

NSF's RUI Program

Perspectives from the Inside

ROBERT COYNE

Program Director, Division of Molecular & Cellular Biosciences
National Science Foundation

My goal here is to summarize the main features of the Research in Undergraduate Institutions (RUI) program at the National Science Foundation (NSF) and offer the perspectives of one who has been on both sides of the fence, as a principal investigator of a RUI project and as an NSF program director managing the review of RUI proposals. Most of the additional details you need to know about RUI can be found at <http://www.ehr.nsf.gov/crssprgm/rui/start.shtm>.

What is the RUI Program?

The overriding purpose of RUI is to support faculty research in non-Ph.D.-granting departments at Primarily Undergraduate Institutions (PUIs — for NSF's definition of a PUI, see the website above). Through this activity, NSF expects to promote the progress of significant research, enrich departmental research environments, and further the integration of research and education at PUIs. There are three primary funding mechanisms within the RUI program: research awards to individual faculty members or groups of collaborating faculty members, awards for the purchase of major research instruments, and Research Opportunity Awards that allow PUI faculty members to conduct research with NSF-supported investigators at other institutions. I will focus on the first of these mechanisms.

Although RUI has its own program announcement (<http://www.nsf.gov/pubs/ods/getpub.cfm?nsf00144>), there are no special funds set aside and there are no special panels for review of RUI proposals (with the exception of the Biology Directorate's C-RUI program: <http://www.nsf.gov/pubs/2004/nsf04536/nsf04536.htm>). RUI proposals are reviewed and awards managed within the appropriate disciplinary programs, along with those from major research institutions. However, NSF recognizes the special circumstances of PUI investigators and provides reviewers and panelists with specific instructions to consider the generally heavier teaching load of PUI faculty members, the limited experience and independence of their students, and, in many cases, their limited facilities. In my experi-

ence, reviewers are quite receptive to well-designed RUI proposals, and this attitude is reflected in their success rate — about the same overall as non-RUI proposals.

Another NSF program with the related goal of promoting integration of research and education is CAREER (<http://www.nsf.gov/home/crssprgm/career/start.htm>), but since RUI and CAREER have different formatting requirements, a proposal must respond to one program announcement or the other. If you decide to apply for CAREER, the nature of your institution will certainly be noticed by your program director, but it wouldn't hurt for you to make it clear to reviewers as well. Another source of some confusion concerns the EPSCoR program to stimulate research in U.S. states (plus Puerto Rico and the U.S. Virgin Islands) that have been under-represented in federal support. No action is required by the PI to notify NSF of the potential for EPSCoR co-funding. Still, an award to an EPSCoR state has a positive "broader impact" (one of the two NSF review criteria — see below) that you may wish to mention to reviewers.

How Does the NSF Review Process Work?

I'll now take you inside the black box whereby your carefully crafted proposal goes in one end and, about six months later, either cash or a "We regret to inform you ..." e-mail comes out the other. Before I worked at NSF, I wondered why it took this long; now I'm amazed it all gets done so quickly. Understanding this process can help you craft a successful strategy to obtain RUI funding.

First, who are the program officers (POs, or PDs, for program directors)? About half are permanent staff and half "rotators," like myself, who are on leave from academic or research institutions for a period of one to two years. NSF's purpose in having such a large contingent of temporary staff is to maintain contact with the scientific and engineering community through a two-way flow of individuals into and out of the agency, bringing in new ideas and acting as emissaries. I believe this is a very healthy system, but the rapid turnover of POs can result in some confusion

among PIs. You may feel you have just established a good relationship with your PO when s/he “rotates” out and a new one steps in, who may not be aware of the history of your funding search. It’s a good idea to get to know your PO, permanent or rotator. We are people much like you, who have known the disappointment of a declined grant proposal and the thrill of a funded one. A phone call is the easiest way, but face-to-face meetings can often be arranged. POs attend many scientific conferences in the field for which they are responsible. Find out if your PO will be at your next conference and arrange a meeting place. If you happen to travel to the D.C. area, you may want to inquire if your PO has time for a drop-in visit. POs also engage in “outreach” visits to campuses across the country, including biannual “Regional Grants Conferences” (<http://www.nsf.gov/bfa/dias/policy/outreach.htm#future>).

