LSUHealthNewOrleans

Grant application writing: scientific content and persuasion

ORS Professional Development Series / CME course

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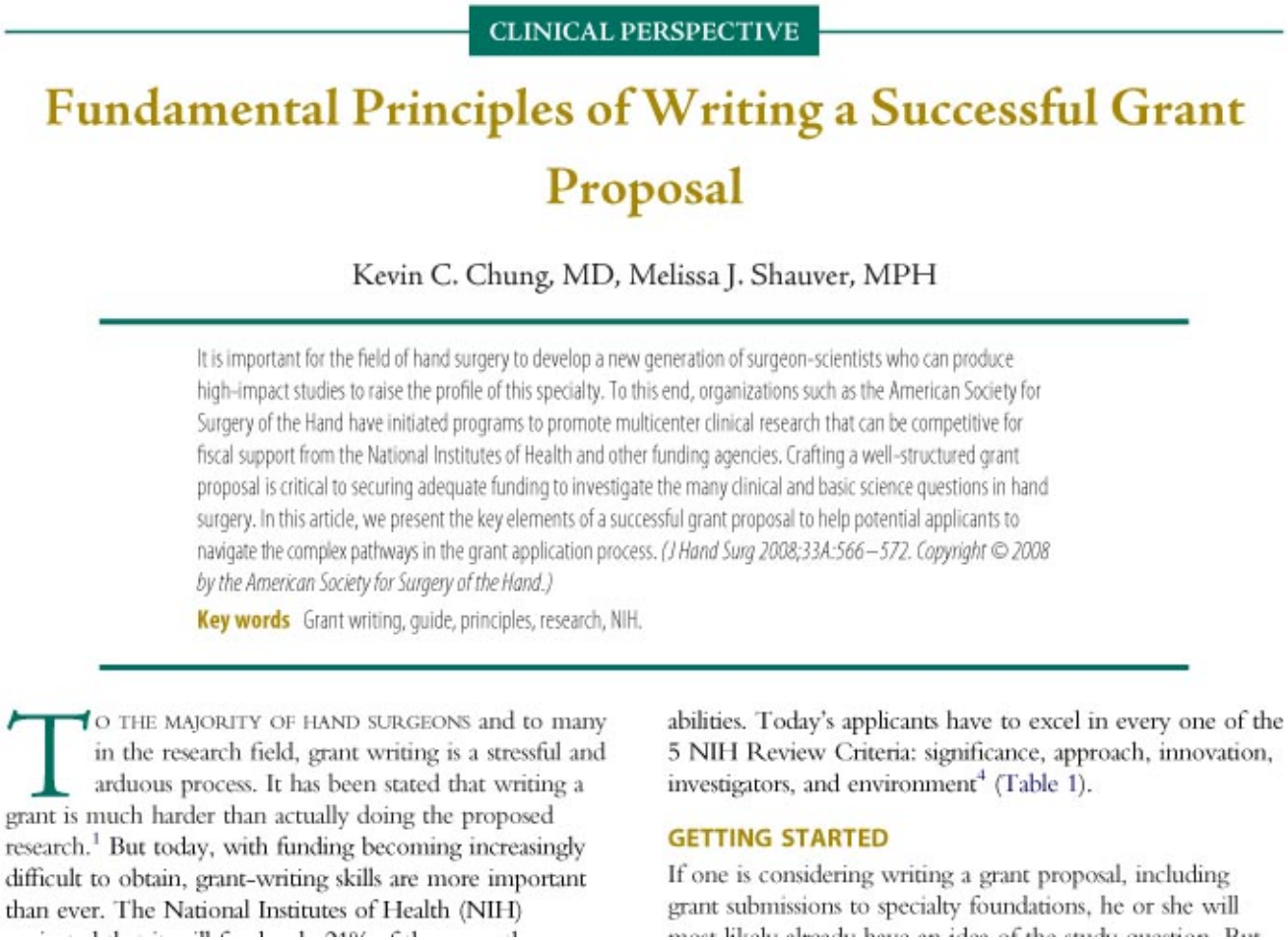
Learning objectives

- Develop a compelling grant application with an emphasis on a strong hypothesis and achievable aims
- Edit judiciously while communicating complex scientific concepts
- Respond constructively, via application resubmission, to peer review comments

Developing effective grant writing skills is essential to acquire competitive funding

There are many resources that provide grant writing advice



CLINICAL PERSPECTIVE

Fundamental Principles of Writing a Successful Grant Proposal

Kevin C. Chung, MD, Melissa J. Shauver, MPH

It is important for the field of hand surgery to develop a new generation of surgeon-scientists who can produce high-impact studies to raise the profile of this specialty. To this end, organizations such as the American Society for Surgery of the Hand have initiated programs to promote multicenter clinical research that can be competitive for fiscal support from the National Institutes of Health and other funding agencies. Crafting a well-structured grant proposal is critical to securing adequate funding to investigate the many clinical and basic science questions in hand surgery. In this article, we present the key elements of a successful grant proposal to help potential applicants to navigate the complex pathways in the grant application process. *(J Hand Surg 2008;33A:566–572. Copyright © 2008 by the American Society for Surgery of the Hand.)*

Key words Grant writing, guide, principles, research, NIH.

