

# Chapter 1

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## Getting Started

### 1.1 INTRODUCTION

Scientific research today is quite different from what it was even a few decades ago. Modern science aims at tackling complex problems facing our society, from the understanding of the global environment in which we live, to the origin and development of organisms and life, to the construction of sustainable habitats, and to human behavior and learning. In order to investigate such complex problems, scientists must be engaged in interdisciplinary research, crossing traditional disciplinary boundaries and collaborating with other scientists who have different background knowledge and expertise. Moreover, because complex scientific problems are universally challenging, the approaches and solutions to the problems must also be globally positioned, and as such it requires international perspectives and collaborative engagements. The National Science Foundation (NSF) is a U.S. federal funding agency that promotes scientific research with interdisciplinary and international perspectives.

NSF was established in 1950 by the U.S. Congress with the mission of promoting the progress of science, among other objectives. It supports competitive research projects in all scientific disciplines through a rigorous review process. NSF has seven directorates, including Social, Behavioral and Economic Sciences; Mathematical and Physical Sciences; Geosciences; Engineering; Education and Human Resources; Computer and Information Science and Engineering; and Biological Sciences, which cover the entire spectrum of basic science domains. In addition, it has several offices under the Office of the Director, such as the Office of Cyberinfrastructure and Office of International and Integrative Activities, which also provide funds to support research projects with specific research orientations and tasks (see the NSF Organizational Chart at <http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/ex1.pdf>). NSF is the funding source for about 20% of all federally supported research conducted by colleges and universities in the United States. NSF funds reach nearly 2,000 universities and institutions in all 50 states. NSF receives over 45,000 funding requests and makes over 10,000 funding awards each year. In fiscal year 2010, NSF had a budget of about \$6.9 billion. Over the last decades, NSF has further differentiated itself from other federal funding agencies, such as the National

Institutes of Health (NIH) or the Defense Advanced Research Projects Agency (DARPA), by focusing on supporting basic research at the frontiers of knowledge rather than health- or defense-related projects. This focus, however, does not mean that the NSF is uninterested in research that directly benefits society; on the contrary, NSF is interested in translational and transformative projects that can bridge the gaps between basic research and applied science and technology. In addition to research discoveries, NSF is also keen on supporting projects that can cultivate and educate a new generation of scientists and educators for the 21st century. Toward that goal, NSF provides funds to support science and engineering education, from pre-K, to K–12, to college, and to graduate school and beyond. A major merit index of NSF-funded research is thus the research project’s ability to integrate science and education in the research context.

It is quite clear that NSF has been a major engine for scientific discovery, learning, and innovation in the United States, and across the globe through its international partnership efforts (see the latest NSF Strategic Plan at <http://www.nsf.gov/news/strategicplan/index.jsp>). NSF supported-research has led to the winning of 180 Nobel Prizes, and to many other important scientific discoveries—hence the slogan of NSF: “Where discoveries begin.”

This book is designed as a practical guide for researchers interested in applying for NSF funds through its competitive review process. The authors are both active researchers who have received NSF funding and who have both served as Program Officers (sometimes called Program Directors) at the NSF. The overarching goal of this book is to provide investigators with a detailed picture of the NSF application, review, and awarding processes, while at the same time discuss techniques on how to develop and write the best NSF proposals and to maximize chances of funding success. Some of the procedural details may apply only to NSF proposals, but many of the basic principles about proposal preparation and review are applicable to other competitive research proposals. Note that this book is not meant to be a substitute for the official guidelines issued by the NSF. Instead, investigators must closely follow the Grant Proposal Guide (GPG, part of the Proposal and Award Policies and Procedures Guide, last updated on January 14, 2013) in preparing their proposals. Over the course of our discussion, we will cover the basics of NSF proposal preparation, but given the objectives of the book and the space limitation we will not be able to address all the detailed stylistic and procedural requirements.

## 1.2 FIRST STEPS

Science professionals of all ranks, especially untenured junior faculty in research institutions, are under tremendous pressure these days to seek external funding for their research. This pressure is particularly strong in light of today’s business model adopted by many institutions. On the one hand, external funding from a federal or private agency provides the institution of the principal investigator (PI) with increased revenue because of the overhead costs associated with the funding, and on the other hand, it demonstrates to the administrators of the institution (who may be unfamiliar

with the PI's specific work) that the PI's research is important because of the rigorous peer review process associated with extramural proposal evaluations. Thus, a researcher's ability to seek and receive external grants is frequently used as an important index for administrators to determine personnel issues such as tenure and promotion. In what follows, we discuss a number of issues you may have regarding the first steps for a grant proposal.

### 1.2.1 NSF or NIH?

Even before writing a grant proposal, you may be unsure whether you should apply for NSF or NIH funding. Every funding agency, public or private, has its own focuses and priorities, and so do NSF and NIH as the two main federal granting bodies for scientific research. You are strongly encouraged to first study the focuses and priorities of a funding agency before applying. Without a thorough understanding of the funding agency itself, chances of success are slim. Thus, simply knowing that NIH projects are in general funded with more money compared with NSF proposals is not a good reason for applying to NIH (see Section 1.3.4 and Chapter 2, Section 2.4.8, for more on the NSF funding level).