The first step after a new proposal arrives is to ensure that it is assigned to the appropriate program for review. The mechanics of this process are different in different NSF Divisions, but there are some general themes. The first PO(s) to look at your proposal will be from the organizational unit (program or cluster) you selected in FastLane when submitting the proposal (you may want to select more than one if you are uncertain). Sometimes, however, s/he will decide that the proposal would “fit” better in another unit and show it to a PO from that unit. If that other PO agrees, the proposal will be transferred, or a co-review may be arranged so that two programs consider the proposal, each from its own perspective. PIs are notified of the assignment by e-mail. Although some PIs are upset when the program they selected is not where the proposal ends up, it’s important to recognize that the assignment is made in the PI’s best interest. The boundaries between programs are difficult to define, and often change in response to the evolution of scientific fields, community size fluctuation, and even PO interests. The Program Officers are in the best position to decide where a proposal will be given the best reception by reviewers and panelists. Nevertheless, if you want clarification on the assignment, feel free to contact your PO by phone or e-mail.

POs rely heavily on the advice of external reviewers to make funding recommendations. Many programs convene special advisory panels where every proposal is vetted by a team of experts and sorted into from three to five categories based on relative priority. Because many panels consider over a hundred proposals, the time devoted to discussion of each may be as little as ten to fifteen minutes! Identifying reviewers and panelists is one of the major jobs of a PO — more on their selection below. Once all the reviews have been considered, it is the PO’s responsibility, in consultation with the Division Director, to make final recommendations to fund or not. Since there are generally more worthy proposals than available money, difficult decisions must be made. We take into consideration not only the reviewers’ comments, but also how the greatest impact can be made toward NSF’s mission, as mandated by Congress (see <http://www.nsf.gov/home/about/creation.htm>). This can

What is a PUI?

Predominantly Undergraduate Institutions (PUIs) are defined by the National Science Foundation as U.S. two-year, four-year, masters-level, and small doctoral colleges and universities that (1) grant baccalaureate degrees in NSF-supported fields, or provide programs of instruction for students pursuing such degrees with institutional transfers (e.g., two-year schools), (2) have undergraduate enrollment exceeding graduate enrollment, and (3) award an average of no more than 10 Ph.D. or D.Sc. degrees per year in all NSF-supportable disciplines. Autonomous campuses in a system are considered independently, although they may be submitting their proposals through a central office.

be summarized as the promotion of science and engineering research and education among all groups, throughout the country (a tall order!). To “balance the portfolio” of awards, sometimes projects that will strengthen research and education in a certain geographic region, or among an under-represented minority group, fare better than others that may be more “cutting edge” scientifically. In this regard, RUI proposals can have an advantage.

One of the best ways to understand the review process (and benefit from that knowledge) is to get involved! POs are always looking for qualified reviewers and panelists, especially ones from PUIs. Identify the program(s) that handles proposals in your area of expertise (if unsure, check the searchable award database at <http://www.nsf.gov/award-search/index.jsp>), contact the PO, and volunteer to be an external (*ad hoc*) reviewer. Send your CV, a brief summary of your research interests, and/or the URL for your website, if you have one. Reviewing other people’s proposals, especially those with a successful track record, is a great way to see the variations on how they can be constructed, and will allow you to assess your own with a fresh eye. If you are thorough, fair, and conscientious about returning reviews, most likely the PO will continue to ask you (Remember that new rotators periodically arrive, and you may need to reintroduce yourself.) The next step up is to serve on a review panel. Often, but not always, this opportunity would come after you have received an NSF award. In addition to your own disciplinary program (which may or may not hold panels, depending on the field), there are panels for a variety of special funding programs; ask your PO for details on opportunities appropriate to your interests and expertise. Panel

service is a major commitment of time but can be very rewarding. Finally, if you really want to get the inside scoop, consider serving as a rotator at NSF. The experience can be fun and intellectually interesting, and NSF takes pains to enable you to maintain contact with your home institution and research program. Because of the rapid turnover, rotators are in constant demand; contact your PO or the appropriate Division Director for more information.

What Makes a Fundable RUI Proposal?