TO THE MAJORITY OF HAND SURGEONS and to many in the research field, grant writing is a stressful and arduous process. It has been stated that writing a grant is much harder than actually doing the proposed research.[1] But today, with funding becoming increasingly difficult to obtain, grant-writing skills are more important than ever. The National Institutes of Health (NIH)

abilities. Today's applicants have to excel in every one of the 5 NIH Review Criteria: significance, approach, innovation, investigators, and environment[4] (Table 1).

GETTING STARTED

If one is considering writing a grant proposal, including grant submissions to specialty foundations, he or she will

There are many resources that provide grant writing advice

Hematology Grants Workshop

James L.M. Ferrara and Alvin H. Schmaier

The process of writing an NIH grant application is complex and difficult. Understanding critical details of the review process is a key to success. In this article the authors analyze the NIH grant application process from the reviewer's perspective. They discuss NIH review criteria and highlight the characteristics of successful grant applications. They also suggest specific strategies to improve applications in terms of timeliness, clarity, focus, and independence and cover the key elements to revising an application that is not funded initially.

I. Writing Successful NIH Grant Applications: A Primer

*James L.M. Ferrara, MD**

Ground Rules for the Review of NIH Grant Proposals

Any writer should consider his or her audience. The audience for an NIH grant proposal is the NIH study

pertinent to his or her proposal. Furthermore, the applicant should perform a quick literature search of several SS members to discern their areas of expertise. If one or more have published in an area relevant to the proposal, it is wise to include at least a couple of their papers in the bibliography. Few things are more displeasing to a scholar than the perception that his or her important contributions to a field have been overlooked.

Once a potential SS is identified, the applicant should

There are many resources that provide grant writing advice

Article

Western Journal of Nursing Research
2014, Vol 36(1) 31–46

DOI: 10.1177/0193945913485162
wjn.sagepub.com
SAGE

Writing a Competitive Individual National Research Service Award (F31) Application

Susan M. Rawl[1]

Abstract

The National Institutes of Health (NIH) are committed to increasing the number of PhD-prepared persons to meet the demand for well-trained behavioral, biological, and biobehavioral scientists. The Ruth L. Kirschstein National Research Service Award (NRSA) individual Predoctoral Fellowship (F31) program provides financial support for full-time PhD students who

There are many resources that provide grant writing advice

Current Paediatrics (2004) 14, 501–506

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www.elsevier.com/locate/cupe

How to write a grant application

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KEYWORDS
Research funding;
Power calculations

Summary This paper outlines the basic areas of work needed to write a successful grant application, the timetable you need to work to and the issues that most often cause problems. It is vital to read the background literature thoroughly and allow

There are many resources that provide grant writing advice

Journal of Surgical Research **128,** 226–231 (2005)
doi:10.1016/j.jss.2005.06.004

An Introduction to Obtaining Extramural Funding[1]

David H. Berger, M.D.[2]

Michael E. DeBakey VA Medical Center, Houston, Texas

Submitted for publication January 10, 2005

The ability to obtain extramural funding is a critical part of developing a successful academic career. This manuscript provides an introduction to the sources of funding, the process by which a research proposal is developed, and the process by which a research proposal is reviewed and funding. Emphasis is placed on the process of grant review is performed at the National Institutes of Health.

Key Words: **grant writing; research; training grant; grant review.**

INTRODUCTION

The mechanism by which academic programs are funded is an arduous process. The key portion of this process is the writing of the research proposal or grant.

tutes of Health (NIH), the Department of Veterans Affairs (VA), the National Science Foundation (NSF), and the Department of Defense (DOD). These agencies have numerous career development grants. The national specialty societies, including the American Heart Association, American Cancer Society, and the American Diabetes Association, have young investigator programs. Many of the surgical societies, including the Association for Academic Surgery (AAS) have grant funding mechanisms for junior faculty investigators. The AAS has a resident research award, as well as the Joel J. Roslyn faculty research award. Additionally, the AAS has expanded the Fundamentals of Surgical Research Course. This course will be held just before the start of the Annual Clinical Congress of the American College of Surgeons. The funding rates for career development awards are usually higher than for other awards: up to 50% of

I was asked to provide you with a very personal perspective of how I succeeded in obtaining federal funding, despite the odds.

If I can do it, so can you.

NIH grant criteria

			K/F awards	R01
investigator	PI qualifications	Preliminary data Productivity (CV)	70%	**40%**
	Environment	Space/resources collaborators		
science	Approach	Will experiments work? And when they don't?	40%	**60%**
	Significance	Impact on field Size of field		
	Innovation	Technique/reagent Topic/perspective		

Ferrara & Schmaier. (2002) Hematology grants workshop. ASH Education Book, pp. 484-488.