While both NSF and NIH support basic research, their focuses are indeed different. As discussed in Section 1.1, NSF supports basic science, work that elucidates the basic principles and processes underlying the physical world or an organism. NIH, on the other hand, has a mandate to promote public health and welfare and as such puts more emphasis on health-related sciences and applications. In the past, when the funding situation was not so dire, a given proposal often could fit both NSF and NIH goals; today, the division of labor between NSF and NIH has become very clear due to lack of funds, so often you may need to choose one or the other. As an example, a proposal with a significant component on diagnosis and treatment of children's mental disorders would not be appropriate for NSF, whereas a proposal simply on children's developing mental capacities in mathematics or language would not fly at NIH. Of course, this is not to say that you could not have a proposal that would fit the scope and missions of both NIH and NSF (see more discussion below).

Does NSF support work on applications at all? The answer is yes, but the focus is different from that of NIH. In the new merit review guiding principles, NSF further emphasizes projects' potential to benefit society, for which application of basic sciences in achieving societal goals is highly relevant. NSF has a huge interest in integrating science and education, so work that has implications for and applications in the educational setting would be welcome. NSF is particularly interested in supporting work that can boost the education of STEM (science, technology, engineering, and mathematics), as dedicated funds were appropriated by the Congress to support STEM education research. Thus, research on STEM education is a highlighted area for NSF proposals.

What if you feel that your research actually fits both NSF and NIH goals? Can you submit to both funding agencies? Indeed, a proposal that addresses both basic science issues and societal applications may well be entertained by both NIH and

NSF. In such cases, you can simultaneously submit your proposal to both agencies, and it is not illegal or unethical to do so (unlike in the case of submission to peer-reviewed academic journals for publication). It is advisable, however, that you discuss your plan with the Program Officer who is handling your proposal at both NSF and NIH. The Program Officer may give you advice on how to tailor your proposal, even if slightly, to the requirements of his or her agency. On the NSF cover page (see Chapter 3, Section 3.2.2.2) you also need to check the box for “Is this proposal being submitted to another federal agency?” and provide the acronym of the agency to which you are submitting (e.g., NIH, or other federal agencies such as the Department of Education (DOE) or Department of Defense (DOD); see Chapter 7, Section 7.2.2, for further details of these other agencies).

Finally, there may be programs at NSF that are jointly supported by the NIH or other federal agencies to which you can apply. One example is the Collaborative Research in Computational Neuroscience (CRCNS, NSF 11-505), which involves joint NSF and NIH processes (including review and funding efforts). Another example is the Joint DMS/NIGMS (NSF Division of Mathematical Sciences and the National Institute of General Medical Sciences) Initiative to Support Research at the Interface of the Biological and Mathematical Sciences (DMS/NIGMS, NSF 12-561). See Chapter 7, Section 7.2.2, for more on cross-agency collaborations.

## 1.2.2 Who Can Apply?

Given the importance of extramural funding, a first question that arises is: Who can apply? Different funding agencies tend to use different criteria, some based on eligibility of the investigators, others on research topics, and many based on both. Here we focus on the criteria that NSF uses.

A very important starting point, which has not always been clear to many researchers, is that the official recipient of NSF grants is not the individual PI or researchers, but the institution with which the PI is affiliated. This fact affects the eligibility issue significantly, as it leaves the responsibility for deciding who is eligible for applying for NSF funds in the hands of the institutions rather than NSF. In other words, it is the institution that assigns the PI and that receives the funds from NSF. Indeed, most U.S. institutions have registered with NSF for receiving NSF funding, as well as some foreign institutions such as those from Canada. In the event that your institution is not in NSF’s database, this needs to be worked out between your institution and NSF, which is particularly important if you are from a foreign institution (e.g., serving as a collaborator on a project with a U.S.-based PI). Implications of this institution-based grant process also include, for example, that the institution can transfer, terminate, or take other actions with regard to the received NSF funds, although in practice these actions are almost always taken in consultation with the PIs. For instance, the recipient institution, A, can allow the funds to be transferred to another institution, B, in the event that the PI moves to B (see Chapter 6, Section 6.6, for further details on the transfer process). However, institution A can also refuse to transfer these funds to B, and can assign a new PI to the project, if

the institution believes that the new PI is perfectly suitable for carrying out the proposed study. In such a situation, the original PI will not have access to the NSF funds proposed in his or her project.

Because of the abovementioned grantor-grantee relationship at an institutional level, it is therefore important for potential applicants to first check with their institution's Sponsored Research Office (SRO) or other units of similar functions before submitting a grant proposal. In general, if you are employed at a four-year college or university in the United States and are a full-time employee at the rank of Assistant Professor or above, you are eligible to apply for funding from NSF. What if you are a postdoctoral fellow associated with a research lab or a research center (sometimes called a research associate)? This becomes a little tricky. First, you should discuss with your postdoctoral mentor to see if he or she is willing to let you apply for NSF funding as an independent PI. Your mentor might prefer to be the PI and have you be the co-PI, so that in case you leave the institution, the funds will remain at your mentor's institution. In some cases (e.g., you move to another institution), your mentor might be willing to transfer some of the funds to you as a subaward (see Chapter 6 for subawards). Second, if you feel strongly about being the PI, make sure that you can carry out the research independently, that is, without your mentor's close supervision and that the work is really yours (of course this needs to be couched tactfully in the face of your mentor). Finally, if you do get an okay from your mentor, you should check with the SRO to see if they are okay with you applying for NSF funding as a Research Associate (a title change may be involved). The institution may want to make sure that by allowing you to be a PI it does not feel obliged to extend your contract.