Probably what you most want to know is how to be successful in a grants competition. Much useful advice can be found in the NSF publication “A Guide for Proposal Writing” (<http://www.nsf.gov/pubs/2004/nsf04016/start.htm>). I will offer some general thoughts and then some particular points on the various sections of a standard NSF proposal. As anyone who has read the Grant Proposal Guide (GPG; http://www.nsf.gov/pubs/gpg/nsf04_23/start.htm — essential reading!!) knows, all NSF proposals are evaluated through the use of two National Science Board approved merit review criteria: what is the intellectual merit of the proposed activity, and what are the broader impacts of the proposed activity? A proposal that is weak by either of these criteria will have an extremely low chance of funding.

First and foremost, a good proposal must focus on a scientific question of significant interest and lay out, in sufficient detail, a well-designed approach toward its resolution. There must also be evidence, through preliminary results and a tangible record of achievement (usually measured in the common currency of publications), that the PI has the expertise and facilities to carry the project through. Many RUI proposals come from junior faculty members, within a few years of completion of graduate school or a post-doc, with a solid publication record from their pre-PUI days. An even stronger case can be made for a faculty member who has demonstrated his/her ability to make progress and publish within the PUI environment, particularly involving undergraduate researchers/co-authors.

Selection of an appropriate research topic is critical. Your problem should be interesting, naturally, but ideally not so “hot” that major labs are directly competing with yours. In the words of many reviews I have seen, you need to “develop a niche.” Often, this is an offshoot of recent graduate or post-doctoral work. If so, a letter from your former mentor clearly stating that s/he won’t step on your toes (and may provide essential support, such as reagents) can be reassuring to reviewers. On the other hand, such a letter shouldn’t suggest that you’re not a fully independent investigator. It also shouldn’t cross the line into being construed as a letter of recommendation, which is not allowed. Collaborations with other scientists can show that you are in close contact with colleagues in your field and reassure reviewers that all the proper expertise is available. Once again though, the bulk of the research and its direction should be clearly centered at your home institution.

One of the most common criticisms of RUI proposals, especially from beginning faculty members, is that they are “too ambitious.” It’s very unlikely you will be able to move forward at the same pace you maintained as a post-doc. Reviewers and POs know this and accept it, and so should you. If you simply can’t resist putting in an extra aim or two, at least be sure to prioritize, and qualify your statements, as in: “It may be beyond the scope of this proposal, but if time permits, I will create life in a test tube [Aim 3.D].” Another point to consider is the timing of grant activation. Beginning a project just as the summer starts, or at the beginning of a sabbatical or “light” semester may allow you to get it rolling before your teaching responsibilities take priority.

One potential way to allow more steady progress is to hire a full- or part-time technician. Such requests are common in RUI proposals, so don’t be shy. Training a tech from scratch can be time-consuming, so if you can find a candidate with prior training and identify him/her by name in your proposal, it would be a plus. Another option that is less common, but that I think has some advantages, is to request funds for a post-doc. Many graduate students desire a position at a PUI and direct experience working with undergraduates, while they pursue a significant research objective, could be very valuable to them. If your department chair is supportive (and a letter from him/her in your proposal would document this), a post-doc may even be able to take over some of your teaching responsibilities (e.g. lab sections, some lectures), thus giving the post-doc more experience and you a little more time to devote to research. Sounds like a win-win situation. Again, if you could possibly identify a qualified candidate (perhaps a student from your former institution, or the student of a colleague), it would reassure reviewers that you will be successful in recruiting.

Now for some specific advice on sections of the proposal... The **Project Summary** should begin with a general statement of the question under consideration. It is also a good idea to include a list of the specific objectives so reviewers know up front what you plan to attempt. To emphasize the importance of the broader impact review criterion, NSF’s policy is now to return without review any proposal that fails to separately address both criteria in the Project Summary. As a PUI investigator, the training potential of your project generally is readily apparent to reviewers, but “playing to your strengths” is still a good strategy. Most NSF applicants have now “caught on” to the importance of including reference to broader impact, so a simple, unimaginative statement will no longer capture the attention of reviewers. Try to personalize your proposal (in the **Project Description** section) with specific examples of students in your lab — what have they accomplished, and what plans do you have for the training of your current group? Have any of your students been members of under-represented minority groups? What specific plans do you have for recruiting more, and what is the available pool at your institution? Tracking the outcome of student training is something few

