The Human Frontiers Science Program: Funding That Crosses National and Disciplinary Boundaries

Science is increasingly an international and interdisciplinary endeavor. One major stimulus for international scientific collaborations is the Human Frontiers Science Program (HFSP; for more information, visit www.hfsp.org). HFSP has provided grants to support this sort of research since 1990. Whether scientists are engaged in international collaborations or contemplating such collaborations, HFSP is a funding agency worth considering.

HFSP supports "novel, innovative and interdisciplinary basic research focused on the complex mechanisms of living organisms; topics range from molecular and cellular approaches to systems and cognitive neuroscience." The HFSP offers many opportunities, including program grants for scientists at any career stage, young investigator grants for teams in their first five years of independence, as well as short- and long-term postdoc fellowships. Program grants can provide up to $450,000 per year for the entire collaborating team for a period of three years.

Building Connections, Expanding Focus

As we can testify from personal experience, an HFSP grant can provide a terrific boost to a new project. For example, the 1998 HFSP grant to Hans Clevers (Hubrecht Institute, Utrecht, Netherlands), Mark Peifer (University of North Carolina at Chapel Hill, USA), and Ken Kinzler (Johns Hopkins University, USA) provided their labs with the opportunity to expand their work on Wnt signaling. Both the Peifer and Clevers labs began studying the tumor suppressor APC with this HFSP funding. This was a new project for the Clevers and Peifer labs, and while neither had a large body of preliminary data in the area nor a long track record, the Kinzler lab had extensive experience in this area. The HFSP grant led to several joint publications, and, in the case of the Peifer lab, allowed the investigators to obtain a U.S. National Institutes of Health R01 to continue studying APC function in the fly model after the HFSP funding ended.

When applying for HFSP funding, one can build and strengthen existing connections between labs; these connections in turn provide a strong foundation for the proposal. In 1998, the Peifer lab had recently begun collaborating with the Clevers lab on the role of the TCF transcription factor in Wnt signaling in *Drosophila*. This connection provided a base on which to build. The Clevers lab also was already collaborating with Kinzler's group. These existing collaborations provided confidence to the HFSP that we would be able to bridge the geographical gaps separating our labs.

Strengthening International Collaboration

In some ways obtaining HFSP funding is only the first challenge. The next challenge is to make international collaborations work. In the case of the Peifer/Clevers collaboration, this involved several reciprocal visits, including a six-month stay in the Peifer lab by a Clevers' lab senior undergraduate. This and other shorter visits helped strengthen more personal connections. In addition, many long telephone calls helped build bridges between the labs. In retrospect, a more formal set of joint lab meetings, which today could be easily arranged by Internet video conferencing, would have increased information transfer from lab to lab still further. It would have sped science on both sides and built stronger connections among team members.

The final challenge is to build a collaboration that will survive the end of funding. This is even more difficult than obtaining funding or building a successful international collaboration. In our case, the distance between the labs, the inevitable divergence of interests over time, and the departure of some of the personnel involved in the initial connection all contributed to a gradual loss of common goals. In retrospect,

more effective efforts to build ties between the labs during the ongoing collaboration would have made this less inevitable. And in our case, this clearly would have provided additional opportunities for scientists in the Peifer lab to benefit from the talents and technologies of the other labs.

Encouraging Interdisciplinary Collaboration

The HFSP now encourages even more interdisciplinary collaborations, encouraging groups that include biologists, physicists, and computational biologists to answer questions in new ways. As we learn more about molecular mechanisms, we need to integrate the data into coherent, multiscale, and quantitative models. This raises major conceptual and methodological challenges. It also requires the input of scientists from different disciplines with a shared interest in similar biological problems.

The 2008 HFSP grant to the Thomas Lecuit, Pierre-François Lenne (both at the Institute of Developmental Biology, Marseille, France), and Ed Munro (University of Chicago, USA) labs illustrates how this can work. Lecuit, an experimental biologist, Lenne, a physicist, and Munro, a computational and experimental biologist, share common yet complementary interests in tissue morphogenesis. They chose to investigate how tissue level dynamics emerge from local mechanisms of force generation and transmission at the subcellular level. This requires integrating different modes (molecular/mechanical/physical) and scales (subcellular to tissue) of description of the process in a quantitative manner. The HFSP grant provided a unique opportunity to create a multidisciplinary collaboration that integrates molecular genetics, pharmacology, quantitative microscopy, biophysical manipulation, and computational modeling.

Speaking a Common Language

The success of multidisciplinary projects hinges on the ability to speak a common language, despite differences in the approaches and backgrounds of the investigators. This requires prior preparation and cannot be improvised on the fly. For the Lecuit, Lenne, and Munro groups, prior collaborations between Lecuit and Lenne facilitated the grant project. So did convergent work by Munro on different systems. In fact, this convergence triggered the collaboration. Obtaining funding was the necessary second step. Working together to write a coherent proposal cemented the collaboration. It also stimulated the collaborators to frame questions that none of the individual labs could answer alone. As a result, when funding was obtained, the collaboration could start immediately.

Modern means of communication, e.g., Skype and email, make these collaborations much easier to implement once funding is secured. In addition HFSP grants support travel between labs, including extended visits to launch and adjust the project as it unfolds. However, continuing efforts to speak a common language and embrace the sense of complementarity remain essential ingredients to facilitate progress, despite the distance.

Continuing Collaborations

With two of the collaborators in Marseille, HFSP could have considered the proximity of the Lecuit and Lenne groups to be a disadvantage. After all, HFSP's mission is to support collaborations among people from different countries. However, the HFSP was flexible enough to view the proximity as an advantage instead, as they understood that exceptions to geographic distance can exist when proximity can be justified on scientific grounds.

Although it is still too early to say, the Lecuit, Lenne, and Munro labs are determined that their collaboration will extend beyond the HFSP 2011 funding period. Technologies that ease communication across international boundaries should facilitate the continued collaboration. Moreover, new questions will arise from the collaborative results, stimulating further experiments, and the teams will thus be encouraged to continue to work together. After all, removing one ingredient of a successful recipe will not improve the cake. ■

—Mark Peifer, University of North Carolina at Chapel Hill, USA, and Thomas Lecuit, IBDML, CNRS/Université de la Méditerranée, France