Getting Funding for Research in Developmental Biology at Primarily Undergraduate Institutions

Why talk about funding at PUIs?

Promotion and tenure at liberal arts colleges is increasingly dependent upon the research output of the faculty member. However, new faculty at PUIs cannot always get the research mentoring they need at their home institution. Therefore, the Professional Development and Education Committee of the SDB has convened this panel to provide resources for faculty who are interested in obtaining research funding for their undergraduate research programs.

Who's doing the talking?

Karen Crawford teaches Developmental Biology (and other things) at St. Mary's College of Maryland. Her research on the development of squid embryos has been supported by NSF Research Opportunity Awards (ROAs) and Wood's Hole MBL fellowships.

Julie Drawbridge teaches Developmental Biology (and other things) at Rider University. Her research on kidney organogenesis in amphibian embryos has been supported by an NIH Academic Research Enhancement Award (AREA) and NSF Research at Undergraduate Institution (RUI) Awards.

Scott Gilbert teaches Developmental Biology (and other things) at Swarthmore College. His research on turtle shell morphogenesis has been supported by the NSF RUI program.

Gary Radice teaches Developmental Biology (and other things) at the University of Richmond. His research on lymph heart development has been supported by the NIH AREA program. His research on teaching and technology has been supported by the NSF Course Curriculum and Laboratory Improvement (CCLI) program.

What are we talking about?

Our goal here is to provide our colleagues at PUIs with the essential information for writing a fundable proposal. We hope that our perspective provides some useful insight into the grant writing (and getting) process.

NSF Research Opportunity Awards and Summer Fellowships at the Marine Biological Laboratory, Woods Hole, MA

Contributed by Karen Crawford, St. Mary's College of Maryland
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NSF Research Opportunity Awards (ROA):

Research Opportunity Awards (ROAs) are small supplemental awards to existing NSF grants. These awards are designed to bring faculty from Primarily Undergraduate Institutions (PUIs) together with scientists at research universities or foundations. Ideally they facilitate training and create continuing collaborative networks for faculty and students at PUIs. Important to mention, ROAs may also support work at summer research laboratories or field stations. Although awards are typically smaller than 20,000 dollars, this funding can go a long way toward supporting part of a sabbatical year or summer research project away from the undergraduate institution. In addition, they may play a critical role in the professional development and advancement of the scientist from the PUI by demonstrating recognition of professional activity from the NSF in their field of research. An initial discussion between the sponsor holding a current NSF grant with their NSF program officer regarding the proposed project and funding schedule is strongly recommended. Following this initial discussion, ROA applications are submitted by the NSF grant sponsor to their Program Officer via Fastlane. Unlike other NSF grants, ROAs may be submitted anytime throughout the year. Moreover, ROAs are evaluated on a case-by-case basis and are awarded at the discretion of the NSF program officer. As with all NSF support, awards are dependent on the scientific quality and merit of the research and are limited by the availability of funds. Therefore, submitting a proposal well before the funds are needed is best. To allow for enough time for the review and funding process, proposals should be submitted at least 4-6 months before the funding is required. Overhead funds accompany the award and are directed to the home institution of the PI holding the sponsoring NSF grant.

Typical expenses that may be covered by an ROA include: travel, housing, supplies and summer salary (a real plus for faculty at PUIs). Summer salary, if a component of the ROA, is paid to the awardee from the sponsoring institution and as a result, they become a temporary employee of that institution for the duration of the award and are taxed accordingly by the home state of that institution. After the research experience, a report is prepared by the PI holding the sponsoring NSF grant to summarize and highlight the activities and accomplishments of the visiting scientist.

Summer Fellowships at the Marine Biological Laboratory, Woods Hole, MA:

Each year the Marine Biological Laboratory supports 20 or more scientists through their fellowship program. Several of these fellowships are specifically designated to support developmental biologists and in some cases female developmental biologists, although fitting your particular research project/profile to the individual fellowship descriptions listed in the Guide to Research & Education booklet is not necessary. Information regarding the different fellowships may be found at the MBL website: www.mbl.edu/research/fellowships. The