Another question that often comes up is whether the applicant for NSF funding needs to be a U.S. citizen or permanent resident. The general answer is no, given that the institution with which you are affiliated determines your eligibility, and few U.S. institutions, if any, impose a citizenship or residency requirement on its employees as a criterion for applying for extramural funds. On the other hand, it is important to note that if other personnel such as postdocs or graduate students are part of the proposed project, there may be rules as to whether they need to be U.S. citizens or permanent residents to receive payments. This may especially be an issue with specific programs or solicitations; for example, for the PIRE program (Partnership for International Research and Education), research or travel funds must be used to support only U.S. citizens or permanent residents.

### **1.2.3 Determining to Which Program to Apply**

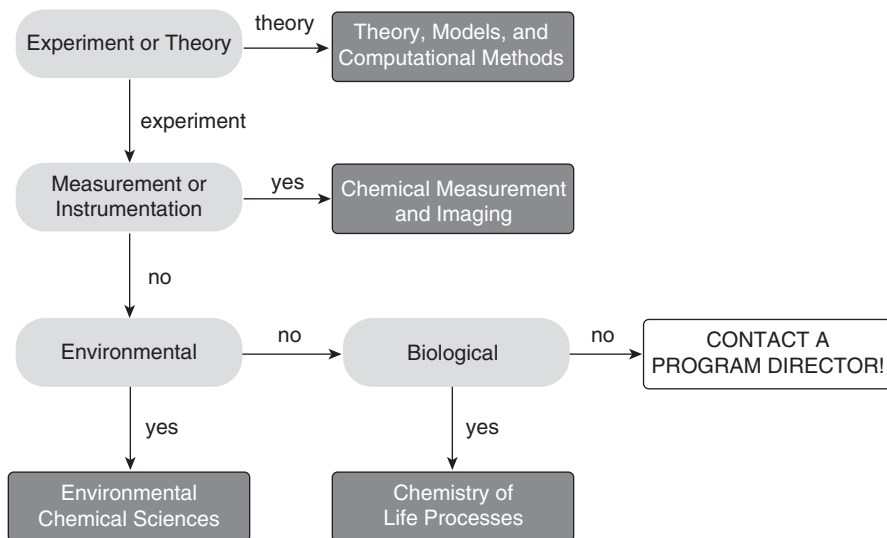
Once you have determined that you are eligible to apply as an investigator (PI) or co-investigator (co-PI), you should not start the writing of the proposal yet. You should do some more homework before the actual writing. First, understand how NSF works by studying the website <http://www.nsf.gov/>. This website contains a lot of useful information for potential investigators. For example, it gives an overview of the structure of NSF in terms of the Office of the Director overseeing

seven disciplinary Directorates, and Directorates containing Divisions, and Divisions containing Programs. The core unit that evaluates research proposals is at the level of Program, and therefore before you write your proposal you should determine which NSF program or programs you want to apply to, as this will significantly affect how you write your proposal. Even if you have the same ideas, you may be writing quite differently depending on the audience (the Program Officer and panelists). Again, consider the focus and priorities of the specific NSF program to which you apply, just as you do in deciding on the granting agency (NSF vs. NIH; see Section 1.2.1). Often, the match of your research with the profile and priorities of the program may be more important than the actual science itself in getting your work funded.

How do you narrow down your focus onto one or two programs? In practice, this could be quite straightforward. It might be a simple conversation with colleagues in your department, your former advisor, or other experts you know who have overlapping research interests and who have grantsmanship experience. As mentioned in Section 1.1, NSF programs cover a wide spectrum of basic research, and there is a good chance that your research fits squarely with the aims of a specific program. You can determine if this is the case by looking at <http://www.nsf.gov/>, which contains information about the scope of a program, program contacts, deadlines, and proposal guidelines for different types of applications. It is also important to note here that each program may have a set of program-specific criteria for reviewing proposals, other than the common NSF review criteria (see Chapter 2, Section 2.5).

NSF has a funding opportunity search site (“Find Funding”; <http://www.nsf.gov/funding/>) that is very useful to investigators to identify the opportunities and programs for their applications. You can type in keywords and the website will return with a list of programs that match your search criteria, along with descriptions of the relevant program. You can also search for what has been awarded by keywords, or narrow down your search by specific program areas at NSF. This Find Funding website also provides links to special programs, such as opportunities to support students or postdoctoral fellows, and to recently announced funding opportunities and upcoming due dates.

