© 2022. Published by The Company of Biologists Ltd | Journal of Cell Science (2022) 135, jcs259851. doi:10.1242/jcs.259851

Cell scientist to watch – Dora Tang

Dora Tang studied chemistry and then completed her PhD in membrane physics at Imperial College London, UK, under the supervision of John Seddon and Richard Templer. She then received Knowledge Transfer Secondment funding from Imperial College and worked for a year at Diamond Light Source, Oxfordshire, the UK's national synchrotron science facility. In 2011, Dora joined the lab of Stephen Mann at the University of Bristol, where she worked in the areas of the origin of life and bottom-up synthetic biology. Her research there included developing a hybrid protocell model based on the self-assembly of fatty acid membrane on coacervate microdroplets, as well as showing that coacervates support cell-free gene expression and building communication networks between two different populations of synthetic cells. In 2016, she started her own group at the Max Planck Institute of Molecular Cell Biology and Genetics (MPI-CBG) in Dresden, Germany, as part of the MaxSynBio consortium. Her research aims to understand the chemical and physical processes that drive molecular organisation in lipids, polymers and proteins in order to rationally control their self-assembly and understand how molecular ensembles make life.

Dora Tang. Photo credit: MPI-CBG.

What inspired you to get into science?

In school I studied chemistry, mathematics and art for my A-levels, and then I actually started off 'life as an adult' as a painter. I was quite interested in interdisciplinary approaches, but at the time it was very difficult to do a joint degree in art and science, or to be part of two different faculties. So, I did an art foundation course before a chemistry degree. After a master's degree in chemistry, I went back to art school for a short stint. What hooked me to chemistry, at school, was realising how things are patterned, and that patterns on a small scale seem to be relevant on a larger scale. Then at university I really enjoyed learning about chemical concepts such as entropy, which seemed quite an abstract idea to me.

How has your art background influenced the way you do research?

It actually plays a massive role in the way I approach my research. During my PhD, I was studying the transitions between flat 2D and curved 3D structures formed by lipid membranes. These structures have a beautiful spatial element that influences their biophysics, so visual arts were very useful here in understanding the structures that might form in biological models. Furthermore, bottom-up synthetic biology, where one of the goals is to build artificial cells from scratch, is actually like doing sculpture with molecules. Starting from small and simple molecules and building complexity is also connected to research on the origin of life.

What is the main theme of your lab's research?

The broad overarching question of our research is: what is the minimal complexity that can drive life-like functions? We are particularly focused on integrating reactions, compartments and communication as the basic features to address this question. We build synthetic cells and use these to understand how compartmentalisation can affect molecular reactions. A lot of the models for compartmentalisation are in steady-state conditions, but life doesn't work in that regime. Using bottom-up synthetic approaches, we can build maquettes from any type of molecule, so we are not confined to biological systems, and can begin to unravel general physico-chemical principles that might be critical to support life from ensembles of molecules. Discoveries from these experiments can enable new insights into why compartmentalisation can affect the biochemistry in cells, even though we're using different molecules to those in a living cell.

How do you view the ever-growing interest in compartmentalisation in the context of phase separation in biology?

I got into coacervates through researching the origin of life, so it was very interesting to see this concept grow in biology after the papers in 2009 that identified that these biological condensates are liquid-like. It is very exciting to think about how these compartments can regulate biochemistry in the cell; in science, there are some questions that need multidisciplinary approaches, and phase separation is one of them. It's great that physics, chemistry, biology, engineering and theory can all converge to unravel the mechanisms of life. We think our synthetic systems can contribute to some of the questions around phase separation in biology from a physico-chemical perspective.

Could you tell us about your approach to studying the origin of life?

Studying the origin of life is very difficult, because there is no fossil evidence, and you don't know what the environment or the chemistry

Dora Tang's contact details: Max Planck Institute of Molecular Cell Biology and Genetics, Pfotenhauerstraße 108, 01307 Dresden, Germany.
E-mail: tang@mpi-cbg.de

Journal of Cell Science (2022) 135, jcs259851. doi:10.1242/jcs.259851

Fishing for supper, Cinque Terre, Italy.

was on early Earth. One approach is to look at modern biological systems and get some clues from there, such as what molecules – lipids, RNA or peptides – would have been important, and shape the narrative around those molecules. In our lab, we try to understand whether compartmentalisation would have been important for containing and segregating reactions on early Earth. Here, we can probe the physical effect of compartments on reactions to ascertain whether having compartmentalisation would have provided a selection pressure for particular reaction pathways. In this way, we will learn something about how compartments could have played a role on early Earth, even if the chemistry is not entirely correct.

