© 2017. Published by The Company of Biologists Ltd | Journal of Cell Science (2017) 130, 3951-3953 doi:10.1242/jcs.211961

CELL SCIENTISTS TO WATCH

Cell scientist to watch – Lukas Kapitein

Lukas Kapitein studied physics at the VU University in Amsterdam and graduated with a master's degree in experimental physics. He went on to do his PhD in the research groups of Christoph Schmidt and Erwin Peterman on the motility of mitotic kinesins, and in 2007, he won the biannual best thesis award from the Dutch society for Biophysics and Biomedical Technology. Lukas then joined the laboratory of Casper Hoogenraad at the Erasmus Medical Center in Rotterdam to work on the cytoskeleton and polarised cargo transport in neurons. In 2011, he became an assistant professor at Utrecht University, received a European Research Council starting grant and then a Vidi fellowship from the Netherlands Organisation for Scientific Research (NWO), and became associate professor in 2016. His group uses super-resolution microscopy and optogenetics to study how motor proteins achieve transport of cargo and organelles in different cell types.

Lukas Kapitein

What inspired you to become a scientist?

I have always been interested in science, but initially more from a historical perspective. I was fascinated by the emergence of key concepts in science and philosophy. I especially liked fundamental questions about gravity, the planets, Greek philosophers, Copernicus, Galileo and so on. That's why I started studying physics and philosophy, and for a long time I didn't actually spend any time on the life sciences.

But then you changed from physics and astronomy to cellular motor proteins. Was there a 'eureka' moment for you during your studies?

Towards the end of my studies, a new professor, Christoph Schmidt, had started a research group that worked on motor proteins and he gave a tour of his lab and showed movies of cellular transport. The fact that all these molecules can really do mechanical work, take steps and walk over long distances was really mind-blowing to me. It was a completely new perspective on what molecules do, and the fact that you could study it with optical tweezers, see single molecules using fluorescence and really think mechanistically about it was really fascinating.

So you found your calling in life science. What was the transition like?

My transformation was triggered when I saw these motor protein movies and actually entered Christoph's lab for a small internship. I got the feeling that you could really contribute to the development of science, whereas before I was more interested in 'big thinking' and was not really a super hands-on person. I actually barely went to class when I studied physics – I mainly went to the philosophy lectures. However, working in a research lab for a short project taught me that experimental science might be more satisfying than philosophy. The type of questions you ask in life science are narrower, almost down to earth; but as an occupation I think it's very satisfying, as you actually see progress in your field.

What questions are your lab trying to answer just now?

We are interested in the 'spatial biology of the cell' – how things are organised within the cell, why organelles are in certain locations and what the functional consequences of mispositioning are. We want to know the mechanisms by which organelles get their cellular position and this definitely involves the cytoskeleton and motor proteins. Recently, we developed an optogenetic toolbox for intracellular transport; we use light to reposition organelles in very precise ways to learn what different motor proteins are doing inside the cell by recruiting motors to immobile organelles and seeing how the organelles move. We can also use this system to see how repositioning affects cellular functioning and whether active organelle repositioning can rescue phenotypes that are associated with mutations in certain motor proteins. It's what we call '*in vivo* reconstitution', or building complexity in the context of a living cell. We also want to better understand the organisation of the cytoskeleton, for example in neurons. How can you regulate directional transport in dendrites, where microtubules have a mixed orientation? That's why we need controlled tools and use optogenetics, chemically-induced heterodimerisation and super-resolution microscopy. Consequently, we do quite a lot of technique development as well. Recent examples include the optimised use of mCherry for super-resolution microscopy and the development

Lukas Kapitein's contact details: Cell Biology, Department of Biology, Faculty of Science, Utrecht University, Kruytgebouw, room Z.501, Padualaan 8, 3584 CH Utrecht, The Netherlands.
E-mail: l.kapitein@uu.nl

Journal of Cell Science (2017) 130, 3951-3953 doi:10.1242/jcs.211961

of an assay to independently reposition two types of organelles with two different optogenetic modules. Overall, the aim is to have very clean tools to understand organelle patterning and functioning inside cells.

Are you still doing experiments yourself?
I'm still quite hands-on when it concerns technical details, but I don't do experiments anymore. I think most people in the lab are actually much better at cloning or coding than I am, so it was a good choice not to do this anymore. I'm still involved in designing and aligning microscopes, as well as data and image analysis.

What is the biggest experimental roadblock that you faced and how did you deal with it?
We struggled to get the light-sensitive heterodimerisation to work. This was actually the first project that I wanted to do in my own lab and I found a student that was brave enough to try! It was pretty frustrating in the beginning, because at that point a lot of new dimerising modules had come out and it was not clear which one was optimal for our goals; we tried them all and it took quite some time to optimise it. However, I was pretty convinced it would be possible because we already did similar things with chemically induced heterodimerisation. Typically, what we do to overcome problems is to have several projects for most people and to always try more than one thing. It's a pretty brute-force approach to problems [laughs], but so far it has been pretty successful.