What if your research project is highly interdisciplinary and does not fit into the scope of one program? As mentioned previously, NSF promotes interdisciplinary and cross-disciplinary research (see [http://www.nsf.gov/od/oia/additional\\_resources/interdisciplinary\\_research/index.jsp](http://www.nsf.gov/od/oia/additional_resources/interdisciplinary_research/index.jsp)), and, as such, several programs within NSF often work together to co-review and co-fund interdisciplinary projects (see Chapter 4, Section 4.3.3 for more on the co-reviewing process). NSF also often ships out new calls for proposals in response to new demands or trends in science; for example, Cyber-Enabled Discovery and Innovation (CDI), Accelerating Discovery in Science and Engineering through Petascale Simulations and Analysis (PetaApps), Social-Computational Systems (SoCS), and Interface between Computer Science and Economics and Social Sciences (ICES), all of which are jointly supported by multiple units involving computational science, social science, engineering, and education. In some cases, entire divisions have undergone restructuring or realignment to better align the programs with the sciences they represent; for instance, the Division of Chemistry has undertaken a program realignment effort (see <http://www.nsf.gov/mps/che/realign/brochure.pdf>) in response to changing demands in the field.



**Figure 1.1.** Example decision tree for determining which program is the best home for an unsolicited research proposal from a chemistry investigator. Shaded boxes with white lettering are the programs within the Division of Chemistry.

Figure 1.1 provides an example from the Division of Chemistry on how to determine the appropriate home for an unsolicited proposal, a proposal that is written not in response to a specific solicitation or announcement from NSF (although all NSF regular programs do have solicitation numbers).

In sum, it is very important to gather enough information about the program that may be funding your research in the future. If you send your proposal to the wrong program, sometimes a Program Officer may help you transfer your proposal to other programs within NSF (if the Program Officer has the knowledge of where your proposal would best belong), but more often your proposal will end up in the “Decline” category, much like what happens when you send an article to the wrong journal and get rejected right away because it does not fit the scope and aims of the journal. To keep yourself abreast of new developments at NSF, you may want to subscribe to NSF alerts, by clicking on the upper right-hand side of the website <http://www.nsf.gov/> (the envelope icon), “Get NSF Updates by Email.” NSF will email you information regarding new programs, new solicitations, or Dear Colleague Letters via this alert system (A Dear Colleague Letter [DCL] is often issued to the research community by NSF to tell colleagues that some new changes or opportunities have arisen. See more discussion in Section 1.3.2).

### 1.3 BEFORE WRITING THE PROPOSAL

In some ways the process of getting a research proposal funded is like the process of getting a paper published, as mentioned above, but in other ways these two



processes are different. Notably, getting a research proposal funded involves more homework to be done other than the writing of the proposal itself. In this section, we will discuss a few more steps that are essential, or in some cases just helpful, to the success of a research proposal.

### 1.3.1 Where to Ask for Help

It's interesting that Figure 1.1 ends with the box "Contact a Program Director" when the decision tree cannot lead you to an appropriate program. Indeed, it is often a good idea to contact the Program Officer even if you have determined the program you want to submit to (see Chapter 2, Section 2.2, for further discussion). Program Officers are in general very helpful and receptive to questions. On the other hand, they would be much happier to answer your questions if you cannot find the relevant answers on the NSF website first, which shows to them that you have done your homework prior to contacting them.

It is probably best to contact the Program Officer first by email and then followed by a phone conversation (they are all busy individuals, often traveling, and may be handling the program while doing some research). You can start your email with something along the following lines (break these into several paragraphs, as appropriate): *"Dear Dr. [insert name of Program Officer], I am in the process of preparing an NSF research proposal in the area of [insert research area]. I am wondering whether I can make an appointment to speak with you by phone to discuss the appropriateness of my proposal for your program. If you prefer to have the discussion by email, that would be fine with me too. I am attaching here a 1-page summary of my research plan. Your comments and suggestions will be most welcome."* Attaching the summary should be very helpful, as it allows the Program Officer to do a first-pass check on whether your application fits the aims of the program. But remember not to send more materials than necessary—they won't have time to read your whole proposal at this stage, and if they need more information to make a judgment, they will ask you for more (see Chapter 2, Section 2.2, for further discussion).

NSF organizes an annual regional conference as an outreach activity, where NSF Program Officers and staff members provide detailed information regarding NSF and funding. Many investigators who have attended the conference find this meeting useful, as it provides a chance for them to interact with NSF Program Officers and staff in an informal setting (see Chapter 7, Section 7.4, for more details). Other informal settings where you can find NSF staff may include annual meetings of the professional societies in your field; sometimes there are booths or posters from various funding agencies, and you should use these opportunities to make contact with NSF Program Officers. Again, it would be good if you prepare specific questions to ask before meeting with the Program Officers. In some cases, the Program Officer may not have all the information you need but he or she can help you identify relevant information from other programs or sources and establish contacts with other Program Officers at NSF.



Another good resource, as briefly mentioned above, comes from the colleagues in your department, your former mentor or advisor, and other experts you know who have overlapping research interests and who have grantsmanship experience. Some of these individuals may have served on NSF or NIH panels or as Program Officers at federal or private agencies. They can provide you with many useful and insightful tips regarding proposal writing and funding opportunities, at NSF or elsewhere. When there is sufficient research overlap between you and your colleague, it might be a good idea to work on a joint research proposal as a start, although at some point you do want to distinguish your work as an independent line of research and not as part of a larger project by your advisor or your colleague.