Deficits identified in grant applications

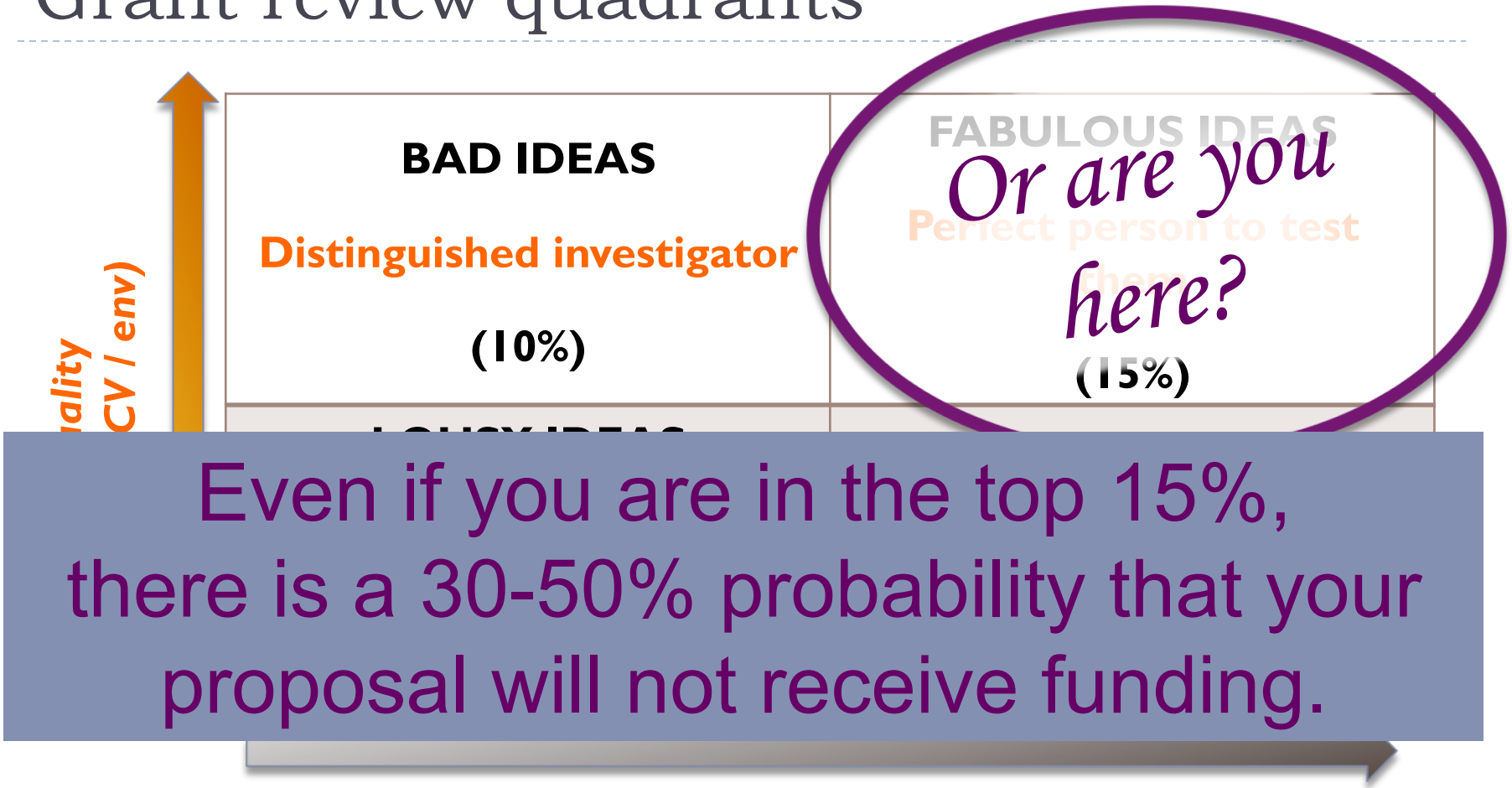
Issue	Fellowship (F- & K-awards)	Faculty (R awards)
Study design issues	71%	**90%**
Statistical issues	43%	**40%**
General issues	23%	30%
Hypothesis problems	24%	**40%**
Methods issues	33%	10%
Significance of the study	10%	**40%**

Agarwal et al. (2006) Clin J Am Soc Nephr 1, 340

Grant review quadrants

Ferrara & Schmaier. (2002) Hematology grants workshop. ASH Education Book, pp. 484-488.