deadline for fellowship submission is January 15th. Fellowship proposals are fairly short and include: a registration form, fellowship application form, housing application form, a detailed curriculum vitae, a brief statement or abstract of your proposed research at the MBL followed by a more detailed description of your work (not to exceed three pages), budget, statement of the potential relationship of this fellowship to your career development, list of previous summers spent at the MBL, and list of previous MBL Fellowship support. Fellowships are typically small, in the 6-12 thousand dollar range, and may cover housing, board, travel, lab space rental (most often shared with other summer scientists) and supplies for the visiting scientist. Summer salary is not included in fellowship support. An important component of the application process involves a statement of justification for why this project should be done at the MBL. While using marine organisms available at the MBL would be considered an obvious justification, use of the many different and excellent research facilities available at the MBL and described in the Guide to Research and Education booklet or collaborations with existing research scientists or clusters may also serve to strengthen or link the proposed project to the MBL. An important element to keep in mind: MBL fellowships are not restricted to young faculty members and are often awarded to more advanced associate level and full professors. Fellowships may also be awarded to advanced postdoctoral fellows or new assistant professors, although this is less common. Ideally fellowships are designed support scientifically strong independent research projects and to nurture the professional relationship of the scientist with the MBL and foster future externally funded research programs for these individuals at the MBL. Although recipients are frequently previous MBL summer course students or individuals connected to established year round or summer laboratories, applications are welcome and encouraged from all members of the scientific community who feel that their work would best be facilitated within the vibrant scientific community of Woods Hole.

Doing Research at a Liberal Arts College

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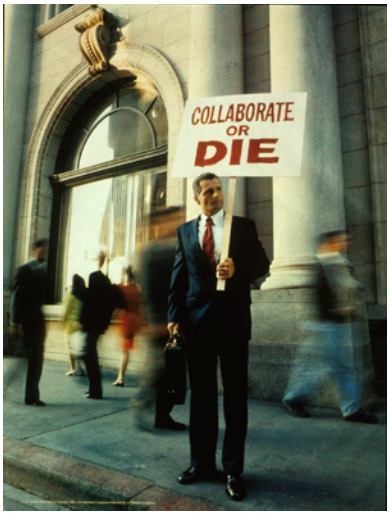
I. Modes of doing research with undergraduates:

Doing research at a liberal arts college is like doing research in the "third world." We are faced with three possibilities:

1. Compete against the big labs.
2. Work in some area that the big labs haven't realized is important.
3. Collaborate with a big laboratory.

In my personal experience, I have found that strategy 1 does not work. I've been scooped both times I tried it.

Strategy 2 can be interesting, but it demands some creativity and even more luck. *Drosophila* got its big boost from being the perfect organism on which to do senior research projects. Today, one can use non-model organisms to train students in the current procedures of developmental biology. I think that evo-devo might be a big resource for liberal arts college research. For instance, Abouheif and Wray used *Drosophila* probes to look at genes in the *ant* wing discs. One can either use the existing probes or make one's own (and teach the students some bioinformatics). One can also take advantage of the big benefit of liberal arts biology departments--their interconnectiveness. There are all sorts of projects between disciplines that are not being done. The first use of monoclonal antibodies in plant development was published from a liberal arts college wherein the immunologist heard a talk given by the department's plant physiologist. Similarly, one laboratory got its reputation by taking the molecular insertion procedures of neurobiology and using them to insert molecules into other types of developing tissues. Jim Collins sent me this:



The third strategy provides the perhaps the best chances for success and has many collateral advantages. If one lives near a university or medical school, one can often become affiliated with a developmental biology laboratory there. You can then use their equipment and the knowledge of its PIs and graduate students. Furthermore, you can work out some arrangement for either working on one of their projects with your students or working on your own project within their laboratory. One can sometimes even get technical help to keep your projects going. The students you bring with you (in the summers, for instance) get to see what "real" scientific life is like and to partake in graduate student life for a while. It is also fun to do, and sometimes you can co-opt some excellent graduate students or post-docs into your own projects. (My turtle projects have benefited enormously from the post-docs, grad students, microtomes, and journal clubs of Jefferson University.) Depending on the institution, this could be great or damaging for tenure. It depends on what is considered "independent research." It's good to get equipment for your college and do the work on campus during the school year. Like most anything else in research, fruitful collaboration involves a combination of the right people, the right location, and luck.

II. When to do research:

The first 95% of a project consumes 95% of the time. The last 5% of the project consumes another 95% of the time. Given lectures, course laboratories (and ordering supplies), advising, and committees, we have very little time to actually do research. Therefore summers and sabbatical leaves become critical. If one can get funding for a technician (or find a grad student or post-doc at a big laboratory who is interested in continuing your project), that is a fantastic boon to one's research. Another way of getting research done is to normalize it into your curriculum. If you have a seminar on the field in which you do research, you may be able to have these students work on aspects of your project. It is actually a good way of learning to "live in the lab", and it is possible to make seminars into laboratory courses wherein students read material to help them with their projects.

III. Grants for research with undergraduates:

Thank goodness for RUI, ROA, and AREA!

