Physical signals between cells

Dr Daniel Fels, an independent researcher at the University of Basel, is shining a light on how cells, such as the 40 trillion in our bodies, use physical signals in addition to chemical ones to communicate.

What are non-chemical signals, and how do cells use them?

A non-chemical signal is a physical signal. In my research, I focus on electromagnetic signals (photons). Cells use them to stay informed about and to adapt to the existence of other cells, e.g., by altering the rate at which they proliferate. We do not yet know for sure what physical factor or process is responsible for the phenomenon, and since scientists generally assume cell communication is based on chemical signals, researchers in my field speak of non-chemical signals.

What inspired your decision to work with the non-chemical signals of the cell?

Extensive academic education has encouraged my current research: a Master’s degree in Biology from the Zoological Institute of the University of Basel, a Master’s degree in Educational Science for high-school teaching from the University of Zurich, a doctoral thesis again at the Zoological Institute of Basel and a postdoc at the National Centre for Scientific Research from the Pierre and Marie Curie University in Paris. During my thesis and postdoc, I got involved with host-parasite systems and their interactions. Even though that was a highly interesting time, the decision to work with physical cell communication was inspired from my adolescence. In my youth, a book (The Secret Life of Plants) had imprinted the message that organisms are connected to each other by invisible means.

How do you go about testing for non-chemical signals in cells?

When testing for non-chemical communication in cell systems, scientists actually test for physical communication. Hence, an experimental set-up has to meet two requirements: disabling chemical while enabling physical communication between cells. This can be achieved by keeping certain populations of cells in separate vials of different size, with one being placed inside the other or in a side-by-side manner. Knowing that cells emit light (photons), scientists can then ask whether this light serves a function in cell-cell communication. Such experiments are part of a working hypothesis that investigates the significance of cells’ electromagnetic fields.

Why is it important to understand how cells communicate? What sort of information are they communicating?

We are multicellular organisms that consist of about 40 trillion cells performing different tasks. Such a system can only be upheld if its constituents communicate with each other. Discovering how this is done is important for philosophical, scientific and utilitarian reasons. On the one hand, we are driven by our curiosity to simply learn about ourselves and the world around us; on the other hand, research into cell communication could help in the context of health and disease. The sort of information the body uses can be categorised into coordination of space-time dynamics, such as embryology and body rhythms, that create unity and harmony in the body’s functions. Hence, the signals emitted by cells refer to this context, and when we know what signals they are using and how they interact, we can help the body in ways that are closer to the ‘language of the body’.

Your work into cellular communication is an independent research project. What inspired you to do this research independently? Has collaboration also played a role in your work?

To work independently means I am my own boss; it also means I am not employed and therefore do not receive money for my work. My decision was not to be independent but to look for what I believed must exist: the invisible, the non-material connecting part of life. This is what inspired me and still does inspire me. Collaboration is only possible on a very small scale, as my working space is limited. Therefore, my collaboration refers mainly to meetings where we share our thoughts and develop our questions, and to some small experiments performed in other laboratories by interested colleagues.

Are there any other projects you have been involved with concerning your research that you would like to talk about?

In an a posteriori data analysis (2012, Axiomathes), I found that two cell populations can link similarly to quantum mechanical objects in a typical entanglement experiment. This raised the question of whether there are laws that matter and life follow, laws that did not evolve. Furthermore, and as known by many experimental biologists, cell growth was not only influenced by controllable factors (like temperature or chemically separated neighbours) but also by uncontrollable factors. For example, there are indications that life ‘swings’ in accordance with heliogeophysical rhythms and events. Future data analysis and experiments will shed more light on this. Further, yet unpublished, results indicate that cell populations regulate their density by physically sensing the amount of neighbouring cells (physical quorum sensing).
THE COMMUNICATION BETWEEN different cells within an organism is fundamental to the function and survival of that organism. By having the ability to communicate, cells can coordinate themselves within an organism to carry out specific functions. The human body consists of trillions of such cells, all of which can interact with each other on a constant basis to keep it operating in ways we often take for granted.