Grant review quadrants



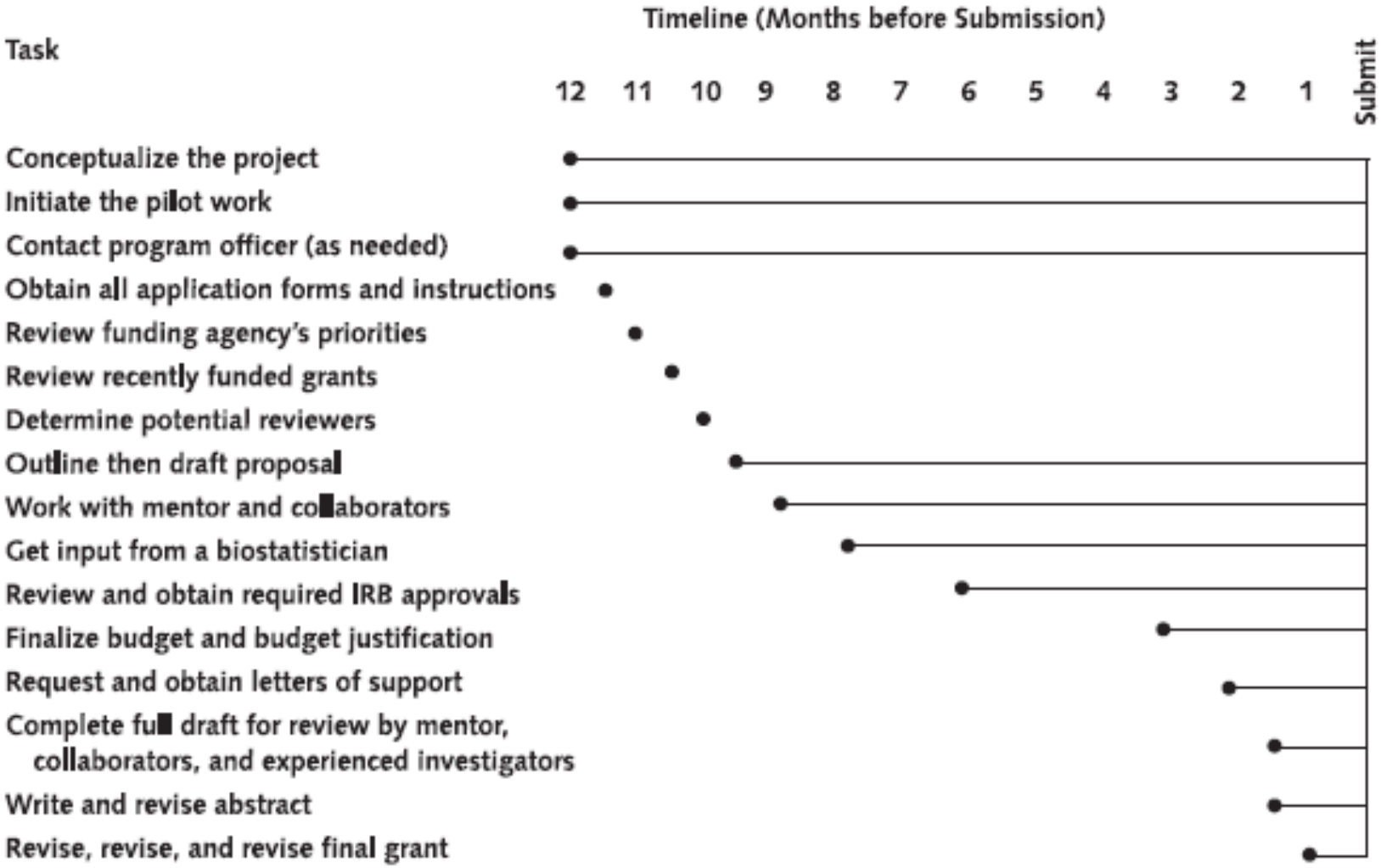
Ferrara & Schmaier. (2002) Hematology grants workshop. ASH Education Book, pp. 484-488.

This is not to depress you or to make you feel sorry for yourself

- Getting a research idea funded is time-consuming, testing, and highly competitive
- Carrying out research is costly
- Research carries potential risks
- Spending federal and foundation dollars requires careful assessment of the balance of risks and benefits
- How those risks and rewards are conveyed are key

There are three things to remember from this workshop

Grant awardees are pro-active planners, preparers & responders to criticism



Inouye et al. (2005) Ann Intern Med 142, 274

A grant application is not science;
it is the marketing of science.

J.L. Ferrara and A.H. Schmaier
University of Michigan Medical Center

Learning objectives

- Guidelines on how to craft a competitive proposal
- Guidelines for improving readability of grant application

Write to the correct audience

- The application has two audiences:
  - the majority of reviewers, who will NOT be familiar with the techniques or the field, and
  - a smaller number, who are familiar with the field
- To succeed in peer review, win over the primary reviewer, who should be familiar with the research field and who will act as an advocate in guiding the group's decisions

Write to the correct audience

- The objective is to write and organize the application so the primary reviewer can readily grasp and explain what is being proposed
- During discussion, other reviewers will ask the primary reviewer questions about the application
- Other panel members will also skim it during that time (and possibly before the meeting, as well); most likely, other reviewers will only read the abstract, significance, and specific aims.
- All reviewers are important because EACH reviewer gets one vote.

Origins of the research question

- Know the literature in an area of study (depth, not breadth)
- Be aware of new ideas and techniques – attend meetings and seminars
- Be inquisitive and learn to think like a researcher
  - Attend meetings and seminars
  - Apply critical thinking to research/clinical problems
- Present research seminars and discuss your ideas with colleagues
- Apply for seed grants (i.e., Louisiana Board of Regents)

Outline of critical grant sections

ELEMENT	PURPOSE
Specific aims	What do you want to do?
Significance and innovation	Why is it important
Approach	How is the study structured (design)? Who are the subjects and how will they be selected? What measurements will be made (variables)? How large is the study and how will it be analyzed (statistical issues)?

Reviewers use their experience to get a sense of how the application stacks up against the science in the field, using a hypothetical standard of excellence for the particular field.

