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1. INTRODUCTION

"Grantsmanship is the art of acquiring peer-reviewed research funding"

The objective of these guidelines is to assist both new and veteran investigators to optimize their chances of successfully competing in a peer-reviewed grant application competition. It is a competition. With success rates falling to 50% or below, the difference between success and failure often results, not just from the quality of the science, but from the quality of the grant application. In all probability, the quality of science of the applications in the 10% below the cut-off for funding by an agency is not significantly different from that in the 10% just above the cut-off. "Grantsmanship" can make the difference.

The art of "grantsmanship" will not turn mediocre science into a fundable grant proposal. But poor "grantsmanship" will, and often does, turn very good science into an unfundable grant proposal. Good writing will not save bad ideas, but bad writing can kill good ones.

Why am I qualified to give advice ? First, I was successful in obtaining peer-reviewed funding and I served on a number of national and international reviewing bodies for some 30 years. But perhaps more relevant is the fact that I was responsible for the administration of a peer-reviewed research grants program for four years. During this time some 1600 research grant applications were processed.

My comments, suggestions, and recommendations are based on this experience, plus documents and discussions listed in the acknowledgements. They are relevant to most peer-reviewed research grant applications to most granting agencies. The information required, formats, and review processes are generally similar.

2. BEFORE YOU START TO WRITE

Read the Guidebooks, Guidelines, and Application Forms carefully and follow them exactly. Make sure that you have the latest versions.

- Make sure that your proposal "fits" with the mission of the agency and that your objectives match with those of the agency. Make this "match" explicit in your written application.
- If you have any doubts or questions, contact the relevant granting agency person, who will welcome your questions and answer them. They really do want to help.
- Find out the median funding level for the agency. This will allow you to formulate a reasonable budget.
- Find colleagues who have served on, or have received grants from, the agency. They can give you "insider" information on how the agency works, and what "sells".

Begin to formulate / clarify your ideas.

- Do you have a clear, concise and testable hypothesis ?
- Are your objectives and aims coming into focus ?
- What questions are to be addressed ?

- Can you define and design specific experiments that will test directly your hypothesis?

Start the process early (see timetable suggested by Tutis Vilis (section 3.2), which I have modified slightly).

Put together and write up your recent work and submit it to appropriate peer-reviewed journal(s). Do this well in advance so that the work can appear in your application as "published", "in press" or "a submitted manuscript". Most granting agencies will not accept a manuscript "in preparation". Your track record, as judged by publications, is an important criterion in the assessment.

Carry out appropriate preliminary (pilot) studies, so that their results can be included in the application. This is especially important for new applications. It will also establish for you, and for the reviewers, whether the experimental approaches are feasible and where the pitfalls may be.

Find and study previous grant proposals of colleagues that have been successful. Consider these as models.

Find out, if you can, who are the members of the review committee and focus accordingly.

Identify essential and appropriate investigators who wish to collaborate with you.

Discuss ideas with colleagues in the same and relevant fields. Just going through the process of explanation and discussion will help to clarify and focus your ideas, and to identify possible gaps in logic.

3. THE APPLICATION

3.1 General

- Read the general instructions CAREFULLY and follow them EXACTLY.
- Successful applications must be "a joy to read" and must stand out from the ever-increasing competition.
- Make the display pleasant and attractive.
- Use appropriate type size, font, spacing and margination.
- Do not go over the maximum number of pages allowed (many agencies will not accept applications that have one page too many).
- Send the instructed number of copies.
- If attachments and/or appendices are not allowed, do not submit them. They will not be distributed to reviewers. Similarly, if reprints are not required, do not send them (they will be discarded).
- Do not submit additional information after the deadline (unless explicitly allowed).
- I was astonished to find that in one agency, about 25% of research grant applications were incomplete and required that the applicant submit additional information urgently. This does not make for a good beginning. "A sloppy application = a sloppy scientist"
- Polish your application extensively. Make the application well-focused, clear, well organized and accurate.
 - You want the reviewers to be your enthusiastic champions and advocates. A luke-warm review is fatal.
 - Remember that the reviewers are doing the reviews as a task over and above their daily mandated activities, and are often unpaid. They may be overwhelmed with applications and manuscripts requiring reviews. They often carry out the reviews under less-than-ideal conditions (evenings, weekends, holidays, at meetings, or even on the way to review committee meetings). They may wait until the last minute to begin their review.