A third source of help is your institution's sponsored research office (SRO). Depending on the size of your institution, the SRO may have one or several staff members who are very knowledgeable about NSF and other federal or private foundations. These officers or staff members constantly interact with funding agencies, and some of them may have traveled to funding agencies or to conventions or meetings organized by the agencies (such as the NSF regional conference mentioned above), and have first hand-experience with regard to the process of research funding. They may also be the ones who know about any changes or updates to guidelines, policies, and other requirements (e.g., the new GPG guidelines). Your SRO staff may not have the expertise in your particular domain of research but they have valuable insights in the preparation and funding processes associated with a research grant, and they may also point you to various special opportunities at NSF that you are not aware of.

Finally, you should use the Award Search function at NSF's website (<http://www.nsf.gov/awardsearch/>) to look for information associated with each awarded project, including abstract, awarded amount, PI names, and the program that provides the funding. In many disciplinary programs' websites, there is a link to "What has been funded," which points to the award search results that pertain to the particular program, providing relevant information on recent awards including abstracts. In some cases, you may want to get in touch with the PI (directly or through NSF) to ask for a copy of the successful research proposal (with personal information redacted). Not every researcher is willing to share his or her proposal in its entirety with the public, but you may be surprised at how helpful some researchers can be in providing valuable information to you. Be aware that NSF Program Officers cannot share copies of full proposals with you; only the PI can do this.

### **1.3.2 Know the Special Opportunities**

*Regular programs versus solicitations.* NSF has regular programs, as discussed earlier. Each program is associated with a program announcement (e.g., NSF 11-584), available at NSF's website (or you can simply Google the announcement number if you know it). If you apply to the regular program, your proposal is an "unsolicited" proposal. NSF also has temporary and occasional one-time programs, often issued as solicitations. These solicitations are announced to the public via NSF's website and other forms of dissemination (e.g., through institutions' SRO contacts). If you

apply to these temporary programs, your proposal is in response to a solicitation, and at the NSF submission website you need to indicate so.

While it is clear from our discussion above that the regular programs may be the main source of funding, you should definitely also pay attention to new solicitations and other new initiatives. Receiving NSF alerts regularly (see Section 1.2.3) may be a good way of being informed about these opportunities, in addition to other means (see Section 1.3.1). For example, NSF recognized the need to bridge the gap between social sciences and computational sciences, and in the last few years it put forward a series of initiatives, such as Cyber-enabled Discovery and Innovation (CDI), Social-Computational Systems (SoCS), and Interface between Computer Science and Economics and Social Sciences (ICES). CDI, SoCS, and ICES were each associated with a solicitation announcement (e.g., 11-502 for CDI, 10-600 for SoCS, 11-584 for ICES), often updated annually (with new solicitation numbers). The CDI program is a particularly interdisciplinary initiative, as it encourages strong collaborations among scientists from computer science, engineering, education, and social sciences. It is important for the potential investigator to read the announcements very carefully to understand the rationale, objectives, eligibility, funding line, timeline, and other requirements associated with each new program or initiative.

One question with respect to the budget of the Program Solicitations is how to read the anticipated funding amount, which is generally specified in the solicitation. The anticipated funding amount is usually the total budget allotted to the new initiative/program for a given academic year (unless otherwise specified), which gives you an idea of how much your own project should aim at. For example, if the anticipated funding amount is \$5 million, and the estimated number of awards (usually also specified in the solicitation) is 20–25, then you can put up to \$200,000 per year for your project (up to 3 to 5 years, depending on the nature of the program and your project).

*Dear Colleague Letters.* Another temporary mechanism of funding that NSF uses is the Dear Colleague Letter (DCL). DCLs are also associated with an announcement number (e.g., 11-053 for NSF-DFG collaborative research, and 12-030 *Interdisciplinary Research across the SBE Sciences*), but unlike the regular programs or new solicitations, DCLs are often one-time, having no dedicated new funds or having only limited (supplemental) funds, and in some cases they are simply reminders of changes to existing programs. To give an example, the NSF-DFG Collaborative Research DCL (11-053) announces opportunities for supplementary funds to current NSF awards to enable U.S.-based researchers to collaborate with Germany-based researchers who are funded by the German Research Foundation (DFG), the German counterpart of NSF. The research topics must fit the NSF's Robust Intelligence program and make strong connections to DFG's Autonomous Learning program. To give another example, the HSD (Human and Social Dynamics) program had funds left when the competition was formally completed in 2008, and a DCL was issued to the community that the remaining funds would be used to support large-scale interdisciplinary programs, complexity science projects, and infrastructure projects through existing programs rather than to create new programs in the social and behavioral sciences. Thus, these additional funds augmented the existing

programs' capacity to fund more projects in the specified categories, and the projects that received funding might also be larger in size than the regular projects (this is sometimes specifically mentioned in the DCL). In actuality, what happens is that if a proposal receives favorable reviews from an existing program, the proposed project may be supported by funds from both the regular program and the DCL one-time allocations (without the investigators' awareness). Finally, a DCL may simply be a "dear colleague letter," in which an important announcement regarding updates or changes at NSF is made. For example, the most recent and important DCL is 13-004: Issuance of a New NSF Proposal and Award Policies and Procedures Guide (<http://www.nsf.gov/pubs/2013/nsf13004/nsf13004.jsp>).

