1 The Scientific Grant Proposal and Its Narrative

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A ***scientific grant proposal*** is a request for funds to conduct original research in a discipline or a subject area typically associated with science, technology, or medicine. A ***principal investigator***[1] (PI) is the researcher who is responsible for the content of a scientific grant proposal and for submitting it to a funding agency on time, and who will be responsible for directing, developing, and executing the research on time. The PI is usually the person writing most of the narrative, if not the entire scientific grant proposal. The narrative comprises the major prose sections of the scientific grant proposal, including the abstract.

There may also be ***co-investigators*** (Co-Is) who help the PI design and develop the proposed research and write the narrative, and who will help the PI execute the research. Sometimes there are ***collaborators*** who will perform a significant part of the research and are, to a certain degree, responsible for designing their limited portion of the proposed research, subject to the PI's approval. Finally, there may be ***contractors*** hired to perform a relatively small portion of the research, but who have not helped in designing or developing the research project.

[1] Depending on submission requirements, close synonyms to *principal investigator* are *principal researcher*, *project director*, and *program director*.

There are many very good resources on the market dealing with strategies and other information to select funding mechanisms from public and private agencies that support scientific, technical, and medical research. However, there are far fewer resources dealing with how to write the narrative of the scientific grant proposal that describes and argues for the proposed research.

The focus of this book is on the narrative of a scientific, technical, or medical grant proposal that is typically submitted to a funding agency by an individual PI (and possibly involving Co-Is and collaborators) who is proposing novel research and who usually has preliminary data to support the grant proposal.[2] This book provides guidelines to help PIs describe the narrative and to argue for the scientific merit of the proposed research. You need to convince reviewers that you are credible and that if you are given the opportunity to execute your research as proposed, you will produce novel, valid, significant, and relevant findings.

The information in this book about writing the narrative can be applied to a variety of grant proposals from public and private funding agencies that support scientific, technical, and medical research. The first chapter introduces terms and concepts that will be used and expanded upon in later chapters.

1.1 Funding agencies

The PI submits a grant proposal to a funding agency, which applies criteria to decide which research projects to fund. These criteria encompass the scientific merit of the proposed research as evaluated by reviewers, research priorities within the funding agency, and the availability of funds.

Each funding agency has its own ***submission requirements***, sometimes called ***submission guidelines***, for narratives, and you must follow them for serious consideration. There are many similarities in submission requirements across funding agencies, but there are notable differences. Before writing the narrative, you need to read these guidelines, become familiar with them, and follow those that are required and seriously consider following those that are recommended, regardless whether you agree with them and whether guidelines in this book are consistent with them.

Guideline 1.1 *If any of the information in this book conflicts with the submission requirements from your targeted funding agency, follow those from the funding agency.*

1.2 Your reviewers

Each funding agency has its own procedures and criteria for selecting reviewers to serve on review panels, and each gives reviewers evaluation criteria for determining the merit of scientific grant proposals. Some panels consist exclusively of technical

[2] Some grant proposals do not need preliminary studies, such as an R21 from National Institutes of Health.

reviewers who are your peers in your discipline; others consist of both technical and lay reviewers. When submitting a grant application, you need to keep in mind that the funding agency, not the reviewers, ultimately approves research projects for funding. As a consequence, when writing a grant proposal, you need to satisfy 2 types of readers: the reviewers and the funding agency.

Guideline 1.2 *Write scientific grant proposals for 2 readers: the reviewers and the funding agency.*

The less technical and less knowledgeable the reviewers are in your proposed area of investigation, the more you need to lower the technical level of your explanations, definitions, vocabulary, and visuals. However, even if your reviewers have your approximate education, skills, and experience in your area of investigation, often times you will need to explain information to them – ***information that you know they already know*** – in order to facilitate their evaluation of you and your proposed research.

Guideline 1.3 *Do not assume that the reviewers' background in science, technology, or medicine lessens your responsibilities as an investigator to explain experimental fundamentals in your proposed research.*

There will be times in this book when you will be encouraged to explain something to your reviewers that they may already know.

