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Authors

Fabius, Jacqueline M

Krogan, Nevan J

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Commentary

# Creating collaboration by breaking down scientific barriers

Jacqueline M. Fabius[1,2,3,*] and Nevan J. Krogan[1,2,3,4,5,6,*]
[1]Quantitative Biosciences Institute (QBI), San Francisco, CA 94158, USA
[2]QBI COVID-19 Research Group (QCRG), University of California, San Francisco, San Francisco, CA 94158, USA
[3]School of Pharmacy, University of California, San Francisco, San Francisco, CA 94158, USA
[4]David Gladstone Institutes, San Francisco, CA 94158, USA
[5]Department of Cellular and Molecular Pharmacology, University of California, San Francisco, San Francisco, CA 94158, USA
[6]Department of Microbiology, Icahn School of Medicine at Mount Sinai, New York, NY 10029, USA
*Correspondence: jacqueline.fabius@ucsf.edu (J.M.F.), nevan.krogan@ucsf.edu (N.J.K.)
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**The scientific world rewards the individual while often discouraging collaboration. However, times of crisis show us how much more we can accomplish when we work together. Here, we describe our approach to breaking down silos and fostering global collaborations and share the lessons we have learned, especially pertaining to research on SARS-CoV-2.**

Academic science is highly siloed. Scientists often do not communicate efficiently due in large part to the reward system that exists in the scientific world, where individuals, rather than groups of scientists working together, usually receive the awards, tenure, and grants. This helps to create an environment where sharing and collaboration is often discouraged, which is particularly problematic for young scientists who have new and fresh ideas but become guarded because of flaws on the system. Here, we briefly describe the success of our collaborative group, the QBI Coronavirus Research Group (QCRG) (http://qbi.ucsf.edu/QCRG/overview); outline the key ingredients to successful collaborations; and call on funders to recognize the value of collaborative, international research.

## Creation of the QCRG

The QCRG was immediately successful and has been recognized worldwide. The question is, why? A number of factors contributed to the success; the formula was the same one we have used when building our other collaborations. Like-minded people, who were excellent scientists with whom we already had relationships were part of the initial team and strong vocal supporters of the effort. Our well-established international network was ready to be tapped into with a phone call. Everyone was wary of this unknown virus at the beginning, and fear can often be a propellor to progress. It became apparent that no one place was self-sufficient regardless of its caliber; this in turn made all of us value each other's work and discoveries even more. Work that normally takes years was carried out in months thanks to a coordinated and heroic effort from trainees and staff (Bouhaddou et al., 2020; Bracken et al., 2021; Gordon et al., 2020a, 2020b; Schoof et al., 2020; Schuller et al., 2020; White et al., 2021, Reuschl et al., 2021), the speed being a testament to the collaborative spirit from hundreds of scientists around the world. Empowering the trainees to take on leadership roles was key to the success and helped them develop as independent scientists. A particular liaison with the French Consulate of San Francisco played a crucial role in the developments of the QCRG, as they aided with the shipment of drugs and compounds to our collaborators in France at the height of the pandemic. At the onset of the SARS-CoV-2, UCSF did not have a BSL3 laboratory, where the virus could be propagated, whereas both the Institut Pasteur and Mount Sinai in New York did. Both partners, along with more recently University College London, played a key role in these studies and ultimately in the identification of therapeutics.

Having diversity in the group is extremely important; different voices, different perspectives and approaches to the same problem mean that we will get to an answer much faster. However, a large group brings its challenges. Currently the QCRG at UCSF, hundreds of scientists, has been broken down into 12 manageable subgroups with leaders, and a project manager has been hired.

We should ask ourselves why it had to take such a gigantic human tragedy for us to work together.

## Develop a unifying vision

While most will agree that working together and sharing is important in science, how many would feel this is the most important facet for success? Our initial motivation behind the formation of Quantitative Biosciences Institute (QBI) (http://qbi.ucsf.edu) at UCSF in 2016 was simple: collaboration. Were there scientists out there who could also imagine that bringing people with different disciplines, expertise, and points of view together would enable all sides to grow and see problems and scientific questions from a different perspective, which would induce creativity and ultimately help progress science? The groundwork of building significant relationships with scientists and institutes both domestically and internationally would prove to be a indispensable element in our rapid COVID research output in the form of the QCRG in 2020.