PIs do, but doing so (either as an individual PI or as a department) can make a strong impression on reviewers. How many students went on to graduate or professional school? Where are they now? How did their experience in your lab/department influence them? The **RUI Impact Statement** is another place to include such information, but not all reviewers will read it as carefully as the main body of the proposal. Of course, training undergraduate researchers is not the only form of broader impact. Many diverse examples can be found at: <http://www.nsf.gov/pubs/2004/nsf042/bicexamples.pdf>. Reading this list may be overwhelming; you're not expected to be "SuperProf," but if you can find the time for, e.g., outreach to your local elementary school or community group, an active role in a scientific society, or writing editorials on scientific topics for your local newspaper, it shows a greater commitment to the "broader impact on society" ideal.

A compelling **Project Description** must contain many elements, including: a clear exposition of the state of the field and how the results of your project will contribute to further understanding of an important question, a summary of preliminary results including some key data figures (even if they are published — few reviewers will search out references), a detailed experimental plan (schematic figures are often helpful) with alternative approaches to follow if the first line of attack is not successful, and clearly stated hypotheses and plans for interpretation of the results. Many reviewers look for a list of the specific aims near the beginning of this section; it's prudent not to disappoint them. A common complaint of reviewers is that the research plan is not "innovative." For RUI proposals, there is not as much expectation to push the envelope of technology, but a proposal that simply applies a common method to another gene or molecule may not be seen as contributing valuable new information. Also, the training potential will be weakened. If a cutting edge technology that you do not have the experience or facilities to apply is really necessary to make significant progress on your project, you should consider arranging a collaboration or refocusing your project.

Attention to Broader Impact also needs to be paid in the Project Description. What most applicants do, however, is tack on a paragraph or two about student training to the final page and call it a day. A more compelling approach is to weave all aspects of broader impact that apply into the body of the text. For example, maybe one of your students has obtained a certain preliminary result and, if the proposal is funded, will be able to follow it up in a certain way. Personalize the proposal by including the student's name and story. Essentially all reviewers still devote greater attention to scientific merit, but often it is broader impact that separates the "very goods" from the "excellents."

There is no page limit on the **References** section, but that doesn't mean you should include hundreds. Recent review articles can substitute for some of the non-essential primary literature. One of the main points is to demonstrate to

reviewers that you are familiar with the most relevant, up-to-date material in your field. Another thing to be aware of is that your PO may scan the references list to find potential external reviewers, so be sure to include articles by the most knowledgeable, active researchers in your field, and include all author names. I would also recommend providing lists of **Suggested Reviewers** and **Reviewers Not to Include**. Your PO does not know your field as well as you do, and may not assign your proposal to that one perfect reviewer who can assess it most keenly. Of greatest usefulness are names of other PUI faculty members qualified to review both the science and the broader impact (don't just suggest your PUI colleagues who work in separate fields) and names of newly independent investigators who may not yet be in the NSF reviewer database (young faculty members tend to be more conscientious about actually returning reviews when asked). POs generally are happy to receive and use such suggestions. We often need to send out twice or more as many requests to review as are accepted, so providing six or more names (with institutions and current e-mail addresses) is a good idea. Reviewers may be based in the US or other countries and may be active researchers at academic, private, government, or corporate institutions. If a potential reviewer is in direct competition with you, or you have reason to suspect s/he would not be an unbiased critic, it's OK to request that person not be used.

Many new applicants have questions about the **Budget** section. The answers to many general questions can be found in the GPG. Answers to other questions, such as the general range of award amounts, may be program-specific, so it's best to ask your own PO or search the awards database mentioned above. In general, most standard awards, RUI or not, are for three years of support. Don't feel that by scrimping you will increase your chance of funding; ask for what you need to accomplish the project goals. If your program cannot afford the amount requested, your PO will negotiate the amount with you, and the aims of the project may need to be adjusted. On the other hand, an artificially inflated budget makes a bad impression. It is generally expected that you will request financial support for student stipends, summer research, and perhaps travel to conferences. Another source for additional student support, if your proposal is funded, is an REU (Research Experiences for Undergraduates — <http://www.nsf.gov/home/crssprgm/reu/start.htm>) supplement. Except for research instrumentation awards, RUIs do not require cost sharing, unless specified in a special program solicitation.