Basic, safe assumptions about your reviewers – whether technical or lay – are that they: (1) are educated beyond high school for lay reviewers and well beyond undergraduate studies for technical reviewers, (2) are fluent readers of English, whether English is their native language or not, and (3) may likely be reading your narrative under less than ideal circumstances, when their reading comprehension might not be in top form, such as when they are tired or stressed. In brief, narratives to scientific, technical, and medical grant proposals need to be written with tired and stressed reviewers in mind, as explained in Guideline 1.4:

Guideline 1.4 *Structure your narrative for tired or stressed reviewers, and write:*

(*a*) *As **clearly** as possible so that your reviewers can readily understand your prose without a lot of mental effort.*

(*b*) *As **concisely** as possible so that your reviewers do not need to read through extra words and sentences to access your key information.*

(*c*) *As **consistently** as possible, repeating key terms, so that your reviewers can follow your discussion.*

(*d*) *With **details** so that your reviewers can understand precisely what you are proposing and can evaluate its scientific merit.*

(*e*) *With **research objective**, **aims**, and **hypotheses** made obvious.*

(*f*) *With transparent **layout** and **organization** so that the arrangement of information reinforces your research design, contributes to your credibility, and helps reviewers anticipate, locate, and retrieve information from the narrative with little effort.*

Reviewers take their role of reviewer seriously. They ***try*** to understand your narrative. However, only you can be sure of what you really mean. Remember:

- **Reviewers cannot read clarity into an unclear text.** It is your responsibility to write clearly and to make your topics and themes clear.
- **Reviewers cannot read quickly through a narrative that is not concise.** It is your responsibility to write as concisely as possible while maintaining clarity and representing your proposed research.
- **Reviewers cannot supply details for general or vague passages.** It is your responsibility to write precisely.
- **Reviewers cannot perceive the structure of your content where there is no or little organization.** It is your responsibility to organize and to lay out your text in a way that reviewers easily understand the narrative and can readily access its information.

This book provides specifics on how to write clearly, precisely, concisely, and with transparent organization and high readability.

An important concept about the review process for narratives of scientific, technical, and medical grant proposals is that it is influenced by social and political realities: reviewers often have biases about how grant proposals ***should*** be written. You need to write in a style associated with a person of higher education, not only because this style will help you express your ideas clearly and precisely, but also because your reviewers expect such a style from a PI who has achieved a high level of education. In this book, this style is called ***scientific English***.

1.3 Scientific judgments

Your proposed research will most likely not be considered meritorious if you fail to convince reviewers that you are credible; that your research will produce novel, valid, significant, and relevant results; and that you will follow accepted legal, administrative, and ethical standards in the execution of your methods. Tables 1-1 and 1-2 present review criteria for scientific grant proposals targeted for National Institutes of Health (NIH) and National Science Foundation (NSF). These review criteria are generally representative of criteria for many funding agencies. Each review criterion reflects at least one issue related to credibility, validity, novelty, significance, and relevance.

- **Credibility**. Credibility deals with how believable you are and how you impress your reviewers in terms of your qualifications to execute the proposed research successfully and on time. You need to convince your reviewers that you and your research team have the scientific and technical knowledge, skills, experience, and intelligence to: (a) timely and successfully execute the proposed methods, (b) analyze and interpret the results logically and objectively, and (c) disseminate results from your research.

- **Validity**. You need to convince reviewers that your research design and methods will yield accurate, reliable data that will likely support your hypothesis. Thus, in the narrative, you need to present a precise, reasonable hypothesis based on your discipline's current body of knowledge about your research topic. You also need to identify, justify, and explain your methodological approach. With this information, reviewers should be able to evaluate your proposal and determine whether your experimental approach involves confounding variables that will likely compromise the assessment of your results – results that should be based on sound reasoning and that should advance scientific and technical knowledge in novel and significant ways.

- **Novelty**. In the narrative, you need to convince your reviewers that your methodological approach will lead to the discovery of new information in your discipline. The perception of novelty emerges from an effective review and analysis of the previous research on which your proposed research is based.

- **Significance**. You also need to convince your reviewers that your research results will be ***important***, as judged against current scientific and societal knowledge, norms, and values. You need to argue that your discoveries will ultimately have a substantial, positive impact on your discipline and/or on the larger domain of science, technology, or medicine; and on society in general.

