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National Institutes of Health grants are extremely competitive, and getting funded has become increasingly difficult over the recent years. While we would like to report we have assembled a list of secrets to NIH grant writing made easy, the truth is, there is no such thing. A successfully funded grant is a blend of thorough preparation, persistent hard work, scientific ingenuity, expert collaboration, strategic planning and just plain good fortune. We hope that this article will provide sound advice for successful NIH grant writing, whether you are applying for your first fellowship as a pre- or post-doctoral trainee, establishing yourself as an independent investigator or simply looking to improve your grant writing skills. In the following sections we will walk through the key components of the NIH grant writing process from start to finish, including:

The essentials of grant preparation.

Salient points in the NIH grant process including understanding funding mechanisms and grant types.

The basics of study section, the review process and how your grant is scored.

An essential breakdown of the critical components of the specific aims and research strategy of an NIH research application.

**NIH grant preparation: Know your resources**

Start early, like really early. Even six to nine months ahead of an NIH deadline is a reasonable target to begin planning your proposal and to make sure you’ve completed the necessary preliminary data. Discuss your proposal with your mentor, department chair, colleagues and/or faculty to gauge level of interest, suitability of ideas and preparedness. Also, don’t forget to check with your university or institute about whether they offer grant-writing classes or seminars. This is one of the most simple, but often overlooked, means for obtaining expert advice and resources.
There are three main types of NIH grants for which you can apply depending on your stage of training and years of being an investigator, including:

1. Research Training and Fellowships for pre- and post-doctoral trainees (F, T series; i.e. NRSA F30-32, T32)

2. Career Development Awards for those working toward becoming an independent investigator (K series; i.e. K01, K99)

3. Research grants for independent investigators (R series; i.e. R01, R03, R21)

If you can, try to obtain copies of funded grants for the type you are applying from your mentor or colleagues if you are not familiar with the writing style. You can also see what’s already been funded by using the RePORT Expenditures and Results Tool, which searches a repository of NIH-funded projects and provides access to reports, data and analyses of NIH-supported research. The NIH program staff is an additional valuable resource, which you can contact before you apply or after you have been reviewed.

**Understanding the NIH grant process**

We cannot emphasize enough how important it is to take the time and effort to understand the NIH grant process from start to finish, including funding mechanisms, proposal components, submission and review. This will most certainly reduce stress and save you much-needed time and energy as deadlines near.

First, be familiar with the NIH and its types of grants and funding mechanisms. There are in fact 27 different NIH Institutes and Centers (ICs) with varying missions and budgets. Your best resource is the NIH Funding Opportunities and Notices website. This contains the NIH Guide for Grants and Contracts; which is the official publication for NIH research grant policies, guidelines and Funding Opportunity Announcements (FOAs). Look for active Requests for Applications (RFAs) and Program Announcements
(PAs); these are topics the NIH has particular interest in. You can also subscribe to the NIH Guide LISTSERV to receive the weekly Table of Contents (TOC).

Once you've identified a suitable FOA, it can be of benefit to contact the assigned program officer (PO) for the announcement, who can advise you on preparing an application or requesting a specific study section (see discussion below). While the focus of this article is on grant writing, it is worth briefly mentioning some of the frequent administrative headaches that arise. If you are not already registered with the government application eRA commons (https://public.era.nih.gov), set up your account at least two months ahead of your deadline, as it can take four to six weeks to activate. Begin all required approvals at least three months ahead of time, and make sure to contact your collaborators and/or mentors to arrange for their letters of support in a timely manner.

**Study sections, peer review and the importance of the cover letter**

All submitted NIH grants are sent to a central hub called the Center for Scientific Review. The CSR is responsible for assigning applications to NIH Institutes and Centers (ICs) and primarily manages more than 200 Scientific Review Groups (SRGs or 'study sections'). Importantly, applications are assigned to various study sections based on information you provide in your cover letter, prior review history of a proposal (if applicable), the research topic as well as the grant type (R01, F30, K99, etc.). Therefore, the cover letter is an exceptionally valuable document, as it allows you to request a specific study section and a specific institute. It is important to note that not all study sections are created equal and being assigned to the most appropriate study section for your work is critical. You can view the NIH study section roster online and use this to guide your efforts.

