MEMBRANES: UNITY THROUGH SEPARATION

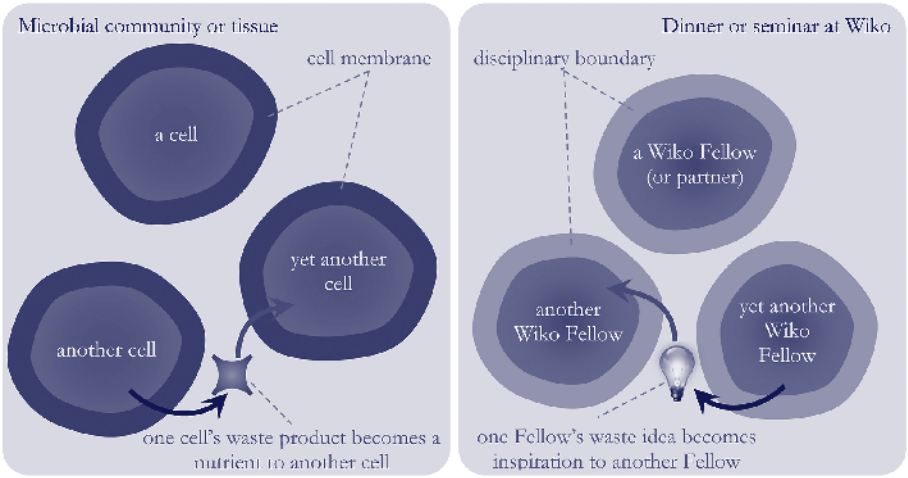
VICTOR SOJO

Victor studied first chemistry and then computer science at the Central University of Venezuela in Caracas, followed by biological modelling and finally a Ph.D. in evolutionary biology at the University of London's University College (UCL). Victor's main research interests are the major events in the evolution of life on Earth (and potentially elsewhere), including the emergence of life, and the origin of complex cells and organisms (i.e., eukaryotes). His main focus is on cell membranes and how they have changed throughout evolutionary history as the branches of the tree of life split and later re-merged into their current intertwined shape. Besides his interests in evolutionary biology, Victor is passionate about education. He has volunteered to develop educational programs in India and the Philippines, and he used a portion of his Wiko Fellowship to continue his contributions to education. – Address: Richard Gilder Graduate School, American Museum of National History, 79th St. at Central Park West, New York, NY 10024-5192, USA. E-mail: vsojo@amnh.org.

I have chosen a deliberately Orwellian title, or maybe just an oxymoronic one. Either way, I will try to explain what I mean by it.

My work at Wiko has been about membranes – those boundaries that define a living cell, separating its innards from the environment. But if that were all that membranes do, life would not happen. At the boundary between a cell and another, new life arises through cell division and gamete fusion, goods are traded, data conveyed, nutrients acquired, waste excreted. Life is thus not a *thing* or a *state*, but a *process*. It exists in this flux of material, energy and information that takes place across membranes, and so membranes are not mere separators – they are *mediators*.

In its own way, that has been the Wissenschaftskolleg to me: not islands of isolated individuals with their own thoughts within their own disciplines. Instead, it is the union of interacting "cells" that, while independent, join together to build a higher-level body, not entirely unlike how complex consortia of multiple microorganisms build a working community (see figure).



As Wiko Fellows interact, what may have started as a minor comment from one Fellow often ends up sparking deep rethinkings and even novel lines of research in another Fellow. And I can say this with full conviction because it happened to me multiple times, and that experience by itself was enough to justify my tenure here.

My far-fetched membrane analogy also reminds me of how independent neurons in the human head build a thinking brain. In one neuron, neurotransmitters are released and, upon reaching the next neuron, they elicit a response that in turn induces the receiving neuron to become an emitter itself. Similarly, Wiko Fellows – and partners (see below) – release ideas into the lunch tables. These ideas reach the membranes of the other Fellows' disciplinary boundaries. There, they often find a neuroreceptor, i.e. a membrane protein or avid curiosity that eagerly accepts them. In other cases, the idea had no predestined neuroreceptor, it was not something the receiving neuron was ready for. Thus the foreign idea may initially bounce off the disciplinary membrane boundary. But slowly, this unfamiliar idea furtively permeates the membrane of the adjacent Fellow's

disciplinary boundary. And once inside, it elicits a response, changes the state of the unexpecting neuron-Fellow, and makes it become an emitter of new ideas itself, inspiring it to inspire, stimulating it to stimulate. Over time, Fellows evolve; they become better adapted to receiving and responding to unfamiliar ideas, more likely to emit them.

Ein Kolleg der Wissenschaftler

The very name of this place was the beginning of my learning here. I like to define myself as a "scientist". Yet, in the German language, the word "Wissenschaftler" applies not only to my fellow biologists and chemists, but also to sociologists and historians. But why stop there: diplomats, visual artists, architects, musicians, politicians … all here are *Wissenschaftler*. Indeed, I find it a fascinating fact that the word's etymology can suggest something along the lines of "pursuer of knowledge". And knowledge I have found – in the day-to-day conversations with luminaries of my own field whose literature I was familiar with since my undergraduate days and in the gentle challenges posed by being exposed to so many views and fields, from people so able to present their ideas with coherence, kindness, generosity, and the occasional healthy dose of mischief.

Beyond the clichés of the different ways natural scientists and humanists see the world, I found a plethora of opportunities to be challenged and to challenge, to question my preconceptions in my own field and its repercussions and parallels to the fields of others. I got to think deeply about entire topics that I had never even heard about, I got to take perspectives that I don't think I would have spontaneously taken had I not come, and I got to ask and be asked questions that I was sure I had the answers to, only to find that I don't, questions that in some cases nobody can answer.

This seems a good opportunity to also acknowledge the contributions of the Fellows' partners to the rich experience of a Wiko Fellowship. Unsurprisingly, Wiko partners are themselves as generous and fascinating thinkers as the Wiko Fellows themselves. I therefore felt that I got to enjoy a 2-for-1 deal whenever I had the chance to interact with a partner, which for future cohorts I should add was never enough.

Wiko has been all I had come to expect of it, and more. The variety of topics in discussion at dining tables, the high level of both critical insight and outright expertise in all sorts of subjects, and the stimulating conversations with researchers and pioneers from such a variety of fields are gifts that I gladly take with me. I will deeply miss the conversations, the camaraderie, the inspiration.

Output

Other than all the wisdom that I gladly received, and perhaps in spite of the endlessly interesting conversations over lunch, I have somehow managed to produce some measurable outcome, too. I produced novel bioinformatics data that I have now turned into a first draft manuscript for eventual publication, I made progress on an educational website that will hopefully one day help teach and learn anything anywhere, I wrote and published a paper that had been waiting to be written for a while, and I became inspired to come up with an entirely new hypothesis that was also published during my time at Wiko (along with a journal cover and video abstract that I also produced here).

Output

Sojo, V., A. Ohno, S. E. McGlynn, Y. M. A. Yamada, and R. Nakamura (2019). Microfluidic reactors for carbon fixation under ambient-pressure alkaline-hydrothermal-vent conditions. *Life* 9, 16.

Sojo, V. (2019). "Why the lipid divide? Membrane proteins as drivers of the split between the lipids of the three domains of life." *BioEssays* 41, 5: 1800251. Video abstract at: youtube./TdKjxoDAtsg.