The Research in Undergraduate Institutions (RUI) program supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions. The specific objectives of RUI are to: (1) support high-quality research by faculty members at predominantly undergraduate institutions, (2) strengthen the research environment in academic departments that are oriented primarily toward undergraduate instruction, and (3) promote the integration of research and education. One can learn about the NSF's RUI and ROA programs at their website at http://www.ehr.nsf.gov/crssprgm/rui/start.shtm. (This handout is taken largely from this site.)

Proposals submitted under RUI are accepted in all fields of science, including research on learning and education. RUI is fully integrated into the regular disciplinary and shared instrumentation programs of the Foundation, and RUI proposals are evaluated and funded by these programs (e.g., through Integrative Biology and Neuroscience, where the developmental

mechanisms cluster is located). Eligible "predominantly undergraduate" institutions include 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 disciplines for which NSF provides research support. Autonomous campuses in a system are considered independently, although they may be submitting their proposals through a central office.
□

The involvement of undergraduate students is an important feature of RUI, providing them with research-rich learning environments. However, the overriding purpose of RUI is the support of faculty research, helping to maintain faculty member's intellectual vibrancy both in the classroom and in the research community. Thus, it is important to show how your getting a grant would benefit the immediate students working with you and subsequent students who will be in your classroom laboratories.

A Research Opportunity Award (ROA) is funded as a supplement to the NSF grant of the host researcher, and the application is submitted by the host institution. This allows you to "piggy-back" onto the grant of a person who already has an NSF grant. The first step in obtaining a Research Opportunity Award is to identify those researchers with NSF support in areas of interest to you (and with whom you would enjoy working). The easiest way is to call or email an NSF program officer in developmental biology or to search the NSF website for existing awards. The developmental mechanisms people can be reached at (703) 292-8417. People studying animal development or evolutionary developmental biology might want to email or speak with Dr. Judith Plesset (jplesset@nsf.gov) and those studying in plant and microbial development might wish to contact Dr. Sharman O'Neill at soneill@nsf.gov . Further instructions for finding NSF researchers can be found http://www.ehr.nsf.gov/crssprgm/rui/Connections.shtm .

Remember, too, that NSF RUI grants can be used for interesting educational initiatives. This is one place where undergraduate institutions (which take pedagogy seriously) are probably at an advantage! The Division of Undergraduate Education (DUE) has several programs for changing laboratories, for making innovative use of computer technology in the classroom, and for finding ways to enhance outreach opportunities to the K-12 schools. Some of these opportunities are discussed at http://www.ehr.nsf.gov/ .

The NIH also supports undergraduate research through its AREA (Academic Research Enhancement Award; R15) grants. These grants support individual research projects in biology which are conducted by faculty in institutions (such as undergraduate colleges) that do not usually receive NIH grants. These studies must involve involving their undergraduate students. The three goals of the AREA program are: (1) to support meritorious research, (2) to strengthen the research environment of the institution, and (3) to expose students to research. It is hoped that students having such an experience will want to continue studies in the biomedical sciences. The AREA grant is a research award and not a training award, so the focus is not on course work but on hands-on research.

The AREA grants are "modular" grants that are funded in $25,000 increments up to a maximum of $150,000.00 in direct costs for a three-year grant. The experience of the investigator in working with students, the availability and involvement of students in the research project, the suitability of the institution for an award, and the impact of an AREA grant on the institution are part of the review criteria on investigator and environment. More on AREA grants can be found at http://grants1.nih.gov/grants/funding/area.htm.

Remember that, for both RUI and AREA grants, you may not receive a funding decision for 6 months. Therefore, if you are seeking salary to support a sabbatical leave, plan your grant application accordingly. AREA grant deadlines are January 25, May 25 and September 25. NSF RUI deadlines for regular grants are January 10 and July 10.

IV. CODA

I find it helpful to remember that research at a liberal arts college is not a lower-level version of research at a university. We are allowed to do research primarily because it is the best way of teaching our best students. Also, there are several advantages to being a scientific researcher at a liberal arts college: (1) We experience an interconnectivity within our departments, wherein we routinely go to talks and listen to topics given by people whom we would never see at a university; (2) We experience an interconnectivity of the campus, wherein we have lunch with all sorts of scholars whom you would never see at a university. (This can lead to all sorts of interesting teaching experiments;) (3) We have what universities crave: potential graduate students who are already doing research as undergraduates. Many universities and medical schools have programs to support such undergraduates; (4) We have the freedom (at least post-tenure) to do certain types of research that might be too risky for graduate students. Our undergraduates just need letters of recommendation. They don't need to have their names on papers. This allows us to work on projects that we are interested in rather than those that we know have to work.