- **Relevance**. Your proposed research needs to be appropriately targeted to the types of research that your funding agency funds and to the appropriate funding mechanism. There may be times when your proposed research may be appropriate for more than one funding unit within a funding agency, in which case you need to decide which funding unit should receive your grant proposal. Likewise, there may be times when your proposed research may be appropriate for more than one funding mechanism, with some tweaking of the research approach and design.

- **Legal, administrative, and ethical standards**. You need to provide reviewers with information for them to conclude that you are following current legal, administrative, and ethical standards expected of investigators. For example, if your experimental design calls for subjects, you must discuss at what point in the proposed procedures that you will inform them of potential risks and will seek informed consent. For subjects, you may also need to ensure that the ethnic, racial, and gender composition of your subject groups is representative of the local population. Equally important, you may need to describe how you will achieve and control the confidentiality of each individual subject's identity and data.

1.4 Persona of a scientist

In the narrative to a scientific grant proposal, you need to sound like a scientist. If you cannot sound like a scientist, your credibility will be questioned.

Regardless whether you are an investigator in basic, applied, clinical, or translational research, you need to evaluate previous research and describe your proposed

research in ways to reflect your familiarity with scientific methodology. You also need to be accurate – that is, to be as factually correct as possible and not to give the appearance of subjectivity. You need to support conclusions, substantiate the likely accuracy of your claims, and indicate that you have not designed your research arbitrarily. In other words, you need to indicate that you carefully crafted a research design that controls or eliminates variables that may influence the data that you will collect, that may affect your analysis of the collected data, and that may ultimately impact your results and outcomes.

Guideline 1.5 *Through your narrative, you need to convey that:*
(*a*) *You are a highly trained scientist who is in control of scientific methodology.*
(*b*) *You have support for your conclusions.*
(*c*) *You are aware that your claims need substantiation.*
(*d*) *Your research design is not arbitrary.*

Throughout the following chapters, guidelines are offered to help you describe your proposed research, not only in a conservative writing style of an educated person but also in a style of a scientist.

1.5 Constraints on the narrative

When you prepare to write a narrative, you need to consider 3 major constraints that influence your decisions about its content, organization, phrasing, and layout: (1) the genre of the narrative in scientific grant proposals, (2) current submission requirements from the funding agency, and (3) the novelty of your proposed research.

1.5.1 Overview of constraints

Most chapters in this book address the 3 major constraints that will influence the design and composition of your narrative. Each constraint is introduced here.

- **Genre constraints**. By the submission date, your narrative should look like a typical narrative that other professionals in your field would submit – typical in terms of appearance, organization, content, and phrasing. Of course, the key question is, what are these typical features? This book provides information to help you better understand the genre of the narrative to a grant proposal in science, technology, and medicine; and to help you draft the narrative. However, if you follow only the information in this book, your narrative will likely be unsuccessful because your narrative also needs to meet constraints from the funding agency and those imposed by the novelty of your proposed research.

- **Constraints from a funding agency**. Constraints from a funding agency are the ***submission requirements*** that a funding agency publishes. By the time you submit your scientific grant proposal, the narrative needs to follow all submission requirements from your targeted funding agency – yet still reflect genre constraints and do justice to

the novelty of your proposed research. Submission requirements range from content specifications to format, organization, and font specifications. Two major federal funding agencies with extensive submission requirements are NIH (www.nih.gov/grants/funding/phs398/phs398.html [November 19, 2014]) and NSF (http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpgprint.pdf [November 19, 2014]). Many other funding agencies adopt features of current and previous NIH, and NSF submission requirements as their own.[3]

- **Constraints from your novel proposed research**. Constraints on the narrative are not only imposed from the genre and the funding agency, but also from the novelty of your proposed research. This constraint implies a document design that allows you to describe novel aspects of your proposed research while your description follows submission requirements and reflects the genre of the narrative.

The need for the narrative to reflect all 3 constraints is one reason why the narrative is hard to write. Guideline 1.6 offers suggestions for how to draft a narrative that respects all 3 constraints:

Guideline 1.6 *Write a narrative that respects and reflects constraints from the genre, funding agency, and the novelty of your proposed research design by:*
(*a*) *Including specific information that is phrased with terminology from the funding agency's submission requirements and your discipline.*
(*b*) *Organizing and producing headings for the* ***major sections****, according to the genre of the narrative, unless submission requirements specify otherwise.*
(*c*) *Organizing and producing headings for* ***subsections*** *to indicate the content and novelty of your proposed research and its historical context, unless submission requirements specify otherwise.*
(*d*) *Drafting sentences that explicitly indicate the significance and novelty of your proposed research.*

1.5.2 Generic content and typical sections

Most of this book focuses on features of a generic narrative to a scientific grant proposal. When you write the narrative, you will need to manipulate these features in order to produce a narrative that is responsive to the genre of the narrative, submission requirements, and the novelty of your proposed research.