What work or scientist in this field has inspired you?

This has got to be Alexander Oparin, who was kind of the forefather of linking coacervates to the origin of life, and we're still very much influenced by his work from the 1920s. In general, I think there's a lot of value in reading older papers – including work from the 1950s and 1960s, or even 1980s, which often have a lot of interesting concepts and hypotheses that could not be tested due to the lack of technology. Some of these hypotheses can now be addressed with the advent of new technologies.

"In general, I think there's a lot of value in reading older papers – including work from the 1950s and 1960s, or even 1980s, which often have a lot of interesting concepts and hypotheses that could not be tested due to the lack of technology."

From the origin of life to the beginning of your lab at MPI-CBG – based on the experience of getting your group going, what advice would you give someone who is about to start their lab?

In the beginning, the pace of doing experiments will be very different to what you are used to, so you should give yourself some time and not worry that you don't have data pouring out of the lab from day one. The startup period is a wonderful time to read deeply, do some of your own experiments and get to know your new landscape (if you have moved). As soon as students start coming, there will be a lot less time for that, and you will never get that time back again.

You co-organised a summer school on protocell models last year. How was that experience?

This summer school was organised with a team of people from the MPI-CBG and our ProtoMet network, and working with them made the whole thing great fun. We originally planned to have this event in person, but then needed to convert everything to online, which gave us an opportunity to try different formats for the teaching. I really enjoyed organising the courses and putting together an interdisciplinary programme, from theory to chemistry and biology. Interacting with the students was very rewarding – this is actually my favourite part about teaching, together with the way it makes me question my understanding of fundamentals and see things from another perspective.

We tried to make the summer school as interactive as possible, and so we included some workshops with hands-on exercises and even a virtual tour of Dresden (courtesy of Brian Von Rueden). Something else that I thought was quite important was having a session entirely focused on careers, so we invited people who did PhDs or postdocs but were not working in academia anymore to discuss their career paths. I think a lot of people feel that they are expected to stay on the academic path, but as a trained scientist there are so many options. It is important that students are exposed to stories about non-academic careers and the different avenues that utilise their scientific skill sets.

"Interacting with the students was very rewarding – this is actually my favourite part about teaching, together with the way it makes me question my understanding of fundamentals and see things from another perspective."

As an advocate for diversity, equity and inclusion issues, what kind of barriers do you think make science less diverse than it could be?

This is very complex issue, and it is hard to give a short answer. When trying to identify what the barriers are, you have to consider the context; barriers for increasing diversity vary depending on the city, country and even the subject, be it physics or chemistry. For example, diversity issues in a chemistry department at a university in London will be very different to those at a theory institute in Dresden. I see two general ways of tackling these issues: through social changes and through infrastructural changes. Implementing social change is difficult; it involves changing awareness and

Journal of Cell Science (2022) 135, jcs259851. doi:10.1242/jcs.259851

mindsets, and also includes things such as unconscious bias, which as the name suggests, we are not even aware of. On the other hand, it is much easier to make changes in regulations and law, not just at the institutional level but also at the state level. Just a couple of examples where infrastructural change could increase diversity include good policies with regard to childcare and parental leave, and flexible contracts to support young parents – both mothers and fathers – to navigate family and career. Also important are infrastructural policies that provide the correct framework for an inclusive and safe work environment that is free from harassment, which helps to increase diversity, equity and inclusion. Let's say, there is still much work to be done, and everyone needs to take part in it!

Finally, what do you do in your free time? Do you still have time for art?

Most of my spare time is spent with family – I have a baby, so I spend a substantial amount of time trying maximise night sleep for the whole family. I love to experience culture through travel (before COVID), through food, through interacting with people and through new experiences. I do not practise art intensely anymore but try to casually draw when I can. Oh, I also try to run as regularly as possible!

Dora Tang was interviewed by Máté Pálfy, Features & Reviews Editor at Journal of Cell Science. This piece has been edited and condensed with approval from the interviewee.