A concrete vision came together to actively implement this team science concept through network mapping of the cell. Since much work has been done on identifying sets of genes linked to a variety

of diseases, one obvious next step was to study how the corresponding proteins were physically and functionally interacting with each other in healthy and diseased states. These maps would help inform more mechanistic and structural studies and links to patient cohorts, so they could ultimately connect scientists across a wide array of disciplines. This vision is disease agnostic and is being applied to many different disease areas in the form of three QBI-initiated cell mapping initiatives: Cancer Cell Map Initiative (CCMI) (http://ccmi.org); Psychiatric Cell Map Initiative (PCMI) (http://pcmi.ucsf.edu); and the Host Pathogen Map Initiative (HPMI) (http://hpmi.ucsf.edu), which includes the NIH-funded HARC (HIV Accessory and Regulartory Complexes) center (https://harc.ucsf.edu/) focused on studying HIV-host interactions. A similar vision could be applied to different disciplines as long as a unifying concept connects people to one another.

These projects, each initially composed of 10–15 PIs with diverse and complementary expertise, have allowed for the acquisition of large collaborative center grants from national funding agencies, such as NIH and DARPA. As a public institution mostly funded by NIH, we feel it is important to both inform and involve the agency in our ongoing plans. From 2017 to the end of 2019, we visited NIH and DARPA program officers over 20 times to update them and forge new alliances by introducing our concepts. This effort ultimately led to the acquisition of five collaborative grants around the different cell mapping initiatives. Initiating NIH visits is key to obtaining support for your vision and concepts. The visits are likewise a great opportunity for feedback and fine-tuning from NIH experts who share their own visions with you.

## Formation of international collaborations: thinking beyond borders

It was natural to think about a similar approach internationally. To make international relationships work, it was imperative to start with initial interactions and meetings between, and among, scientists and then approach leadership to request funding and support to foster the identified collaborations. Often, grand ideas that start at the top do not get much traction if the scientists doing the work are not interested. It was important to find complementary colleagues across the world—those who did similar science but either from a different angle or using different tools. Identifying the various capabilities of each place also proved to be pivotal during the pandemic, including collaborating with those who were capable of growing the virus in a laboratory setting.

Meeting someone specific at any institution in the world is easy through the commonplace but extensive network of scientific connections. When we did not know people directly, we asked for an introduction. If we had participated in a symposium together, a simple email suggested a visit and seminar to introduce the science and explore potential synergy. Our first learned lesson is that we had to put ourselves out there even when we were unsure. Virtually all of these efforts have been fruitful.

The formula is straightforward: give a seminar and meet multiple people to assess the potential for synergy. Almost 100% of the scientists were excited at the prospect of working together. We seldom left a new place without already having some small projects and exchanges identified. Lesson learned: create the opportunities for one-on-one meetings, build and develop relationships, find synergies, and follow up! Once the desire to work together has been established, it is crucial to wrap up the visit with leadership who has influence at the institute. A next step is to suggest an annual symposium that brings together an equal number of people from both institutions to exchange their research ideas. This incentive is welcomed because (1) scientists love get-togethers and (2) being hosted in a great location is never a bad idea. If finances are an issue, what we have learned from the current pandemic is that it is possible to do everything online.

While scientists communicated, we also met with development teams and administrators that could formalize relationships between institutions. These meetings consolidated the agreements we would eventually put together between institutions and fostered the first discussions about possible funds for collaborative research that would emerge following a symposium. We found it useful to travel with both a scientist and a representative administrator. In this way, the scientists focus on the research, and the administrator focuses on different aspects of relationship building. Again, if a budget is not available for travel, communication can occur through video conferencing.

## Implement an action-driven MOU

The creation of a memorandum of understanding (MOU), which is a formal agreement between two institutions, is often required for scientific engagement. Keep the initial MOU very broad to allow for flexibility, but it is important to have some base objectives that allow for an immediate start of activities. These could include student and postdoc exchanges, joint calls for proposals, and collaborative fundraising efforts. Having the signing of the MOU take place at an inaugural symposium can create excitement among the participants. If the institutions do not have discretionary funds available to seed projects, one can take advantage of research funding announcements (RFAs) or international opportunities through NSF, NIH, and others. These are easily found on the web or by asking program officers for advice.

In developing nations, where the funds might not exist, the relationship is developed differently. Activities in this context may include cultural exchanges, capacity building, workshops, and joint grant applications. Both sides bring something very relevant to an increasingly global approach in science, and these particular relationships can offer a great chance to focus on both youth and the advancement of women—criteria that are often a prerequisite for funding applications.

## Organize a compelling symposium

Organizing the first symposium requires the involvement of the scientific leaders who were most excited about the new relationship and its vision. Ideally, the symposium committee is gender balanced and has a healthy mix of young and seasoned scientists. Typically, at our QBI symposia (http://qbi.ucsf.edu/events/archive), we aim to have 50% of our speakers be female; we set this as a condition of the symposium, but we

cannot always force the other side to do the same.