- Reviewers often do their reading in bits-and-pieces. Have your application so organized so that it can be read in this way. You do not want them to have to go back to the beginning after each break.
- Pay attention to the agency's objectives and criteria. It is a waste of time to apply to the "wrong" agency.
- Do not rely on your computer's spell checker. Use a dictionary. "If you can't get the spelling right, how are you expected to get the research right?"
- Avoid abbreviations, acronyms and jargon (that the non-expert may not understand). If you use abbreviations, then define them when used for the first time.
- Assume that you are writing for a reviewer in a somewhat related field, rather than for an expert directly in your area.
- Remember that many agencies, even national ones, send applications for review abroad. Use language that will be easily understood by those for whom the language is foreign.
- Aim the application at both the expert in the field and at the generalist (see subsequent sections).
- Extensive and intensive internal peer-review is essential.
- Ensure that a late draft (not an early one) is examined by at least two colleagues who have experience with, and are successful in, the peer review process : a) in your direct scientific area to check relevance, accuracy, ambiguities and quality of science, b) a "generalist" to check for clarity, and c) someone who is a good editor.
- Make sure that the (late) version they receive is free of mechanical errors (spelling, typos, grammar, etc.) ; it is not their task to make these kinds of corrections. If they are distracted by mechanical errors, they may fail to identify fundamental problems.
- Give the internal reviewers enough time to do a thorough job.

3.2. Timetable (from Tutis Vilis at Survival Skills with slight modifications)

1 year before the deadline:

Start thinking of interesting projects. Try to find a balance between something "sure" and something truly innovative and even risky.

- *These might be side issues of what you are currently working on.*
- *Imagine what the possible outcomes might be.*
- *Start reviewing the literature.*
- *Discuss your ideas with others. Just going through the process of trying to explain things to others is a great way to clarify things for yourself. Don't be disappointed if they do not share your enthusiasm. But listen to their criticisms.*

Complete as many of your current experiments as possible ; write up the papers and submit them for publication.

- *It can easily take 6 months to have a submitted paper accepted, longer if there are several revisions.*
- *A most important element of your application is your track record.*
- *What counts most in your track record is published papers in peer-reviewed journals.*

9 months before the deadline:

Obtain preliminary data.

- *These will greatly strengthen your proposal.*
- *A reviewer can think of a hundred reasons why something that you propose will not work. These objections vanish if you can show that you have done it.*

You may need to submit a small application to your local institution to obtain funds to do the preliminary experiments.

- Getting this support will enhance your application.

6 months before the deadline:

Write an initial draft of the main proposal section.

- This can take a month of very intensive work.
- This section may best be done in one continuous block of time; 3 to 6 hours per day each day of the week.
- Block this time off in advance.
- You will get nowhere, working a few hours a week.

5 months before the deadline:

Obtain comments from your colleagues.

- These are people who are willing to spend hours reading and rereading your grant, not someone who returns it with the word "fantastic" on the front cover.
- Sit down and talk to them about their comments.
- Pay attention to what they failed to understand. Revise.
- Get more comments. Revise, etc.

4 months before the deadline (even earlier for some institutions):

Submit your proposed experiments for approval to local committees where appropriate: animal care, human ethics, safety, etc.

2 months before the deadline:

Reread the guidelines and your application.

Take the instructions seriously. Do what they ask.

Work on the other parts.

- Get quotations for equipment.
- Get letters of confirmation from collaborators.
- Work out the budget.

1 month before the deadline:

Put together what looks like the final version: on the official forms, with figures and references.

- Give this to your colleagues for additional review.
- There is nothing like seeing the whole package. Obvious flaws suddenly become apparent at this stage.

2 weeks before the deadline:

Type the final version.

- Proof read it.
- Have it proof read by someone who has not seen it before.
- Do not trust the spell checker.