Ideally, a good study section has at least some members who work in your field and whose work you are familiar with - and best if you or your mentor have respected colleagues on the study section (remember, you are not allowed to communicate with a review group member directly during this process). Once you identify a study
section and IC of interest, it is useful to contact the Scientific Review Officer assigned to this study section in advance, and see if they agree with the request. If so, you can include this in your letter. The SRO is basically the liaison between you and the reviewers, and can let you know whether your project is suitable for the particular study section and may even have suggestions based on scientific interests (although take this with a grain of salt). You may even use your cover letter to request that a particular reviewer be excluded due to conflict of interest, although you will likely need to explain your reasoning to your SRO, and this should obviously be done sparingly given the nature of this request.

A study section generally reviews 80 to 120 grants and assigns each application a primary and secondary reviewer, as well as one or two readers. Reviewers write specific critiques; however, readers may also provide comments. All study section members score each grant, although it’s likely only the assigned reviewers/readers will have read it closely. Given the aforementioned process, it is essential to understand the specific criteria by which you are reviewed. The NIH details this online, and you should be familiar with it. For example, research grants are evaluated on five core criteria:

- **Significance:** Does this study address a critical barrier to success in the field?
- **Approach:** Are the methods and experimental design appropriate?
- **Innovation:** Does the application challenge or seek to advance the state of the field?
- **Investigators:** Is the necessary expertise present to succeed in the above tasks?
- **Environment:** Are the available facilities suitable to facilitate success?

Your application is then assigned an Impact Score of 1 to 9 for each of the above criteria (1 representing the best, 9 representing the worst), and everyone on the study section (even those who haven't read your grant), score your application based on discussion with the reviewers and readers. Your final score is the mean x10 (ranging from 10 to 90) and you will ultimately receive a structured summary statement with comments from each reviewer.
Writing the science: Your specific aims and research strategy

Now that we’ve discussed everything we think you should know about preparation and the NIH grant process, let’s get to the most important part about your application: writing the science. This must be done in a manner that is crisp, thoughtful and tells a great story. Your enthusiasm for your research should be reflected in your proposal - this is contagious. Remember, your job is to make the reviewer’s job easy. Reviewers are very busy, often reviewing 8 to 12 applications for a study section. Therefore, you must appeal to your audience (reviewers). This likely includes an expert in the field, but also someone who is very smart (yet knows nothing about your topic). This means your application must appeal equally to both types of reviewers, and to do this your writing must be sufficiently succinct, yet appropriately explanatory. Your goal is to make your reviewer your advocate and to win them over.

Before we dive into specifics of the Research Plan, let’s briefly discuss some of the guiding principles in effective grant writing. First, read your FOA carefully, look for special instructions and follow all formatting directions precisely. Prepare a reader-friendly application:

- Use good headings and break up sections in a logical manner.
- Carefully proof for spelling and grammar errors, as too many of these will only make your application look sloppy.
- Define acronyms the first time you use them, and use them sparingly.
- Your final application should be visually appealing – don’t leave too much white space, and use figures and tables where appropriate.
- Don’t write in a vacuum – get other opinions by having colleagues read the whole thing, or even just certain sections if they have limited time.
Be consistent in your writing style and have a steady flow. A good tip for achieving this is to read out loud, listen carefully to the delivery of your words and make sure there is an ease to which intended points are emphasized. If a sentence is exhausting to say out loud, it is surely exhausting to read, especially to a tired reviewer with a stack of grants to look over. Remember the advice above: Your job is to make the reviewer’s job easy.

Now, let’s get to writing the science. This is the Research Plan of your application, and it includes two major components: the Specific Aims and the Research Strategy.

We will start with the Specific Aims. This is just a single page, and is arguably the most important section of your proposal. Reviewers will read this and likely have already formed a strong opinion of the study. If done well, the reviewer will read the remainder of the grant through a lens of searching for confirmatory evidence that the grant is strong. If done poorly, they will likely be searching for fatal flaws, not redeeming components. Therefore, this page must be as perfect as possible. The writing must be crisp and succinct with no wasted words. This section should include a brief introductory paragraph that states the problem in the field, the significance of overcoming this critical barrier and the rationale of the current study.