### **1.3.3 Know the Different Types of Support**

NSF has a variety of mechanisms to support basic research conducted by different researchers at different career stages. See Chapter 2, Sections 2.8–2.11, for further discussion.

#### **1.3.3.1 Standard Research Proposals**

The majority of NSF applications are in the form of proposals for investigator-initiated research projects, regardless of whether you submit to regular programs, targeted solicitations, or other special calls. In the remainder of this book (Chapters 2–5), we will focus on the preparation, submission, and reviewing of this type of proposal.

#### **1.3.3.2 CAREER Awards**

NSF used to have small grants for junior faculty members (similar to NIH's academic career awards, or K-awards), but this has now been discontinued. Instead, junior faculty members who are at the untenured assistant professor level can apply for CAREER (Faculty Early Career Development) awards. CAREER awards are research projects, but differ from the regular projects by a strong emphasis on the integration of science and education. For example, you can propose to develop a new curriculum in conjunction with your research. In addition, the CAREER awards are for a duration of 5 years, unlike other regular research projects (usually for 3 years). Although CAREER proposals are reviewed together with regular research projects within disciplinary programs, they are accepted only once a year, typically with a deadline in July (the exact deadline depending on the particular program). See Chapter 2, Section 2.8, for further details on submitting CAREER proposals.

#### **1.3.3.3 Postdoctoral Fellowships**

Typically, postdoctoral support is integrated as part of a standard research project, and the investigator has to provide a rationale and a plan for mentoring postdoctoral fellows. In some cases, however, there are special opportunities for postdoctoral support; for example, the Division of Earth Sciences provides generous support to postdoctoral fellows for a period of 2 years, and the recipient of the grant can take

the fellowship to an institution of their choice to pursue postdoc research. The Directorate of Biological Sciences has a 1–2 year postdoctoral fellowship in targeted areas of research and teaching in biology, plant genomics, and cross-disciplinary intersections of biology and mathematical and physical sciences. The Directorate of Social, Behavioral and Economic Sciences has a new postdoctoral research fellowship program (SPRF) that includes two tracks: Broadening Participation and Interdisciplinary Research in Behavioral and Social Sciences. The first track was originally the SBE minority postdoctoral research fellowship, whereas the second track is new in 2012 (see details at NSF 12-591). NSF provides a website that contains a list of all postdoctoral fellowship opportunities from various programs (search for “specialized information for postdoctoral fellows” at <http://www.nsf.gov/>).

### **1.3.3.4 Graduate Research Fellowships**

Like the postdoctoral support, graduate student support is typically built into a standard research grant by the investigator. However, entry-level graduate students can apply, under the sponsorship of their research mentors, to the NSF Graduate Research Fellowship program (GRF). The fellowships will provide 3 years of support to predoctoral students. Only graduate students in their first year or the first term of the second year (the fall semester) are eligible to apply. In addition to the GRFs, NSF also has the Doctoral Dissertation Research Improvement grants in selected programs (see NSF 11-547 for an example). These are usually for 2 years, and unlike the GRFs, these grants are considered supplementary funds (hence smaller awards) and are not full-scale stipends to the students.

### **1.3.3.5 Conference and Workshop Awards**

NSF accepts proposals for conferences or workshops (but not regular conferences of professional societies). The proposal should highlight the uniqueness of the conference or workshop, why it is needed at this time, whether similar conferences have been held before, and a detailed plan of invited speakers, schedule, and dissemination. An important consideration from the NSF Program Officer is whether the proposed speakers or presenters will have chances to get together at regular conferences (not a good thing for the proposal), and if not, whether the proposed conference will lead to interfaces and integration of diverse perspectives and to potential collaborations between the scientists. Unlike the previously discussed proposals, conference proposals do not have to go to panels for review if the total budget does not exceed a certain amount (e.g., \$100k), and could be reviewed by the cognizant Program Officers with or without additional ad hoc reviews.

### **1.3.3.6 Exploratory or Time-Sensitive Grants**

There are special smaller-scale grants for exploratory research called EAGER (early concept grants for exploratory research) and RAPID (grants for rapid response research). The EAGER grants are usually for highly novel concepts of research that have not been well established or executed, whereas the RAPID grants are for highly

time-sensitive research that studies the effects of a major natural or human event. A good example of RAPID was a proposal for the study of effects that President Obama's taking office in the White House has on the social perception of race and racial stereotyping in the United States. The proposal was submitted to NSF right after the 2008 presidential election. EAGER and RAPID proposals typically do not undergo regular panel review (often reviewed internally by Program Officers only), given their explorative nature and urgency.