Resources for Grant Writing

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Books:

Getting Science Grants: Effective Strategies for Funding Success
Thomas R. Blackburn
Paperback 160 pages
Jossey-Bass, August 2003 (available soon)
ISBN: 0-7879-6746-7

Research Proposals: A Guide to Success, Third Edition
Thomas E. Ogden (Editor), Israel A. Goldberg
Paperback: 368 pages
Academic Press; 3rd edition (June 2002)
ISBN: 0125247338

On-line Resources, with sample topics:

Project Kaleidoscope (pkal.org), follow *Resources* link:

A Check List: Developing A Competitive Proposal
Preparation of the Research-Grant Application: Opportunities and Pitfalls
Proposal Preparation and Scholarship Assessed
Thoughts on a Proposal as Scholarly Writing

The GrantDoctor, Next wave, online site of Science magazine (requires subscription)
http://nextwave.sciencemag.org/cgi/content/full/1999/08/27/1

Articles with advice and news about various grant topics.

Michigan State University, S. Joseph Levine
http://learnerassociates.net/proposal/

Not specifically for biology, but gives specific examples of how to present various sections of a grant

NIH Grant Tips Page
http://grants1.nih.gov/grants/grant_tips.htm

Preparing Grant Applications
Quick Guide for Grant Applications

Tips for New NIH Grant Applicants
Quick Guide for the Preparation of Grant Applications (Complementary and Alternative Medicine)
Applying for an NIH Grant
A Straightforward Description of What Happens to Your Research Project Grant Application (R01/R21) After it is Received for Peer Review
Review Of New Investigator R01s: Guidelines for Reviewers
SBIR/STTR Policy and Grantsmanship Information

NIH/NIAIS (National Institutes of Allergy and Infectious Diseases)
http://www.niaid.nih.gov/ncn/grants/default.htm

Application Basics
How to Plan a Grant Application
How to Write a Grant Application
How to Manage a Grant Award
Supplemental Materials

NSF Proposal Writing Guide
http://www.nsf.gov/pubs/1998/nsf9891/nsf9891.htm

Introduction
Program Information
Review Process
Criteria for Evaluation
Advice To Proposal Writers
Step 1 - Before You Write
Step 2 - Writing the Proposal
Step 3 - Before Sending Your Proposal to NSF
Step 4 - Awards and Declinations

NSF Getting Started Page
http://www.nsf.gov/home/programs/guide.htm

National Cancer Institute
http://deainfo.nci.nih.gov/extra/extdocs/gntapp.htm

Planning Your Application
Abstract
Research Plan (overview)
  Specific Aims
  Background and Significance
  Preliminary Results/Progress Report
  Research Design and Methods
Budget and Justification
Assurances

Human
Animal
Resources and Environment
Overall Considerations

Grant Programs specifically for Primarily Undergraduate Institutions

NIH-AREA (Academic Research Enhancement Awards)
http://grants.nih.gov/grants/funding/area.htm

NSF-RUI (Research at Undergraduate Institutions)
http://www.ehr.nsf.gov/crssprgm/rui/start.shtm

Summary

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Don't compete with the big labs: All of us panelists work on systems and problems which are important and interesting – squid embryogenesis, salamander kidney organogenesis, turtle shell development and amphibian lymph heart development - but which do not put us in the position of having to compete with investigators who have grad students, post docs, access to state-of-the-art technology facilties, fewer teaching responsibilities and more money. Evo-devo and eco-devo have plenty of unexplored territory for the PI at liberal arts colleges to explore.

Collaborate: Collaboration will give you access to facilities and colleagues that will increase your research productivity. NSF ROAs provide salaries and supply money for beginning or maintaining a collaborative relationship. Fellowships at the MBL can also help forge collaborations with the added benefit of summers spent in Cape Cod.

Get preliminary data before you submit a proposal: Both NIH and NSF are favorably impressed if you show you can generate data *with undergraduates at your home institution*. Consider engaging students in your courses in some aspect of your research. Students in my molecular biology laboratory clone salamander genes for my kidney development research. All NSF grant proposals must now include an "impact statement" explicitly outlining how the proposed research will improve science education. This gives the investigator at a PUI an excellent opportunity to highlight creative ways to engage undergraduates in research.

Ask questions and keep trying: Use all the resources at your disposal – website information, panel directors, colleagues – when preparing your proposal. And, remember that hardly anyone gets funded the first time around. The upside is that your grantsmanship will improve as you write more grants - and keep that preliminary data coming.