While planning the first symposium, it is important to discuss the timing of a second one in order to establish a committed long-lasting relationship. It is imperative to have a similar number of speakers from both places for balance and carefully choose stellar scientists who are prone to collaborate to assure the objective of the first symposium. If possible, it can be very useful to engage funding agencies (from both sides if the symposium is international), in order to have their buy-in to the collaborative concept at its inception. In the United States, we often invite a speaker from federal funding agencies to give talks. Inviting industry contacts to attend and present may lead to alternative funding opportunities. Throughout the pandemic, we have also been successful by having first joint symposia online, followed by enthusiastic collaborations. This is a great option when facing lack of funds.

Engage all possible beneficial parties: funding agencies, regional, national, international; industry relations interested in the specific topic; the corresponding embassy or consulate as well as journals. Almost all consulates have a Science Attaché and are a great liaison to national funding agencies and other funding sources. Create a buzz, and don't be afraid to do it!

## Identifying joint funding opportunities

Shortly after the first joint symposium, announce a call for proposals to maintain momentum. These joint proposals are funded by relatively small seed grants for projects that might be considered too risky for traditional funding institutions. However, once proven, the goal is to have these collaborations funded by more traditional federal agencies. If financial constraints exist, small external grants could be used to facilitate the collaborations. Do not be afraid to put pressure on leadership to help with reasonable seed funding, explaining the valuable investment that will bring more funds from other sources in the future. We often jointly fund 1-year projects where progress is shared with a large group at an ending event that is featured by the communications team. These events serve two purposes: (1) they hold the awardees accountable, and (2) they let the rest of the community know that the collaborative work objective is open to them as well, at the second annual symposium that will typically feature a new set of speakers.

## Maintain momentum

Keep communication channels open with scientists at each institution. Continue calling, visiting, and inviting speakers from both sides to give seminars. If your institution does not have the funds for travel or invitations, NIH program officers can provide advice on resources. Returning to the institution for follow-up discussions, to plan the second symposium, to approach funding agencies, and to spark additional relationships can all help to solidify an existing one. Inviting trainees to give seminars not only exposes the host to the latest research but also opens doors for younger scientists to potential future employers. Facilitating sabbaticals can forge significant relationships and strengthen the scientific bond between institutions. In the current Zoom era, it can be very affordable and feasible to host speakers, regardless of time differences.

Although traveling around the world to create relationships sounds glamorous, it is a committed and demanding endeavor. To build the number of relationships we have between 2017 and 2019, and keep them healthy and alive, the travel was at times grueling, with over 50 visits to institutions around the world. Travel takes a toll, but the benefits well surpass the effort, as has been seen with the international collaboration that has come together to research COVID-19 under the umbrella of the QCRG.

## Choosing the right collaborators and managing expectations

In building these relationships, whether in academia or in industry, a factor to keep in mind is that there are some big personalities and egos in the scientific world. Interact with people you like; don't seek out people just for their name. It is important to start the relationship with clarity and discuss the rules of collaboration and publishing. Discuss upfront who would get credit and push to have the younger scientists get the credit. Agreeing on these basic terms before moving forward will reduce future stress. If for any reason you have radically different philosophies on the topic, then this is simply not the collaboration for you or your institute. Move on.

Some scientists function as lone wolves in the system. This can be an asset: with this type of person, the goal is not to attempt to change them but rather explore how to work with them and explore whether a mutually beneficial relationship can be established.

When a collaborative project starts to have wings, have a call with the relevant parties to establish quickly and clearly who the main players are and who is doing what. Make sure the senior scientists are all on the same page before calling a larger meeting. If the younger scientists are reluctant to share credit, take the time to coach them on the value of team science.

## Communication is crucial

When possible, having a robust media presence focused on your agenda is powerful. These efforts will spread your gospel far and wide and gain you a following, and ultimately aid in raising funds. One can leverage the media teams associated with their institutions or simply exploit social media tools (e.g., Twitter, Facebook, Instagram) or take advantage of platforms such as medium.com or theconversation.com, which often caters to academics.

Try to find an influential or affluent champion who will vocalize your cause. Keep in mind that your development office has a whole institution's agenda to push forward, and your initially perilous project is not where they are going to focus their resources; they tend to be risk averse where donors are concerned. However, once you have gained momentum and showed success, they will be a great ally.

## A call to action

Science does not have borders, and we should not be putting limitations on our field. Different funding mechanisms are needed. That the National Institutes of General Medical Sciences (NIGMS), for example, has swerved away from collaborative funding in favor of funding individual labs speaks volumes. The argument is not to defund single-investigator grants,

