

How to Write a Proposal

Scientific research is very expensive, as I have mentioned elsewhere, and funds are limited. Projections for the next few years indicate that in constant dollars the public money available for research will decline; this projection is more serious than it would first seem because the rate of inflation for research is higher than the general rate of inflation (in part, because the methods become more sophisticated). Not all good research or not even all very good research can be funded. Funding is a major problem in biology in general, but especially in certain fields. In order for your research to be funded, it must be justified. There are many critical needs for public (and private) funds (e.g., juvenile-crime intervention, education) and you have no *a priori* "right" to any of this money simply because you are a scientist and you wish to do research. For a commentary that discusses effective strategies for use of limited funds for plant-biological research, see the Plant Cell 8: 346-347.

All research proposals have certain elements that permit peer and general evaluation. Overall, you must convince your audience that the outcome of your research will be more valuable than the outcome of competing proposals. This competition is exceedingly fierce. (As few as 3% of new principal-investigator proposals are successful in some agencies.) You want your proposal to stand out as the best, but it is self-defeating to attempt to reach this goal by faulting the work or proposals of others. Of course, for our purposes, the proposal will be abbreviated, but in keeping with the spirit of proposal preparation, you are expected to put the same effort into the proposal that you will put into your scientific report. To avoid redundancy, general aspects will not be repeated here; see "How to write a scientific report."

Abstract

Particular care must be taken in the preparation of an abstract. It is generally the first (and maybe only) element of the proposal that an evaluator will read. Consider how it will be used. First, a program manager will read it. On this basis, he or she will select *ad hoc* reviewers who can provide expert opinions of its scientific merit. Second, the program manager will assign it to selected members of a convened panel, which is drawn from the scientific community. Thus, the primary and secondary reviewers will form their first impression of the proposal on the basis of the abstract. Make that a good impression. All members of the convened panel will be provided with a copy of the abstract. The abstract is the only direct input that you have for all members who will take part in the panel discussion. Bear in mind that many members of the panel have only limited expertise in the subject area of your work. Finally, if your proposal is funded, your abstract will appear in several public places, so it must be intelligible to an educated

nonprofessional. The abstract should contain all the elements of the body of the proposal, as indicated below. It should not exceed about 200 words.

Literature Review

The purpose of the Literature Review is to put your proposed work in the context of the literature. An effective way to begin is with a level that any reviewer will be comfortable: "Most energy flow on earth begins with radiation from the sun. Organisms have evolved mechanisms to trap part of this energy. Thus, photosynthesis comprises two parts: (a) light harvest, and (b) synthesis of stable compounds. A key enzyme in" Obviously, the preceding was abbreviated, but it made several points: (a) write from the global to the specific, and (b) avoid clutter (note that "**Most** energy flow" relieves you of the obligation of detailing the non-relevant (e.g., decay of radioactive isotopes) as does "**Part** of this energy" (e.g., absorption of heat).

Subtly convince the reader that you are an expert. Importantly, bear in mind that it is not the research alone that is being evaluated. The total package is being evaluated—the research and the researcher's ability to conduct it successfully.

Near the end of the Literature Review, convince the reader that there is a problem! To move forward in our thinking, do we *really* need the information that you will propose to obtain? Remember that there are all kinds of information that we do not have and that we do not need.

As a broad generality, the Literature Review and the following section, the Proposed Research, should take about equal space. These two sections are the "meat" of the proposal.

Proposed Research.

The proposed research should have focus. You cannot solve all the problems. Somewhat arbitrarily, I would suggest not more than three major ideas (or even just one). These are the ideas that you should have delineated in the abstract and to which your Literature Review should lead.

During a comprehensive proposal evaluation, this element will receive the most attention. Blend the goal of the research with the methods that you will use to accomplish the goals. Although you may not wish to use the word, formulate a hypothesis to test. This hypothesis may be an observational phenomenon ("sun light is brightest at noon") but generally the proposal is immeasurably strengthened by inclusion of a proposed mechanism (" . . . because the distance from earth to sun is shortest at noon"). Be candid about weaknesses ("variation of solar output?") and describe how you will discount competing hypotheses ("sun light is brightest at noon because it travels a shorter distance through the atmosphere"). Do you have necessary controls? Will the experiment be replicated? . . . exactly? Will a second approach be used to corroborate findings? Have

you considered several ways to test your hypothesis? What happens when you have spent \$200 000 and your answer is "maybe." Ideally, your research should yield a black-and-answer, but be prepared for a disappointment. What are your backup options?

The extent to which you blend in methods depends somewhat on the methods used. Often, one may say "by spectrophotometry (Jones et al., 1946)." (Please do not say "by the methods of Jones et al. (1918)" unless you are absolutely sure that everyone knows what Jones and company did.) If the methods are somewhat unusual, you may wish to describe them (there is no guarantee that either the primary or the secondary reviewers will be an expert in the methods that you will use). If the methods are truly novel or untested, you might need to spend more space, or even an appendix (if permitted), on them. Be sure that you have chosen just the right methods—do not go elephant hunting with a sling shot or ant hunting with a cannon. (This example presumes that you have justified hunting in the first place!) Your methods should be the least expensive way (time and money) to provide a credible answer to the question(s) that you posed.

Significance of the Research

Throughout the proposal, you should have followed the central thread that this research is important. Nevertheless, it is common and good practice to include a short separate section on significance. This is an opportunity to exercise your best judgment. Be plain and simple. Do not patronize; do not exaggerate but express enthusiasm. Consider your reader your equal, and remember that he or she may work in another research area that also is "crucial to the survival of humankind."

Schedule

As a separate section, indicate the progress that you expect to make. This section can be brief, but it should convince the reader that you have thought through the time aspects of the work. A table is a good format in which to prepare this section. Remember that you will be expected to reach the milestones that you have indicated.

Because your work must be coordinated with the TA so that all class members will have sufficient access to equipment, we require a strict hour-by-hour schedule. **CONSIDER THIS SCHEDULE TO BE AN APPOINTMENT.** Once set, minimize changes as there is a domino effect. Be sure to let the TA know if you become unavailable to work at one of your scheduled times as he may be sitting and waiting on you and only you!

Literature

Follow the guidelines given under "How to write a scientific report."

Credit

The report cannot be used to satisfy the Gordon Rule.