Get all the necessary signatures.

1 week before the deadline:

Get the necessary copies made.

- The copy machine will probably be occupied by others with the same deadline or it will have broken down.

2 days before the deadline:

Send it out by express mail / courier.

- Get some sleep.

3.3 First / Title Page

Fill it in completely and accurately and ensure that all signatures are obtained (in my experience, up to 10% of applications have something missing from this page).

The TITLE of your project is important.

- It sets the first impression.
- It is often used, with the Abstract, to route the application to the appropriate review committee(s) and reviewers.
- It should be descriptive, specific and appropriate, and should reflect the importance of the proposal(s). But it should not be so specific as to require changes with each renewal (it helps to maintain the same title for renewals). One way to achieve this is to have a two part title ; the first general and the second more specific (eg "The control of secretion of growth hormone : mechanism of action of somatostatin"). The phrase after the colon may then change in subsequent renewals, while the part before the colon will remain unchanged.

3.4 Abstract / Summary of Proposal

THE ABSTRACT SHOULD SERVE AS A SUCCINCT AND ACCURATE DESCRIPTION OF THE PROPOSAL EVEN WHEN IT IS SEPARATED FROM THE APPLICATION. IT MUST STAND ON ITS OWN.

- This is probably the most important section in your application. Take it seriously . Write it last. Work on it extensively after the bulk of the proposal has been fine-tuned. It is the first part that is read, and this sets the first impression.
- It is often used to route the application to the appropriate external reviewers, grants committee, and to the primary reviewer(s) in the grants committee.
- It must be understood by both experts in your field and by "generalists".

- The primary reviewer(s) read the entire application for which they are responsible, but others on the review committee **may only read the abstract**. (see also Appendix - the process in the review committee). The abstract may be the only part of the application that is read by all the members of the grants committee who are not primary reviewers, even though ALL members may have to give their independent scores (given equal weight to the scores of the primary reviewer(s)).
- Review committee members often study the application (and prepare written reports, if required) weeks or months before the meetings. They then quickly review all the abstracts just before the meetings in order to recall the essentials.
- The contents: to include hypotheses, objectives, approaches, research plan, and significance.
 - State the hypotheses to be tested. Give the long-term objectives.
 - State the specific aims.
 - Make reference to how the proposal is directly related to the mission and objectives of the agency to which application is being made.
 - Describe concisely the research design and methods.
 - Tell why the proposal is unique, important, significant, and worth supporting.
- Stay within the allotted space. But it is not necessary to fill this space. When you have nothing more to say, then stop.

3.5 Recommended External Reviewers (if requested)

- Give this some thought. They are often used.
- They need not be of Nobel Award stature, but they should be recognized experts in the field. Also, they should be tolerant of, and sympathetic to, your hypothesis.
- If the application requests their "fields of expertise", be specific (eg "ion channel/patch clamp/receptor-ligand interactions" and not "cell physiology").
- They must, of course, have an "arms-length" relation with the applicant (as usually defined by the guidelines of the agency).
- Most agencies will also honour a request by the applicant that certain named reviewers NOT be used. They will usually do this without requiring specific reasons (check with the agency).

3.6 Proposed Research

3.6.1 General

- Keep the proposal confined to the space allotted.
- The proposals must be focused, original, novel, innovative, and of course feasible.
- Try to find a balance, in the proposal, between something "sure" and something new, innovative and/or risky.
- Set out alternative strategies in case the original ideas fail.
- Write and rewrite : work and rework the application.
- Use of diagrams, cartoons and figures is often helpful (a picture is worth a thousand words). But note that copies will not appear in colour.
- Again, make it a joy to read. You want the reviewers to become your advocates and not your adversaries.
- Never state or imply that a study will be carried out "because it has never been done" or "there are no data on ...". This may be so because it is trivial.
- State clearly what is novel, and what is merely confirmatory.
- State explicitly how the proposal relates to the mission, objectives and priorities of the agency.
- It is useful to organize the presentation with appropriate headings and sub-headings, using a simple and obvious numerical classification.
- Don't forget to cite potential external reviewers and committee reviewers where appropriate. But don't be excessively flattering.