Cells converse by passing information between each other using a variety of methods. There is established evidence showing that one way cells achieve this is through direct contact and the exchange of certain chemical substances or electrical impulses. Experts generally refer to these behaviours as chemical signals. However, fascinatingly, there is now also evidence that cells may be able to convey information with each other using non-chemical signals – essentially, signals that do not require direct contact between the cells or an exchange medium passing from one to another. Dr Daniel Fels of the University of Basel has been conducting independent research into the hypothesis that the emission and reception of photons between cells produces these non-chemical interactions. Each cell has its own electromagnetic field, and he hypothesises that the field allows cells to both send and respond to other electromagnetic signals.

A long held fascination with non-material communication between cells and a desire for further knowledge in the area has driven Fels since his teenage years. Ultimately, the objective of his research is to prove that non-chemical signals occur, establish exactly how and why they occur and propagate this knowledge throughout education in life sciences. Fels states: “A purely chemical description of life induces a distorted vision of life in a student, even though this occurs non-intentionally on either side (as long as we do not know that these fields exist)”. This is an anomaly in the teaching and studying of life sciences that Fels is determined to correct.

NON-CHEMICAL COMMUNICATION

What, then, is non-chemical communication? Fels describes it as a physical signal that can occur electromagnetically or via sound, mechanical contact or quantum mechanical entanglement effects. Since Fels is currently conducting his research under the assumption that cells impart information electromagnetically, he is working to exclude the possibility that communication between cells occurs through sound.

Researchers in the field state that non-chemical signals occur simultaneously to – rather than in place of – chemical signals, which are well established as occurring between cells. In fact, Fels proposes that the two are linked: “Non-chemical communication is most probably not independent from chemical communication as both phenomena occur in the same body that has the same overall requirements that need to be regulated”.

The evidence for cells transmitting photons dates all the way back to the work of Alexander Gurwitsch in 1923, who noticed a
Fels’ research could enable experts to develop the technology to communicate directly with cells in the human body in order to improve health. For his research project, Fels has chosen to concentrate on two of the more fundamental principles of life: cell division and energy uptake. The two are linked to a certain extent, due to the requirement for energy in order for a cell to divide at all. The type of cell observed by Fels was *Paramecium caudatum*, a single-cell organism scientists commonly choose for observation because its large size makes it relatively easy to study. In terms of both cell division and energy uptake, the chemically separated populations of *P. caudatum* clearly influenced each other, strengthening the case for non-chemical communication and in a manner that suggested transfer of photons (2009, *PLoS One*).

WHAT DOES THE FUTURE HOLD?
The discovery that cells converse non-chemically could be far-reaching, not just in terms of our understanding of life science but in the potential applications to which scientists could put this newfound knowledge to use. Fels already has ideas for possible directions that further research could take: “It could be investigated how the non-chemical cell-to-cell communication is changed when manipulating the cells (with chemical or physical factors). The understanding of the physical basis of cell-to-cell communication could also result in novel medical treatments that aim to restore and improve these physical aspects.”

While the notion that Fels’ research could enable experts to develop the technology to communicate directly with cells in the human body in order to improve health is truly remarkable, unfortunately, his research is under serious threat. Currently, he works independently, and he has carried out his work unfunded for a number of years. Not only this, but he is one of very few scientists worldwide who even conducts research in this area. Fels expands: “There are almost no institutes that investigate on the fields of the cell. In my hometown there is none. Hence, and I am very grateful for this, I do work as a guest scientist but only one day per week and alone”. Therefore, one of his goals is to encourage younger researchers to enter the field and establish positions through which they are more likely to receive funding. It may be that the future of non-chemical communication research depends on such actions.

Together with Michal Cifra, Fels edited the upcoming open access book *Fields of the Cell* (2014), targeted at life scientists. He hopes to use it to kindle more awareness of and interest in this fascinating topic. If, through his work, he can inspire a new generation of scientists to take on this research and realise its potential, it could have profound implications for our understanding of life as we know it.