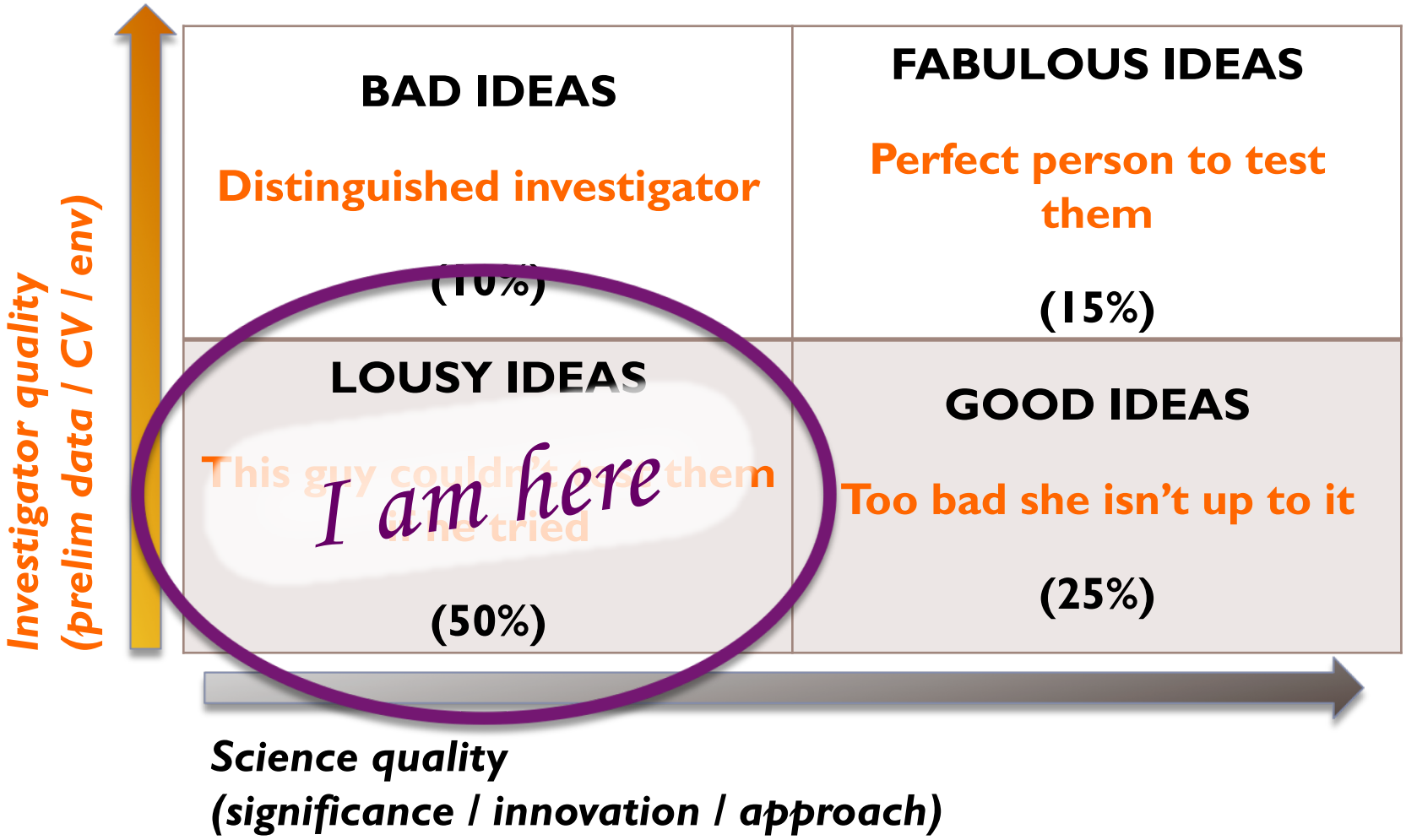
How a reviewer reads a grant

What does a researcher want to do?	Specific aims
Is it important?	Significance
What is its distinguishing characteristic from other work in the field?	Innovation
Can it be done?	Preliminary data + CV
Can she/he do it?	Preliminary data + CV
How is it going to be done?	Research methods

Overall evaluation by Reviewer 1 – 2008

- The most positive aspect of the proposal is the high significance of Eg5 – the kinesin being studied. The tremendous interest in this molecule makes the field extremely competitive and a number of high profile (and well-funded) academic labs and a number of big (as well as medium sized). Pharmaceutical companies are actively working on Eg5 and small molecules that bind to it. This is also the origin of the most worrisome aspect of the proposal; quite frankly, I cannot see that the PI can compete effectively in this field – particularly given her poor track record in terms of research achievements (publications).
- A problem that I have with many of the experiments is that they seek to investigate mechanisms, but they only include one component from a system in which the meaningful mechanisms being sought take place during the association of two components. I regard this as a fatal flaw. (It can be argued, and it is indeed true, that this approach has made big contributions to understanding how kinesins and myosins operate. I would say that with probably ~100 kinesin-nucleotide structures in the pdb, there is little to be gained from repeating the same fundamentally flawed experimental design again and again – even if a different methodology – FTIR spectroscopy - is employed.)

Lessons from 2008 NIH application



Ferrara & Schmaier. (2002) Hematology grants workshop. ASH Education Book, pp. 484-488.

Lessons from the 2008 NIH submissions

- The writing in the proposal was not clear for either the primary or secondary reviewers
- There is quite a bit of confusion amongst the motor field.
- What has structural biochemistry taught them – and how does it pertain to cell biology of motor proteins?
- I needed to publish my work, rather than include it wholesale in the preliminary data (already had two papers and wrote/published three more in 2009)
- PR problem – how do I address that Katrina impacted my productive and research flow? Isn't this a personal problem and a professional problem? Is it OK to discuss it in the proposal?