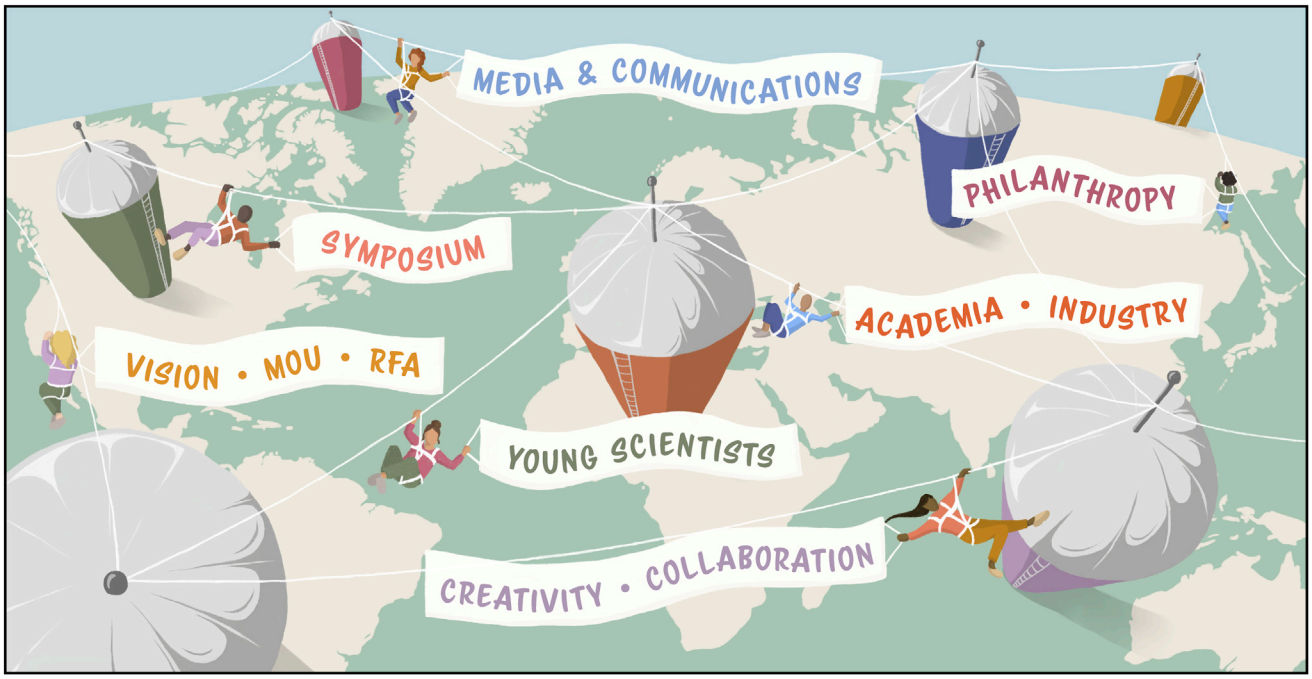


**Figure 1. Breaking down silos**

which allow important discoveries through deep focus on individual problems. However, collaborations between scientists who do not normally work together have produced some of the most unanticipated and exciting discoveries. Funders like the Howard Hughes Medical Institutes (HHMI) could appoint more groups of researchers in addition to the individual investigators.

The exponential growth in biological complexity demands that more diverse approaches be combined to tackle the most challenging problems. In all of this, young scientists must be front and center. These are the minds that will come up with fresh ideas and out-of-the-box solutions. Established scientists must encourage the sharing of ideas and acknowledge junior scientists' contributions prominently.

We propose an academic/industry/pharma approach with tiered funding. We call upon the scientific community to create a formula that works for the advancement of research, without threatening intellectual property, rights to publish, or the sharing of information at the beginning stages.

Other avenues for funding are through philanthropy, which comes in many forms: individuals, foundations, trusts. In order to have a champion outside of the scientific community vocalize the importance of your institute's research, it is important to share your science in a very palpable manner with the lay public. We usually speak a language that is not only foreign but entirely alien to anyone outside of our field. We need translators who can take our exciting discoveries and break them down to the simplest terms in order to get a following.

The scientific community is strictly divided into disciplines, and academic researchers often do not venture into other areas to exchange ideas with colleagues. Unfortunately, this creates an overly competitive and less creative environment, which slows the speed of discovery. Most scientists choose this profession driven by curiosity and a deep wish to contribute knowledge for the betterment of human life. Why do these silos exist then? Why don't we, as the community of scientific researchers, collaborate more frequently and more openly? It is time to break down the silos (Figure 1). If we want to see significant results from studying diseases, the environment, and space, the time has come to collaborate.

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## WEB RESOURCES

Cancer Cell Map Initiative (CCMI), http://ccmi.org
HIV Accessory and Regulatory Complexes (HARC), https://harc.ucsf.edu/
Host Pathogen Map Initiative (HPMI), http://hpmi.ucsf.edu
Psychiatric Cell Map Initiative (PCMI), http://pcmi.ucsf.edu

Quantitative Biosciences Institute (QBI), http://qbi.ucsf.edu
QBI Coronavirus Research Group (QCRG), http://qbi.ucsf.edu/QCRG/overview
QBI symposia, http://qbi.ucsf.edu/events/archive

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