3.6.2 Specific

- A useful plan is to break the proposal into the following headings, which I will expand, in sequence.
 - Hypothesis and Long-Term Objectives
 - Specific Aims
 - Background and Significance : Current State of Knowledge
 - Progress / Preliminary Studies
 - Research Design and Methods
 - Timetable
 - Strengths and Weaknesses

3.6.2.1 Hypothesis and Long-Term Objectives

- A testable hypothesis-driven proposal is best ; a proposal that is primarily descriptive is less favourably received.
- Begin with the stated hypothesis, and tie this in with the long-term objectives. What is the proposed specific research intended to accomplish ? What is the significance and relevance of the research?

3.6.2.2 Specific Aims

- Distinguish these from 3.6.2.1. The Specific Aims are the specific projects, studies and items that will be undertaken in order to fulfill the long-term objectives.
- Put them in a logical and sequential order. Indicate priorities.

3.6.2.3 Background and Significance : Current State of Knowledge

- This should answer 3 questions ; what is known, what is not known, and why is it essential to find out.
- Begin with a brief outline of the highlights in the background review. State where your own previous contributions (if any) fit in.
- Then critically evaluate the relevant literature: not just an uncritical compendium or list.
- Discuss fairly all sides of a controversy, disagreement, and/or discrepancy in published results. But be careful since a participant in a controversy may be your reviewer.
- Identify specifically the gaps and contradictions that you will clarify. Carry this into the rationale for your proposal.
- Emphasize the importance and relevance of your proposal in bridging your hypotheses and long-term objectives to the background review.
- Integrate your previous findings within the background to give the reviewers a sense of your relevant contributions.

3.6.2.4 Progress (as related to Background and Significance)

- This will differ if this is a renewal or a new application.
- If a renewal:
 - Remind the reviewers of the start and end dates of the previous award. You must establish your credibility of excellence in research, and that the proposal will continue the high quality of your research.
 - Summarize your previous hypotheses, long-term objectives and specific aims, and give a succinct description of progress. Emphasize especially the most important and relevant findings.
 - It is appropriate to describe how your specific aims may have changed as the work progressed.
 - Incorporate all publications, manuscripts submitted or accepted, and abstracts (if permitted), of work carried out during the term of the grant.

- In as subtle a way as possible try to convince the reviewers that your recent contributions were outstanding and of great importance. How has your work significantly advanced knowledge in the field? And how will the proposal continue this record of achievement and excellence ?
- Don't complain about previously low or inadequate funding. This is self-defeating.
- If a new application:
 - You need to convince the reviewers of your excellent and relevant training, and that you already have substantive preliminary data and/or pilot studies.
 - Summarize your relevant previous work, highlighting your unique qualifications and skills. Tell how these will assist you in the successful carrying out the proposed studies.
 - Review your preliminary studies and results. Present the actual data. This will help establish your experience, competence and credibility.
 - List your publications and manuscripts submitted or accepted (if this is permitted).
- For both:
 - If allowed, list all of your publications, abstracts and other retrievable material related to your proposal. Do not submit these if not asked for.

3.6.2.5 Preliminary Data / Studies

- These should be included either in the Background, in Progress, or as a separate section and is of great importance. Tie it directly to your hypotheses and long-term objectives.
- Describe preliminary data that are relevant and pertinent. Show the actual data.
- This is especially important in a new application in order to document the credibility, experience and competence of both the proposal and the proposer.