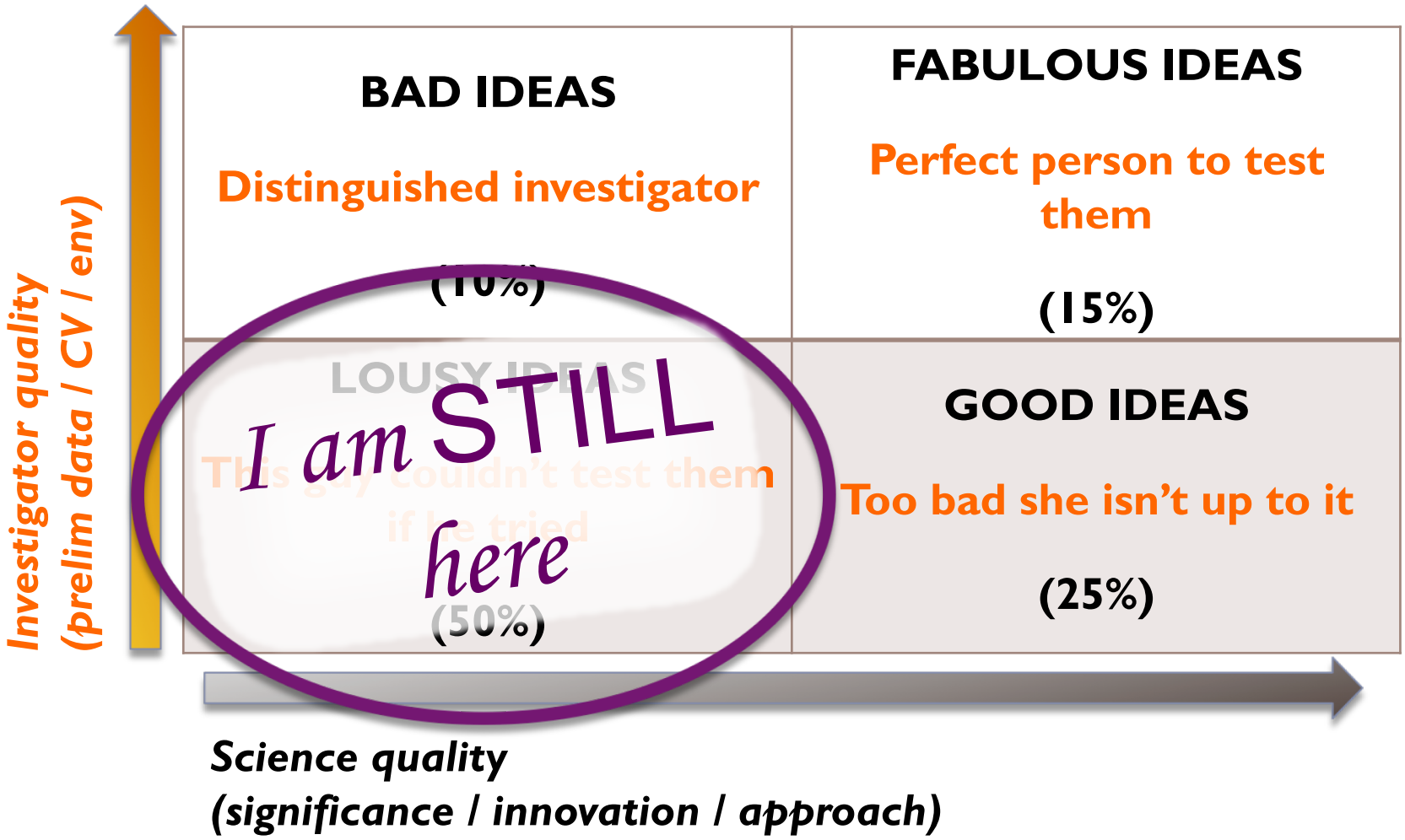
Rewrite - be persuasive

- Write the application as if you were teaching the audience about your application.
- Like a *Scientific American* article, include enough background information to enable an intelligent reader to understand your proposed work.

Rewrite proposal to state the obvious

- Obvious to you, but not reviewers (the not-so obvious)
  - Why proposed experiments are important
  - Key observations in the field that provide background necessary for interpretation of the experiments
  - Critical controls that you always do
- Do not mention what is obvious to everyone
  - Why you wrote the application (i.e., because you really need $ $$)
  - The genetic code, the period table, anything you learned in kindergarten
  - Details on how to make a stock solution of 1 M NaCl

Lessons from 2009 NIH application



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Lessons from the 2009 NIH submissions

- The writing in the proposal was improved, but still did not capture the support of the reviewers.
- There is variability in the reviews between the study sections and no continuity in the review process.
- 2008 application only received criticism for aim 1; 2009 application only received criticism for aims 2 and 3 (due to lack of expertise).
- No longer criticize productivity – now criticize experimental design to prove 'what I most want to believe' and 'overly aggressive interpretations.'
- Reviews from journals and reviews from grant panels are completely disjointed from each other.

Two radical changes were implemented

Appealed to the program officers at NIH

Decided to completely overhaul
my grant writing and scientific focus

Four components that should be meshed together for persuasive grant writing

- Magic power
- Project
- Message
- Audience

Audience

- Collection of peers for grant panel
- First line of review
- Also higher levels of audience
- Have to sell to all levels
- First is panel and second is program officer

- Panel reviewers
  - did not know me or my group,
  - did not understand the scientific techniques well enough to independently assess prior conclusions in the literature,
  - did not agree with my conclusions
- Program officer changed the panel – invited an expert in the kinesin field

Magic Power

- What you are good at
- What you like doing
- What you will be known for
- The resultant collection of excitement and ability

Project

- Solve what problem?
- My proposal was too broad – I would have a hard time convincing others that I would succeed in delineating ALL of biological ATP hydrolysis, when no one else had succeeded.