Table 1-3A presents generic information for the narrative. Different funding agencies may use different terms for this information in their submission requirements. For example, one funding agency may use the term *objective* for the purpose of the proposed research; another may use the term *goal*. Regardless of the terms used by funding agencies to describe their required content, most require similar information. In addition, most

[3] For example, the National Multiple Sclerosis Society notes that "(Our) template parallels NIH format." (http://www.nationalmssociety.org/for-professionals/researchers/get-funding/research-grants/index.aspx; Download instructions for online submission of research grant applications; accessed November 19, 2014)

funding agencies identify the major sections of a narrative that they want, although they sometimes name and organize these major sections differently. Table 1-3B identifies different names for major sections of a narrative. The order that funding agencies want these sections sequenced may also vary. For example, the purpose of the proposed research is often first presented in a major section that is variously entitled **Aims**, **Specific Aims**, **Introduction**, or **Research Objective**. Sometimes, however, a funding agency may want the narrative to open with a section that provides background information.

If the submission requirements of your funding agency do not specify the names it prefers for the major sections, you can select section names from Table 1-3B. The following list gives an overview of generic content in the narrative.

- **Topic**. The topic is the specific area, problem, or question that you intend to investigate in the proposed research. The topic is identified in the **Aims Section** and is reiterated throughout the narrative in the same key terms as initially used in the **Aims Section**.

- **Research purpose**. The research purpose is an explanation of what you intend to accomplish in your proposed research. Although funding agencies vary somewhat in the vocabulary they use to describe the research purpose, there are 3 levels of research purposes that can be associated with proposed research: (1) the long-term ***goal***, (2) the proposed ***research objective*** of the current research, and (3) the proposed scientific and/or technical ***aims***. The research purpose(s) is first identified in the **Aims Section** and is usually repeated in the **Methods Section**. Chapter 2.2.4 discusses the research purpose in detail.

- **Background**. Background information consists of your and other researchers' relevant previous research that directly relates to your proposed research. You explain this previous research in order to place your proposed research into an historical research context and to provide a backdrop against which to claim novelty and significance for your proposed research. Some funding agencies require background information to be located in one major section that is named, for example, **Background Section** or **Literature Review**. Other funding agencies may require 2 separate sections for background information: (1) a major section presenting primarily other researchers' relevant research, which is traditionally termed **Background**, and (2) a major section describing only your relevant previous research, usually called **Preliminary Studies** or **Progress Report**. Background information is also briefly included in the **Aims Section** and in a rationale subsection(s) in the **Methods Section**. Chapters 2, 3, 4, and 5 describe how to explain background information.

- **Significance**. Funding agencies expect you to explain the significance – that is, the importance – of your proposed research. Significance is explained with, and emerges from, background information. Funding agencies, such as NSF, sometimes require significance in dedicated (separate) sections or subsections, called **Broader Impacts** and **Technical Merit**. Other funding agencies, such as NIH, require that significance be explained in a separate background section, entitled **Significance**. Chapter 2.2.5 further explains significance information.

- **Novelty**. Novelty is how your particular topic of research is innovative, unique, or distinct from previous research. Novelty is explicitly identified or emerges from your review of background research. Novelty is first identified in the **Aims Section**, is explained in the **Background Section** and the **Preliminary Studies Section**, and is again mentioned in the **Methods Section**. Some funding agencies require a separate section for novelty. (See Chapter 2.3 and the relationship between analysis in scientific argumentation and novelty.)

- **Proposed work/methods**. ***How*** you intend to accomplish your research objective and aims is your methods. ***How*** includes your research design; the focus of your research, such as subjects, objects of study, or specimen; materials, equipment, and tools that you will use in executing your methods; the procedures you will perform over the funding period to achieve your research objective and aims; and analytical procedures for the data that you will collect. Your proposed work is first very briefly characterized in the **Aims Section** and is later described in the **Methods Section**. The **Methods Section** is covered in Chapters 5 and 6 of this book.