The **RUI Impact Statement** provides an additional opportunity to make a case for funding your project, but it should not be considered five free pages to continue the Project Description. Here, the focus needs to be on your department and institution, its strengths and needs, and how the requested funding will make a positive impact. The type of information to include is clearly described in the RUI Program Announcement. As much as possible, concrete evidence to back up your statements should be included,

such as statistics, independent assessments, and data on awards and recognition received by your department or institution. The most compelling picture is one of an institution-wide commitment to improving undergraduate training through support for faculty-driven research.

Finally, it cannot be over-stressed that a clearly written proposal will receive a much better reception from reviewers than one that is poorly organized or contains grammatical and spelling errors. Reviewers are very busy people who just don't have time to tease out the meaning of tortured prose. Sloppy writing also conveys an impression of sloppy thinking. Finish your first (spell-checked) draft of the proposal weeks ahead of submission and have several merciless colleagues tear it apart, especially if you have trouble with English. Remember that not all reviewers, especially the panelists, will be experts in all the areas you describe, so unusual jargon should be avoided, or if that is impossible, clearly defined. You will impress more with clarity than with an avalanche of details. Clear figures (large enough to read, please) are often very helpful. Many PIs now include color figures; unless very high resolution is essential, it's not necessary to send hard copies. Reviewers can view color figures on their monitors or print their own color copies. Lastly, to comply with NSF font size limitations (and be easy on the eyes), I recommend Times New Roman, size 12.

What if Your Proposal is Declined?

First, don't be too discouraged. The majority of proposals do not receive funding on their first submission. Don't call your PO right away. Carefully read through the reviews and, if applicable, the panel summary. One thing to be aware of with panel summaries is that they are written during very busy panel meetings, while discussion of other proposals continues. Thus, they are not always models of clarity. Let the comments sink in for a day or two and practice some humility. "Was Reviewer #1's confusion about that method really the result of an unclear statement I made? Was the relevance of my work to the field in general understated?" If your proposal was rated in a low priority category, the panel may be sending you a message that this project itself is not worth pursuing and revision of the proposal would not be worthwhile. If you are unclear how to proceed, it's time to contact your PO — we're here to serve. It may be possible, if your program has two submission dates per year, to revise a proposal and resubmit in a matter of weeks. If you think it's too late, determine whether your program uses deadlines or target dates. If it's target dates, your PO may approve an extension.

How should revisions made in response to reviewer criticisms be incorporated? NSF has no special requirements; you're not even required to acknowledge the existence of a previous submission. Reviewers of your resubmission will not have access to any of the materials associated with the original. Nevertheless, since your resubmission will most

likely be sent to some of the same reviewers (and don't forget that POs make the final decisions), I usually recommend making it clear that their advice was not ignored. You may choose to enumerate the changes in a separate paragraph early in the Project Description, or to highlight them as they come up. The stylistic choice is up to you. One common, frustrating experience is that, after addressing every reviewer comment, your resubmission is declined for a new set of reasons. This is usually because new panelists with a different perspective are serving on the panel, and/or new ad hoc reviewers have been selected or have agreed to return a review. It may also be the result of the rapid evolution of a research field. In any case, unless the criticisms are clearly erroneous, they must be dealt with in a new round of resubmission.

Final Comments

I hope that this article has helped you understand a little more about the RUI program and how to apply for NSF funding. NSF greatly values the contributions of PUI investigators to scientific and engineering research and to the training of our next generation. I hope you will investigate the URL links provided above, talk with your PO, and keep those proposals coming. Best of luck.

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Bob Coyne is currently on leave from the Department of Biochemistry and Molecular Genetics at the University of Virginia School of Medicine. He is serving as a Program Officer in the Genes and Genome Systems Cluster within the Division of Molecular and Cellular Biosciences at the National Science Foundation. He received his B.S. from Allegheny College, Ph.D. from Harvard University, and post-doctoral training at the Fred Hutchinson Cancer Research Center. He has held faculty positions at Cornell University, Colgate University, and Oberlin College.



Bob Coyne