems, without having to worry about being judged. They have been a huge source of advice and support.

What is your take on virtual conferences?

I see them as something we can exploit much more than we have been doing. Coming from Australia, travel is hugely expensive and disruptive. Often conferences are held in the summer in the Northern Hemisphere, but that's the middle of the winter and often the teaching season in Australia. So I can see that these virtual conferences are going to allow communities of researchers to become bigger, and I think that's a wonderful thing. What I haven't really figured out yet for myself is the personal engagement; those questions that come up at the coffee break or those projects that spark out of a random conversation when you're in the queue next to each other or sitting with someone at lunch. I don't know how we replace those kinds of interactions. The virtual system is critical, given quarantine regulations right now, but it is also environmentally responsible as we move forward. I'm looking forward to seeing how it develops. I'm sure that we'll come up with some good solutions. I guess the one thing that we can't combat are time zones; that's always going to get us.

How did you and your lab cope with the lockdown and the staggered return to the lab?

The lockdown happened very quickly in the UK. We had about two days where we saw it coming. We were preparing and then, all of a sudden, we had to shut everything down. Everybody just went crazy for a day, trying to prepare and get things set up. At the end of that first day, I set up a Zoom account and we all just logged on and had a beer together. And we acknowledged that tomorrow we had to start a new way of working. We are an experimental lab; we had to completely rethink what work looked like. We don't have huge data sets for bioinformatics analysis. So some people set about learning new skills. We had a couple of data sets, and everyone just started digging in to see what we had missed. Students started writing bits of their theses a year and a half in advance. It was just a matter of trying to be creative. And some of the ideas that have come out from that time have been quite interesting. But now we are back in the lab – the John Innes Centre has some excellent lab managers who really worked hard to get us back. My team has been working some odd shifts for quite a number of months now, because of the distancing rules, and they have done a great job. I'm so impressed with their organisational capacities. I'm really proud of them. The next challenge is how to keep us going. Everybody has a different context that they're battling with in terms of isolation from their friends and family and not being able to go home. The lab have been great in looking after each other.

Could you tell us an interesting fact about yourself that people wouldn't know by looking at your CV?

I'm a runner! And, as one student said to me, I'm quite fast for a woman of my age [laughs]. I run for my own enjoyment. There's a number of us from the John Innes Centre who participate in parkrun (https://www.parkrun.org.uk/). Saturday mornings, 9am, 5K. I think that there have been a few PhD students in the past who have turned up expecting to beat me, and they found that they couldn't. A few egos that have gone away a little bit bruised [laughs]. They underestimate me!

Christine Faulkner was interviewed by Inês Cristo, Features & Reviews Editor at Journal of Cell Science. This piece has been edited and condensed with approval from the interviewee.