Message

- Direct marketing bit that should be in line with magic powers

Each component is connected and linked with the other in your scientific 'brand'

- Highly scored grants have four things in alignment
- Science review can change rapidly
- Have to know what is en vogue
- Have to understand likes and dislikes of reviewers
- If any are out of whack, won't get funded

Specific aims

- First when working out an outline for the specific aims, identify audience and project and make them in alignment
- Is my audience in alignment with my project? NO

So, I need to recraft
my scientific project on kinesin ATP hydrolysis
to be in alignment with the review panels' concerns & interests.

Not good scientific ideas

- Problem not important enough
- Alternative hypotheses not considered
- Issue is scientifically premature
- Lack of original or new ideas
- Project is a fishing expedition, lacking solid scientific basis
- Proposal driven by technology (a method in search of a problem)
- Experiments too dependent on success of initial proposed experiment; lack of alternative methods in case primary approach does not work

Good scientific idea

- Does it address an important problem?
- Will scientific knowledge be advanced?
- Does it build upon or expand current knowledge?
- Is it feasible to implement? To investigate?

So, for kinesin ATP hydrolysis,
there was a number of (poor) structures for the product state.

We had the first structure for the first step in ATP hydrolysis.

I would propose to study the transition state for ATP hydrolysis
– a black box, but an important one.

Rewrite again - be persuasive

- Capture the reviewers' attention by making an argument for why the proposal should be funded.
- Tell the reviewers why testing the hypothesis is worth funding, why you are the person, and how your institution can give you the support you need to get it done.

Do not propose too much

- Sharpen the focus of the application
- Novice applicants often overshoot their mark, proposing too much
- Make sure that the scale of the aims fits the request of time and resources
- Hypothesis should be provable and the aims doable with the resources you are requesting

Overall evaluation by Reviewer 1 – 2010

- This proposal uses advanced methods to investigate the detailed mechanism of ATP hydrolysis by kinesins coupled to conformational changes. This work builds on their recent demonstration of a two-water scheme based on a new x-ray crystal structure of the kinesin Eg5. It is likely to produce new and useful information about these motor proteins that play a critical role in many cellular processes.

Overall evaluation by Reviewer 2 – 2010

- A highly significant area of research, aiming to understand the link between chemical energy, conformational change and molecular motion. An effective in-house collaboration and application of diverse but appropriate techniques to tackle the problem are a plus. Solid preliminary results suggest this may bring new concepts in ATP hydrolysis mechanisms. However, the long-term goal beyond the next cycle is not discussed in detail.