### **1.3.3.7 Other Types of Support**

There are many other mechanisms of support at NSF, some of which may be temporary or due to new initiatives. For example, (1) if you have the need to develop infrastructure to acquire a large piece of equipment for research, you can apply for the Major Research Instrumentation (MRI) grant; (2) if you have a large-scale collaborative project involving multiple institutions, you can consider to apply for the Science and Technology Center (STC) grant, which provides multi-million, multi-year support to interdisciplinary and transformative research that can integrate discovery, innovation, and learning at multiple levels, including knowledge and technology transfer; (3) if you have a vibrant interdisciplinary community of science and you are interested in providing new training opportunities to current and future students, you can apply for the Integrative Graduate Education and Research Traineeship (IGERT) grant; (4) if you have strong international collaborations or can forge such collaborations in a given domain and your institution has unique strength in this area, you can apply for the Partnership for International Research and Education (PIRE) grant. Both IGERT and PIRE grants are training grants, which means you will look specifically at how the sciences and the education can be integrated. MRI, STC, IGERT, and PIRE all have restrictions on the number of proposals a given institution can submit to NSF (usually between 1 and 3), so you might be competing with your colleagues internally before you can even send out your real proposal. Finally, NSF sometimes provides supplements to existing grants, typically with smaller funds, and these supplements may be highly program-specific, such as REU (research experiences for undergraduate students) or RET (research experiences for teachers) supplements to projects that have a strong educational component.

Each of the abovementioned types of funding has different requirements with respect to eligibility, goals, research scope, and, of course, budget, and these requirements may also be updated from year to year. It is therefore important for you to learn more about them by reading the NSF website and by contacting the cognizant Program Officers for further information. A good, brief guide by a previous NSF Program Officer can be found in Chapin (2004, Chapter 4: Special Funding Mechanisms), although some of the information there is already outdated.

### **1.3.4 Budget: How Much to Propose**

What is the typical level of funding at NSF? How much money should you ask for in your NSF proposal? These are among the questions most frequently asked by

investigators. There are really no standard answers to the budget question, for two reasons: (1) NSF's budget fluctuates from year to year, depending on the economy and on the wills of the White House and Congress, and so the funds each program gets may vary from year to year; and (2) different programs (e.g., each of the types of support discussed under Section 1.3.3) entail different amounts of funding to a project. Thus, it is important to read the program announcements, check with the Program Officers, and look up previously awarded projects (<http://www.nsf.gov/awardsearch/>) to get a good sense about the possible budget you should put into each proposal. Nevertheless, there are a few simple general rules in guiding your decision on budget.

First, ask for what you need for the aims and the type of your research. In other words, the budget needs to be well justified. If your work can be conducted in a regular lab by you working with a graduate student, do not ask for a special lab technician or for a postdoctoral fellow. On the other hand, if your institution simply does not have the facility or infrastructure support for the type of work you propose, you may want to include in the budget the cost associated with using a piece of equipment at a different institution (e.g., an expensive fMRI scanner your institution does not have). Justification of budget is looked at carefully, especially today when federal funds are so limited. Second, be realistic with your goals of research. Depending on the nature of research you have in mind, you should propose an amount that would allow you to arrive at a reasonable level of research findings. You will probably not solve a big science puzzle about dark matter and dark energy in the universe with \$100k per year. Third, make your budget in line with the program's scope and goals, so that you don't propose something that is either too ambitious or too modest for what the program is designed to tackle. This is especially important for the special programs discussed in Section 1.3.3.

In Chapter 2 we will further discuss the eligible costs that you may propose in a proposal, but here we note a few big categories accepted by NSF: personnel (including faculty and student salaries), travel (expenses associated with going to conferences or meetings), equipment (including computers and testing tools), and other direct costs (such as materials and supplies, consultant fees, and publication costs). While many special programs list on the website the total amount each program receives in a fiscal year, regular NSF programs do not list the typical amount of support (not even the cap or range of funding) they would provide to individual projects. Thus, using the above ground rules and these categories of eligible costs, you should consider a standard research grant to be in the range of \$300k-\$500k for a duration of 3 years. That is, \$100k per year is a good ballpark figure to have (\$100k as the total cost, direct and indirect together). Given that regular NSF programs typically aim at a 15%-25% funding rate in a good year, the exact amount of each grant will vary considerably, depending on the discipline and the number of proposals received by the program each review cycle (see Chapter 4). In a bad year (e.g., 2010), the funding rate may go down to 10% or lower and proposed budgets are routinely reduced by the program (see more discussion in Chapter 6, Section 6.1).