This is then followed by your Aims – limit them to three to four. These should be well-defined, hypothesis-driven and explicitly state how you will test the working hypothesis by stating something like, “We hypothesize that...” in each of the Aims. Then, you should have a short summary statement that reiterates the importance of the study and the impact of its outcome. The challenge of this section is the scope it must cover in limited space. You must start with the big picture to provide context and illustrate the critical barrier in knowledge, then define sound Aims that show appropriate logic thread and extent of design supporting your assertion that you will attain the stated objectives.
The Research Strategy follows the Specific Aims and is usually six to 12 pages depending on the grant type. It includes three parts:

**Significance**: This section should be no more than one page for a six-page Research Strategy or two pages for the longer types. This section should summarize the state of the field to provide context to the importance of the proposed study. It should describe how your research would advance the field by filling knowledge gaps, technical capability or overcoming a critical barrier to progress in the field. Be sure to generously cite the work of your predecessors and the work of people on your review panel, if applicable. Make sure to give credit to related work by others, and to address competing or conflicting studies directly, explaining how your approach is unique, rational and most appropriate - this will only hurt you if you fail to address this and your reviewers are keen to the data. You should also be able to explain how the objectives in the study are aligned with the NIH mission to improve health through science by resulting in novel or improved treatment strategies or technologies, preventative interventions or potential cures.

**Innovation**: This is a brief section of new emphasis and is unclear the degree to which it is valued by reviewers. It is important to explain how your study might result in a paradigm shift or change in scientific or clinical practice within the field. However, as an early investigator (or an experienced investigator entering a new field) this can be somewhat risky, since challenging the current dogma might be less welcoming to those whose work you may be opposing. Either way, this section should be short and to the point.

**Approach**: This is where you use the organization of your Specific Aims and the inclusion of preliminary data to outline your scientific plan, expected outcomes, potential pitfalls and alternative strategies. Above, we have separated the Significance and Innovation components as preceding sections describing the work collectively, but you may alternatively decide to describe both within each Aim. For simplification, the remainder of the discussion is based on the sections having been described collectively and separated from the Aims and experimental plan.
As far as organizing your Approach, we recommend using a bold header for each Aim, and to restate the Aim as written in the Specific Aims so the reader does not have to refer back to this. When you introduce each Aim, it is helpful to describe the objective of the Aim as well as to restate the hypothesis, rationale and expectation of the proposed studies. If the study is in its early stages of development, you must establish feasibility. This can be done with both preliminary data and strategies for proposed experiments or be based on methods from your lab or others. Your preliminary studies demonstrate to the reader that you can tackle the described methods and interpret the results logically. In combination with the biosketches provided, this is how the reviewers assess the expertise and capabilities of the research team and help build confidence that you can accomplish the described work.

Under each Aim, you should describe the initial set of experiments. This should be concise, and include only the necessary details for the reviewer to understand the strategy. Do not try to impress the reader with details - this only will make you more vulnerable to finding flaws. As an early or new investigator, you need enough detail to convince the reader you understand and can perform the method; this can include citing a publication from your lab demonstrating this.

However, if this isn’t possible, you must provide sufficient detail demonstrating your expertise and state your confidence that you think you will succeed. For subsequent experiments, outline the expected next steps (space may be more sparse here). For more complicated branches of next steps, consider illustrating this with a flow chart. Remember that all text should support the conclusions you are trying to make. If not, consider removing it. For each Aim, demonstrate your preparedness by describing your plan for alternative strategies if you have negative or unexpected results. Also address potential alternative interpretations of the results. This shows the reviewer you’re prepared to accomplish your stated objectives no matter the future challenges or where the data leads. Avoid saying things like, “We will optimize…” or “will search for…,” as this should have already been done ahead of time. Be sure your figures and tables are stand-alone, and can be interpreted independently without referring back to the main text.
Once your application is assembled, try to put it away for a short period of time and come back to it with fresh eyes before you do your final checks and finishing touches. Your final run-through should no longer be for content and thought processes, but for typos, errors, formatting issues and grammatical mistakes. Finally, we hope this information will help you to put your best foot forward and submit a stellar application reflecting your hard work and great ideas.