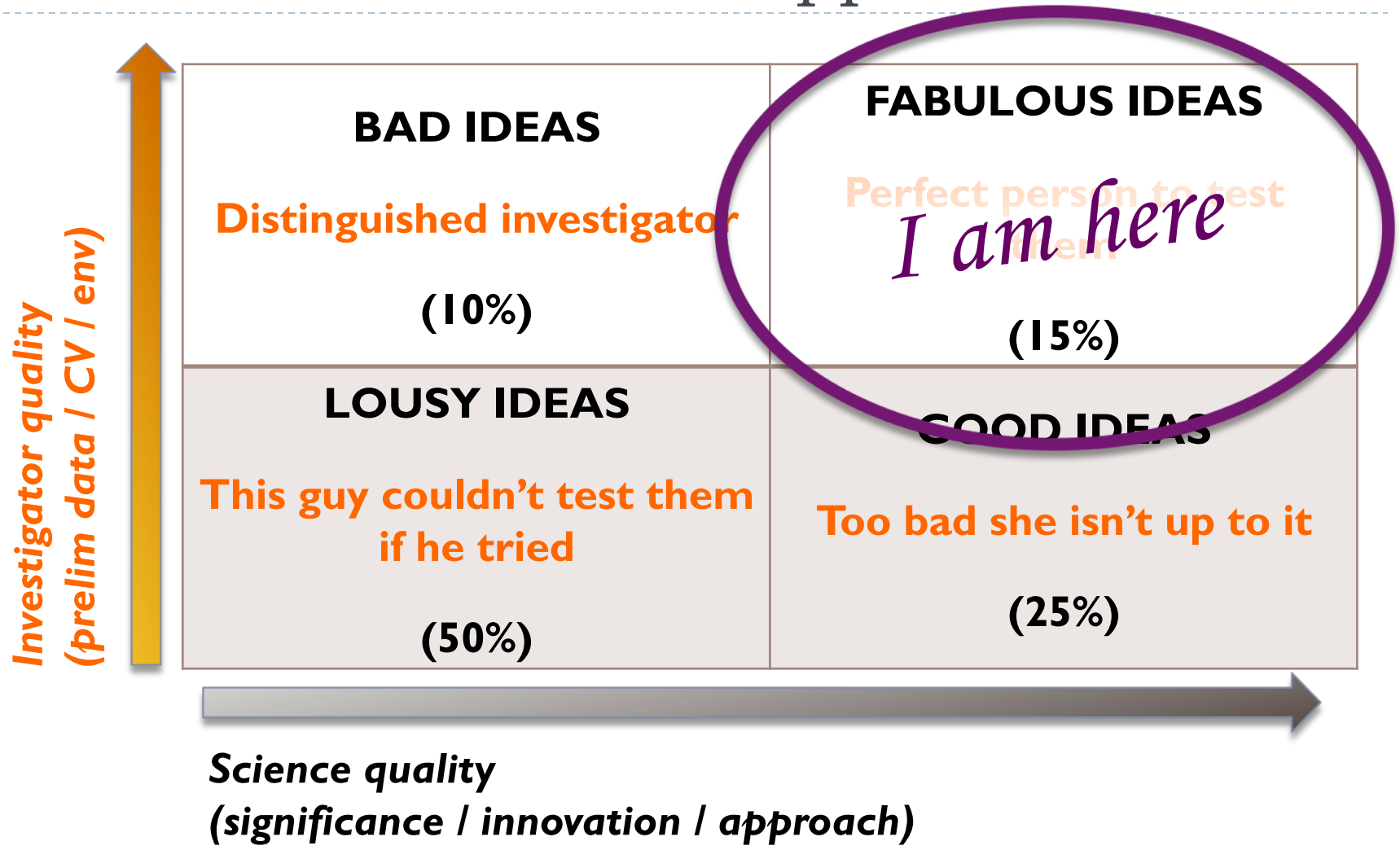
Overall evaluation by Reviewer 3 – 2010

- This proposal is aimed at discovering the underlying details of energy transfer that drive movement of molecular motors, specifically human kinesin Eg5. The proposal could have significant impact on our understanding of allosteric regulation and inhibition of molecular motors. The target, human Eg5, has potential relevance as a target for cancer treatment and inhibitors are currently being examined in early stages of clinical trials. The proposed experiments are innovative and use traditional (kinetic isotope effects) and cutting edge techniques (FTIR) to understand the determinants for hydrolysis of ATP. These techniques are necessitated by the fact that existing crystal structures do not show key determinants of allosteric regulation and catalysis due to disorder in transition state structures.

Summary of NIH panel discussion – 2010

- This new application from a new investigator proposes to apply two-dimensional time resolved infrared spectroscopy and kinetic isotope effect studies to probe the mechanism and linkage to conformational change of ATP hydrolysis in a model kinesin. During discussion, the panel concluded that these experiments would have a high impact because they will complement existing high resolution x-ray crystal structure information to reveal significant insights into the molecular mechanism of these clinically important targets, and motor proteins in general. Key strengths include a clear, hypothesis-driven approach using appropriate new techniques, solid recent productivity, and good collaborations. A weakness that was noted was the potential for kinetic isotope effect data to be difficult to interpret. While some initially questioned the significance of such atomic detail mechanistic information, a consensus was ultimately reached that the results could have a major impact on the field.

Outcome of 2010 NIH application



Ferrara & Schmaier. (2002) Hematology grants workshop. ASH Education Book, pp. 484-488.

Learning objectives

- Guidelines on how to craft a competitive proposal
- Guidelines for improving readability of grant application

Write like a pro

- **Start with an outline.** Each section should logically and smoothly flow from the previous section.
- **Write a topic sentence for each main topic.** Then write a topic sentence for each subtopic in the outline.
- **Make one point in each paragraph.** This is KEY to creating text that is easy to read. State the point in the topic sentence, usually the first sentence, and support it with additional information in the subsequent sentences. Paragraphs have two functions: they aggregate information point-by-point and they break up the page creating much-needed white space. Keep them short.
- **Divide the document into sections and subsections.**
- **Include bullets and lists.** They draw attention to key facts and create a visual break.

Write like a pro

- **Use short sentences with a basic structure: subject, verb, object.** Break up long, involved sentences and paragraphs. Keep sentence average to 20 words or less. Keep subject, verb, and object together at the beginning of the sentence.
- **Include transitions.** At the end of the paragraph or concept, make a transition to the next point. Use words such as: furthermore, additionally, in other words, in another area, in contrast, following the same path, moving to the next stage, etc.
- **Keep related ideas and information together.** Put clauses and phrases as close as possible to (right after is best), the words they modify.
- **Use strong, active verbs.** They are the workhorses of effective sentences. For example, write 'We will develop a cell line,' not 'A cell line will be developed.'
- **Use verbs instead of abstract nouns.** Turn abstract nouns ending in '-ion' and '-ment' into verbs. For example, say 'creating the assay leads to…' rather than 'the creation of the assay leads to…'

Edit and proof like a pro

- **Edit out redundant words and phrases.** Make sure that the writing is concise and informative. Get outside opinions on the writing and presentation. Sloppy work will suffer in review – reviewers feel that if the application is sloppy or disorganized, the research may be as well.
- **Cross check all data and information for consistency.** Also, after the proposal has been written, leave it for a few days, then go back and read it again. Most editors find more errors, particularly with complex data.
- **Highlight and review the conclusions.** Is there any way the supporting facts might lead the reader to different conclusions? If so, revise the work so there is no room for argument (or reconsider the conclusions).
- **Make sure to support all facts with citations.**

Make life easy for reviewers

- **Label all materials clearly.** Make it easy for reviewers to find information, i.e. 'the significance of this experiment is…'
- **Keep it short and simple.** Start with basic ideas and move progressively to more complex ones. State key points directly and write basic concepts as nontechnically as possible.
- **Guide reviewers with graphics.** A picture is worth a thousand words, probably more. Graphics can help reviewers grasp a lot of information quickly and easily, and they break up the monotony of the hundreds of pages of text each reviewer contends with.
- **Edit and proof.** The presentation can also make or break the application. Though reviewers assess science, they are also influenced by the writing and appearance of the application. If there are a significant number of typos and internal inconsistencies in the document, the score can suffer.

Principles for successful grant writing

- Know your reviewers
- Make your grant easy to read
- Pay attention to details
- State important points multiple times
- First impressions are very important
- Do not give up; few grants are awarded at first submission
- Learn from your failures