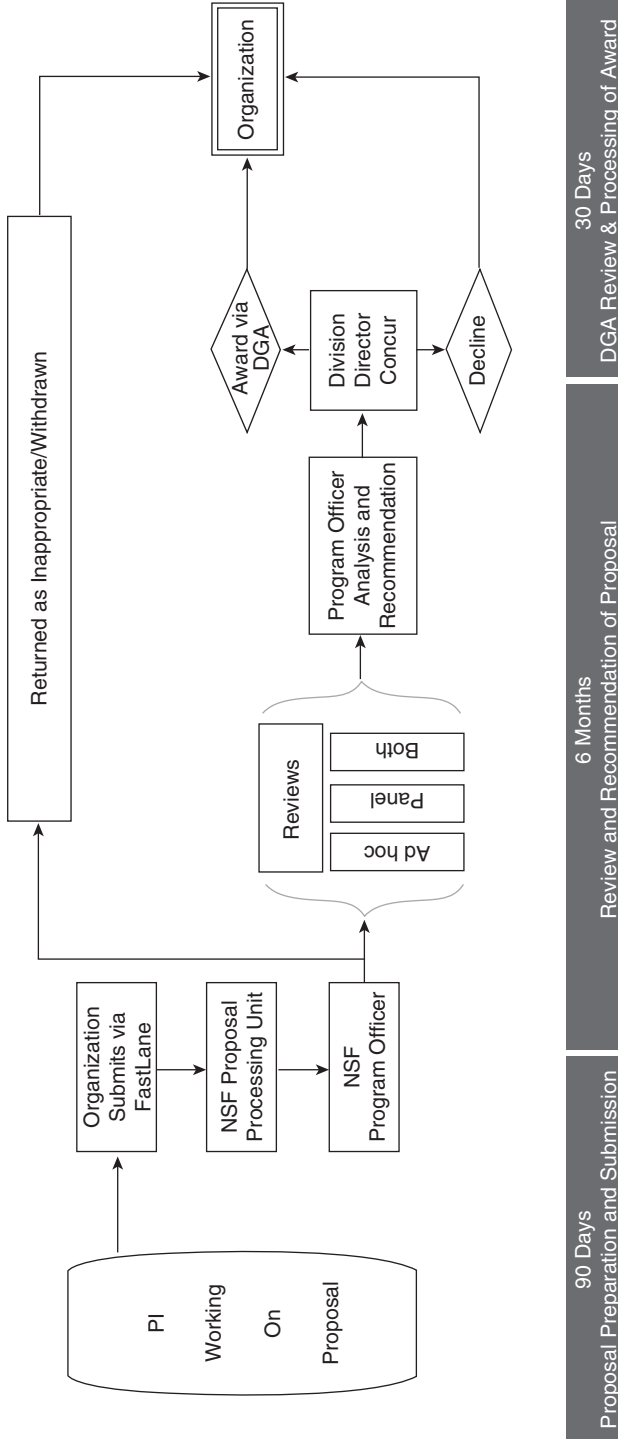
### 1.3.5 How Long to Plan for a Proposal

Research grants are hard to come by these days (think about a funding rate of 10% or lower), so the earlier you plan, the better. If you are an entry-level assistant professor, you may be very busy preparing for your courses, getting your lab set up, getting your first students in place, and so on, and may not have time to prepare for a major research grant. But if you can manage, you need to think about extramural finding, if not in your very first year, definitely in your second year. Like most major funding agencies, NSF research proposals undergo a rigorous review process, and this process takes time (more time than most of us would like!). Figure 1.2 gives you a general idea of what's involved in the NSF proposal receipt, review, and funding processes (see also a new dynamic illustration of these processes at the NSF website: [http://www.nsf.gov/bfa/dias/policy/merit\\_review/merit\\_animation.jsp](http://www.nsf.gov/bfa/dias/policy/merit_review/merit_animation.jsp)).

In the remaining chapters we will discuss the details of each of the processes involved, but here it suffices to say that this is a long process. First, after you have spent a long time (at least 90 days) preparing and have submitted your proposal, your proposal finally arrives at the NSF. It then takes about six months for NSF to handle the review of your proposal until the Program Officer recommends your proposal for funding or declination. Then the Division Director has to concur with the Program Officer's recommendation, which also takes time (a few days to 2 weeks, depending on the time of the year). There is an additional period of time after that recommendation for your proposal to go through the administrative hoops (should the recommendation be positive), including processing for the award by the Division of Grants and Agreements (DGA) at NSF. The DGA will usually need about 30 days after the program or division makes a recommendation before it formally notifies the awardee organization (see Chapter 4 for more on these steps). So even if everything goes smoothly for your proposal, you (or more precisely your institution) will have the money in the bank only after some 200 days. More likely than not, your proposal may not sail smoothly through the first time around, and that means that it would be at least a year (or more) between the time you submit your proposal to NSF and the time you receive your grant from NSF (see Chapter 5 for discussion of the revision process). And this kind of timeline is not unique to NSF. In short, the sooner you plan, the better.

In this introductory chapter, we have provided an overview of what NSF is, what the NSF process is like, and some basic steps to do and basic things to know before preparing for an NSF proposal. In Chapter 2, we will discuss the details involved in preparing your proposal; in Chapters 3 through 5, we will discuss the submission, review, and revision processes at NSF; and in Chapters 6 and 7, we will discuss how you can successfully manage your project and leverage NSF funding for further grants. Throughout the discussion we also provide sample letters and various templates for required documents to show with concrete examples the steps that you can follow for having success with NSF. Readers are reminded of the new NSF guidelines effective on January 14, 2013, discussed in Chapters 2 through 6 (see NSF 13-004).





**Figure 1.2.** NSF proposal process and timeline: (1) The PI and the submitting organization should have at least 90 days for proposal preparation before the target date or deadline. (2) The review and recommendation process usually takes about 6 months. (3) Roughly another 30 days are needed for the paperwork and other processing to complete before the funds reach the PI's organization.