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Voices

The challenges in finding your home as a multidisciplinary scientist

Technological advances in a variety of scientific disciplines are being applied in the life sciences leading to an increase in the number scientists who see themselves or are classed as being multidisciplinary. Although their diverse skills are celebrated and needed to understand the immense complexity of life, being a multidisciplinary researcher can pose unique challenges. We asked multidisciplinary researchers and the director of an institute that fosters multidisciplinary research for their thoughts on what they see as the challenges or obstacles that multidisciplinary scientists can often face.

Sijia Wang
Chinese Academy of Sciences Key Laboratory of Computational Biology, Shanghai Institute of Nutrition and Health

Break out of your comfort field

Multidisciplinary scientists need to master knowledge and skills in more than one field, which usually means extra time and efforts to keep up with the fast-moving pace of scientific development. Just like one usually has a dominant hand, many multidisciplinary scientists have a dominant field that sometimes becomes a comfort field, which hinders the all-round development, particularly for the junior researchers. To break out of your comfort field, one effective way is to surround yourself with teammates from different fields that you need to keep up with. Routine exposure to the state-of-the-art knowledge from the relevant field can lure you out of your comfort field. Nevertheless, more importantly for the junior researchers is to get the first one to two grants in an interdisciplinary setting. Project commitment will then assist you stay on course to a balanced development. The relevant research community could also help by having study sections suitable to attract interdisciplinary projects, particularly from junior researchers. The need for supporting interdisciplinary projects has received considerable attention in the past few years. The National Natural Science Foundation of China (NSFC) even opened a specific branch for interdisciplinary research in 2021. Multidisciplinary scientists, you should be determined to break out of your comfort field, while being assured that you are on the right track, which the research community highly appreciates. The extra time and efforts are all worthwhile.

Linsey C. Marr
Civil and Environmental Engineering, Virginia Tech

Evaluating multidisciplinary research

When people learn that I'm an engineer and ask about my research, they are often puzzled by my response: "I study airborne virus transmission." How is virus transmission related to engineering?

I am an environmental engineer who thinks about viruses like I do about particulate air pollution. Virus particles are emitted into the air, are transported various distances, are subject to physical and biochemical changes while in the air, and are potentially inhaled by a susceptible individual. I view engineering as an applied science, in which we apply all relevant mathematical, physical, chemical, and biological concepts and tools to solve a problem. However, this approach does not always produce outputs that fall into an easily recognizable discipline. There is no single academic department, conference, or journal title that is a good fit for my research.

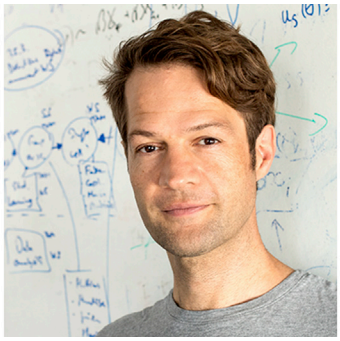
While explaining this in casual conversation can be a challenge, it can be even more difficult to convince reviewers of proposals, papers, and dossiers for promotion and tenure. Reviewers are accustomed to evaluating work that fits neatly into a well-established discipline but may feel less comfortable judging multidisciplinary research. It's like asking judges who specialize in figure skating to evaluate a hockey game. Yes, ice skating is involved in both sports, but the goals and scope of the activities differ. To pave the way for more multidisciplinary advances, we should consider providing reviewers with a framework to evaluate multidisciplinary research. We would all benefit

from more formal recognition of the unique perspectives that multidisciplinary research can contribute to scientific discovery.

Lydia M. Contreras
McKetta Department of Chemical Engineering, The University of Texas at Austin

Cultivating belonging and visibility across disciplines

While impactful science and scientific training often involves multidisciplinary research, there are many challenges associated with this approach. Being trained in a specific discipline and then stepping out to work on scientific problems that lie predominantly within a different discipline often means the need to introduce yourself and your work new communities that are unfamiliar to your different (and new) way of thinking; this can lead to feelings of exclusion and isolation. The introduction of new scientific frameworks can be met with a resistance and questioning; this is aggravated by starting out as an "outsider". This is reflected practically in the additional challenges that reviews of interdisciplinary work encounters in scientific panels and journals, where it is difficult to get the benefit of the doubt. It is also difficult to find "one meeting" that completely fits in your work. A way to mitigate this is to regularly attend multiple conferences and engage with different research communities that can be highly divergent. For instance, two different types of meetings can involve: (1) meetings within your "disciplinary home" to remain connected with those that share your research background, methods, and techniques, and (2) meetings within your "intellectual home", to engage with those that work on problems you work on. The latter effort can be high in energy and in time. One needs to acknowledge that this comes at an even higher cost for disabled researchers, researchers with limited funds, researchers that balance major family and personal responsibilities outside of work, etc.



Fabian J Theis
Helmholtz Munich and Technical University Munich

Biology is big data science

Every biologist has data. Given the pace at which modern high-throughput technology produces vast collections of genomics, imaging, drug screening and other measurements, today more than ever a biologist has to rise to the challenge of dealing with large, complex and heterogeneous data. Biology has thus turned into one of the hottest areas for applying data science techniques, in particular machine learning and artificial intelligence. We bio-data scientists commonly call ourselves computational biologists: our core challenge is to be knowledgeable in mathematics and computation as well as biology, in order to ask the right questions and answer them with the right tools. This makes it difficult to find students with adequate background.

To educate the new generation of data scientists, I have setup the "Munich School of Data Science" together with colleagues from various domains including life sciences, but also from computer science and statistics. We are training our students at the interface between our disciplines. Our philosophy is to match them with two supervisors in what we call a "Y model": one with computational and statistical background, and one from the life sciences. This strategy helps our students to overcome language and expertise barriers in a simple model that I can strongly recommend—and it has brought my lab exciting discussions with our experimental partners, deep insights into making necessary adjustments to our models, and projects neither side would think of in isolation.

Paul Nurse
FRS, Director, Francis Crick Institute, London

Driving multidisciplinarity in the life science

Most of us in the Life Sciences support multidisciplinarity, but we often struggle to deliver it. One of the aims of the Crick Institute in London is to be multidisciplinary, an approach needed to help understand the immense complexity of life, and we are still learning how best to do it, but what have we learnt so far?

One thing is really clear. Life science research institutions have to provide easy access to a diverse range of advanced technical cores. All research groups need to use them, and to get technical advice about how to use them well. Funders need to recognize that they need to support them too, from the provision of databases to sophisticated chemical analyses. The Crick has 17 cores, and that is still not enough. Also crucial is a research faculty that is discipline diverse and highly interactive. That is not helped by the traditional ethos of accumulating a "critical mass" of like-minded faculty. What is required is a "critical concentration" of high-quality researchers from

a range of disciplines, who talk to each other and spark off new ideas and approaches.

Departments and decisions do not always help if they impose too many barriers. It is not always sufficiently recognized that scientists from different disciplines are trained differently, and have different cultures. It needs effort to get them to work effectively together. New faculty should be recruited by broad based search committees and not just by a group of ''specialists,'' to ensure that the recruits can communicate across disciplines.

My own lab has profited by these approaches at the Crick. I have had access to an excellent Mass Spectrometry core, shared a chemist between the core and my lab, and have had two highly interactive graduate students. Between them they have devised a massively parallel *in vivo* protein kinase platform able to simultaneously assay hundreds of CDK substrate activities in living cells. Such an assay has eluded me for decades and was delivered by a focus on multidisciplinarity.