"…you should follow what's possible for you and what you want to do."

What is the most important advice you would give to someone about to start their own lab?
My career choices were not necessarily very common. Therefore, my best advice is that there's not just one way to do it right. For example, if you do a PhD in the Netherlands you should do a postdoc abroad, because you can learn something new and then when you come back to the Netherlands you have really unique expertise. I didn't go abroad for family reasons and during my postdoc with Casper Hoogenraad I obtained individual grants so I could really do my thing. After this, I started my lab in Utrecht where Casper also became full professor, so on paper all these choices are not necessarily very smart. In the end, however, you should follow what's possible for you and what you want to do. If you have a strong feeling about the experiments you want to do and the questions you want to address, then dare to be different for your own interests. To me that's one of the beauties of science: as long as you discover things and have nice results, then the career path you choose is not so important.

What challenges did you face when starting your own lab that you didn't expect?
Starting my own lab was actually pretty smooth, because I moved at the same time as other group leaders to Utrecht, and we immediately started an imaging centre and bought microscopes. I must say that finding the right people to hire was the actual challenge. When you have just started your lab, then who would want to do their PhD with you? Even if you're flattered that people apply, you have to remain very critical and really search for people that you think match your profile for the projects that you want to do.

A selfie of Lukas with his wife Sara, and daughters Judit, Tamar and Loïs (in descending order) at an outdoor climbing activity.

What characteristics did you look for when recruiting new group members?
I looked for complementary skills – people who are very good in molecular biology and biochemistry and afterwards physicists. But first of all I was looking for excitement. When you are proposing a project, if their eyes start shining, you know that they like it and they probably also will continue to try to make it work, even if things initially fail. If you want to work in my lab you need to be able to cope with my constant stream of ideas, because I always bounce off new ideas. I actually learned that my lab has now established a method to deal with this…apparently, if I mention an idea once, they ignore it, and if I bring it up in another meeting then they think, 'oh now…'

'We should look into this…'
Exactly! I think that's a pretty smart way of working.

What are today's challenges that you're facing in the lab?
Besides research and obtaining funding, what's new here in Utrecht is that we are building a new division of biophysics. This involves more teaching responsibility, as the aim is to really provide biophysical training to biology students. I think that's pretty exciting, because it gives you an opportunity to shape some of the bachelor and master tracks and invest in the type of training students need. The challenge is that it should be interesting for both physicists and biologists, so you have to connect with the different populations and shape the courses so that everybody can follow. What I like most about being in science is having a front row seat to

Journal of Cell Science (2017) 130, 3951-3953 doi:10.1242/jcs.211961

witness the advancement of knowledge and technologies, and when you're part of the development, you can actually contribute to it.

"What I like most about being in science is having a front row seat to witness the advancement of knowledge and technologies…"

How do you achieve a work–life balance when you're trying to establish yourself as an independent investigator?

Our first daughter was born at the end of my PhD, the second daughter during my postdoc and my third one was born one year after I started the lab. So I think from my postdoc years on, I had to be very focused and keep a balance. It's something that you have to learn and what's most important is not how you divide your hours, but to really stop thinking about work for some time when you are with your family. This took some time, because as a PhD, you're excited about everything, and as a young group leader, you're nervous about everything and constantly thinking about the next steps. Now this is starting to settle, I am better at compartmentalising.

How do you get the most out of the meetings you attend, particularly in the early stages of your career?

I didn't go to a lot of conferences during the first years as a group leader. I decided it was probably wise to just focus on what we wanted to do, publish it and then hope to get invited to conferences in the future. When I started, we had really small kids and I knew exactly what I wanted to do in the lab, so I didn't need the extra inspiration. I also couldn't go to conferences to present data because we didn't have any. This obviously changed and now I go to conferences quite often.

What is your advice on establishing good collaborations?

We have excellent local collaborations with Anna Akhmanova and Casper Hoogenraad and we all agree that no single paper is important enough to ruin our relationships; it's much better to publish a stream of papers together than to fight over one paper. I think once you have that mindset, then it becomes very nice to collaborate and you benefit from each other. For international collaborators, I'm always pretty open to trying things and often it may not work. As I said, we create tools and people come to us for some super-resolution imaging and then it might lead to something or not. I think I just like a lot of projects and I have a very broad appetite in this regard.

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

Sometimes people compare science with sport, as in it's a race to see who's going to be first. I like to compare it more with art, where you make something that wasn't there before, something new. Perhaps not surprisingly, I don't do so much sports but I do make music. I have been a drummer for a long time, since I was eight years old. I still play in bands and I drum regularly; that's definitely my biggest hobby outside science. We do live gigs, typically at people's homes. People invite their friends and we go there to play.

Lukas Kapitein was interviewed by Manuel Breuer, Features & Reviews Editor at Journal of Cell Science. This piece has been edited and condensed with approval from the interviewee.