- **Investigators' qualifications**. A part of most grant proposals is a curriculum vitae, a biosketch (biographical sketch), a bioparagraph, or a résumé that identifies the key personnel, including the PI; and their education, professional experience, and publication history. A career or training grant might also have a major section of the narrative in which the PI addresses these points. Reviewers use information to assess the investigators' credibility, qualifications, and skills in order to judge whether they will successfully perform their proposed methods and achieve their proposed research objective and aims in a timely manner.

1.6 The NIH model

The organization of sections and section names selected for the generic narrative of a scientific proposal in this book are closely similar to those of the pre-January 25, 2010, NIH narrative.

NIH is the major funding agency in the United States in terms of dollars that Congress allocates for academic research and development. In fiscal year 2013, the NIH had a budget of $29.15 billion, in contrast to the amount allocated to NSF, at about $6.9 billion.[4]

The sections to the NIH narrative were changed to a certain degree for most narratives of grant proposals submitted to NIH on or after January 25, 2010. Table 1-4 gives the previous and the current overall organization of the narrative to an NIH grant

[4] http://nexus.od.nih.gov/all/2013/05/08/funding-operations-for-fy2013 (accessed November 19, 2014) and http://www.nsf.gov/about/congress/113/highlights/cu13_0409.jsp (accessed November 19, 2014). However, NIH funding is primarily for human and health services, in contrast to NSF funding, which is primarily for research in the physical sciences and engineering.

proposal. The most distinctive changes (arguably) for most grant proposals submitted to NIH on or after January 25, 2010, follow in this list:

- **Specific Aims Section**. The previous NIH **Specific Aims Section**, which was a recommended length of 1–2 pages, must now be no longer than 1 page for the majority of NIH funding mechanisms.
- **Background Section**. The pre-January 25, 2010, NIH **Background Section** is now 2 background sections, termed the **Significance Section** and the **Innovation Section**.
- **Preliminary Studies/Progress Report Section**. The previous NIH **Preliminary Studies/Progress Report Section** is now a subsection – usually the first subsection – in the **Approach Section**.
- **Research Design and Methods Section**. The previous NIH **Research Design and Methods Section** is now in the **Approach Section**.
- **Introduction to the Competitive Renewal**. The previous NIH **Introduction for Competitive Renewal** has been reduced from 3 pages to 1 page for most resubmitted NIH funding mechanisms. (See Chapter 7.2.)
- **Page length**. Most NIH narratives (in particular, the R01) have been reduced from the former 25 pages to 12 pages, plus the one-page **Specific Aims Section** and an **Introduction** for a resubmission.

The pre-January 25, 2010, NIH model captures basic content of the narrative with organizational simplicity (e.g., Table 1-4A) and allows PIs to address typical content found in narratives to scientific grant proposals (including the current NIH model's focus on significance). Perhaps due to these features, many funding agencies in the United States, such as the American Heart Association[5] (see Table 1-5C), still basically follow the pre-January 25, 2010, NIH model.

If your targeted funding agency does not specify the organization and the names of major sections to its narrative, you can choose among those in Table 1-5A–1-5D. You can also create your own unique arrangement for this high-level organization, but your end result needs to be a document that reflects the 3 constraints on the narrative discussed in Chapter 1.5.1 – constraints imposed by the genre, the funding agency, and the novelty of your own proposed research.

The generic content and organizational features of the narrative to scientific grant proposals identified in Table 1-5 are based on narratives submitted to funding agencies in the United States. These generic features may need modification before submitting the grant proposal to funding agencies outside the United States.

[5] Note, however, that in addition to the pre-January 25, 2010, NIH sections (**Specific Aims**, **Background and Significance**, **Preliminary Studies**, and **Research Design and Methods**), the American Heart Association also requires a section entitled **Ethical Aspects of the Proposed Research**. See http://my.americanheart.org/professional/Research/FundingOpportunities/SupportingInformation/Creating-the-Research-Plan-for-Strategically-Focused-Research-Networks–17-Pages_UCM_450711_Article.jsp (accessed November 28, 2014).