Cell biologists should specialize, not hybridize

Dry cell biologists, who bridge computer science and cell biology, should have a pivotal role in driving effective team science, says **Assaf Zaritsky**.

Cell biologists have come a long way since Robert Hooke first observed plants through his microscope some 350 years ago. They have adapted and adopted new technologies in molecular biology, chemistry and microscopy. But unlike researchers in genomics and other branches of biology, they have yet to fully embrace computer science.

The days of staring at microscope images to explain cell processes, as Hooke did, are over. Microscope data today are diverse and highly variable, and contain complex cellular patterns that are often invisible to the human observer. Only computers and digital vision can find them, and so identify cell and molecular dynamics. Computer vision can help, for example, to map spatial organization of subcellular components and understand how they work together to generate cell behaviour.

Digital tools already help cell biologists to carry out routine tasks: measuring cell shape or detecting and tracking intracellular components. More complex analysis should be a full-time speciality, but cell biologists do not treat it as such. Rather than embrace a truly interdisciplinary approach, with experts with different skills working together, cell biology has opted for hybridization. Academic departments and principal investigators seek individuals who can do both the biology and the computer analysis, and so encourage students and postdocs to train in both fields. For young scientists, this comes at a cost. Doing top-notch biology or computer science requires long training, expertise and attention. Either is a full-time job — aiming to train experts in both produces Jacks of all trades, masters of none.

My postdoctoral research is in computational cell dynamics, and I would like to continue in this field as an independent investigator. I recently discussed my academic future with several established principal investigators and department chairs from computer science, engineering and biomedical sciences: they were concerned about my inherent dependence on experimental partners to produce data, and warned it would undermine my ability to secure grants. To make myself more attractive to employers and funders, they suggested, I should learn to perform simple cell-biology experiments.

A colleague faced a similar reaction when she proposed to apply computer vision to study cell migration in 3D environments. One reviewer commented that analysis of other people's data was a weakness. My colleague decided to heed the advice and follow the hybrid path. What a waste! Instead of using her unique expertise, she now spends valuable time learning basic bench science that repeats what others already do and will yield only standard data.

Funders laud the importance of team science, but for cell biology it seems those teams must be made up of otherwise independent scientists. True collaborative science should follow industry by including specialists who simply can't do science without the team.

When computer scientists work on collaborative projects, too often we are expected only to provide a service: to develop custom tools and crunch data collected by the experimentalists. In this mode, the computational collaborator is required only to solve a given technical challenge. Accordingly, the emerging field of bioimage informatics develops algorithms and tools to analyse biological images at high volumes and throughput, but its main motivation is to outperform other algorithms on common problems such as registration, detection and segmentation. It demands no deep understanding of the underlying biological aspects, which limits what it can achieve.

The role of a quantitative collaborator can go further. Discovery of complex dynamic patterns requires knowledge of the biological process, the experimental possibilities and the type of information that can be extracted from data. Such insight into where to look, what to look for and how to look for it leads to more productive collaboration, in which quantitative scientists also drive biological inquiry. They adopt the motivation, terminology and intellectual framework of biology. This gives the research a more solid quantitative basis — just as genomics and computer science have combined to develop bioinformatics.

COLLABORATIVE SCIENCE SHOULD **INCLUDE SPECIALISTS** WHO CAN'T DO SCIENCE WITHOUT **THE TEAM.**

This type of partnership has also produced major innovations in evolutionary biology and proteomics. It will not happen in cell biology while we insist on retraining computer scientists to do undergraduate biology.

To promote better collaboration, we need to nurture quantitative scientists with scientific motivations in cell biology. We can call them dry cell biologists. These scientists work at the boundaries of quantitative disciplines and cell biology. They identify scientific problems, steer (but do not perform) experiments, import, adapt and apply quantitative tools, and interpret the data to conceive testable numerical predictions.

Importantly, dry cell biology is different from theory or *in silico* biology. Theoreticians build mathematical models and simulations to explain an observation. Dry cell biologists, by contrast, extract information from data to learn about biological processes.

There are considerably more biologists who can generate visual data than can process and interpret it effectively. Thus, dry cell biologists will fill in a necessary piece of this puzzle, working hand in hand with conventional cell biologists to drive the subject forward.

In some disciplines, such as structural biology, the value of dry research is taken for granted. It is time for cell biology to embrace us. ■

Assaf Zaritsky *is a postdoc investigating computational cell dynamics at the University of Texas Southwestern Medical Center, Dallas.*
e-mail: assafzar@gmail.com