3.6.2.6 Research Design and Methods

- The Specific Aims have stated what you propose. Now you must describe how you propose to fulfil the Aims.
- Be focused and clear. Put the Aims in a logical and sequential order. Also consider a brief opening paragraph describing the relationship of each Specific Aim to each other and to the overall Objectives. It is useful to break this section down, beginning with each stated Specific Aim (plus a one-sentence rationale for each aim?). Then outline the design and methods to accomplish each Specific Aim, and explain why the proposed approach was chosen.
- Then consider a plan something like this:
 - Number the research designs and methods to correspond to the numbers of the Specific Aims.
 - Use sub-numbering within each part when describing several methods applicable to the same Specific Aim.
 - Distinguish clearly between overall research design and specific methods.
 - Do not repeat identical procedures that apply to more than one Specific Aim.
 - Reference, but do not describe well-known or standard procedures. But do describe procedures that are new or unlikely to be known to reviewers.
 - For new methods, explain why they are better than existing methods.
 - Discuss relevant control experiments (This is often lacking).
 - Explain the processes for data collection, analysis and interpretation.
 - Discuss potential difficulties and limitations of the proposed procedures and give alternative procedures to achieve the aims. This will prevent potential criticisms by reviewers and may, in fact, "save" your application. State clearly possible weaknesses and/or ambiguities and respond (i.e. preempt the criticisms).
 - Provide a brief tentative sequence and timetable for the project. List them in order. Be realistic. Consider doing this using a diagram or table. Clearly define priorities.
 - Document all proposed collaborative arrangements, including letters from collaborators confirming the specifics of the arrangement. The role of collaborator(s) should be clearly defined.

Biographic sketches (if allowed) are useful. Otherwise relevant experience and expertise should be included in the collaborator's letter.

3.7 Budget

- In most agencies, the members of the review committee are required to recommend an appropriate budget, independent of the scientific merit of the proposal.
- The budget generally stands alone, separate from the rest of the application. Unlike the research proposal, everyone on the review committee is now an "expert", and all participate actively.
- The budget is usually considered last, after the merits of the proposal have been decided, and a score has been given.
- Often, review committee members are under an obligation to reduce the budget. Therefore, make sure the budget is well documented, realistic, appropriate and justified. Do not inflate, overbudget, or underbudget.
- Check carefully whether the agency supports certain items (eg secretariat assistance, travel, purchase of books, etc.). Do not request items that are not allowed.
- Give sufficient details for each item to make it difficult and unreasonable for the reviewers to arbitrarily suggest major cuts.
- For equipment, document convincingly why the piece is essential (not just "nice to have" or "faster and better"), and why the specified model is required.
- For personnel:
 - Make sure they are allowed.
 - Specify the unique and essential role that each will play, and state how their qualifications are matched with the role.
 - Avoid "to be named" if possible.
- For travel, specify who will travel and whether they will be presenting a paper. Also justify a request for more than one meeting per year for any one person.

3.8 Other Grants Received and/or Pending

- Be honest and complete. The agency can verify this information from independent sources.
- Be careful if stating "no overlap". It may be more accurate to state "There are certain similarities in the systems and/or methods but there is no overlap in specific aims or objectives".

3.9 Appended Documents

- Make sure that all that are required are included. If allowed, include material that is supportive but not integral to the contents of the application. But the application, without appendices, must stand on its own.
- Do not include documents if they are not required:
 - They will not be distributed to the reviewers.
 - A common ploy is to attempt to extend beyond the page limit for the "Proposal" or the "Summary of Progress" by including an Appendix. This Appendix, unless specifically allowed, will not be distributed to the reviewers. This may leave a "gap" or "hole" in your application if you refer to the Appendix in your text.

3.10 Publications

- Unfortunately many reviewers tend to "weigh" or "count" publications, rather than assess the quality, significance and contribution of the applicant.
- Aim for a good number of first authored publications in first-order peer-reviewed journals.
- A high ratio of abstracts / full-length papers is not well received
- Other kinds of publications (books, chapters, reviews, non-peer reviewed articles) may not impress the reviewers.

4.COMMON ERRORS MADE

4.1 By New Applicants

- The proposal includes a lifetime's work and is unrealistically ambitious. There are no clearly defined priorities and the timetable (if present) is unrealistic, with no sense of what can realistically be accomplished during the term of the grant.
- The literature and background reviews are uncritical. They read like an undergraduate review.
- There are no results of pilot studies or other preliminary data.
- The time listed to be spent on research should be at least 50%, and preferably over 75%. Anything less than 50% may be unacceptable (a smaller percent effort is usually acceptable for established investigators).
- The budget is unrealistic.

4.2 By Established Investigators

- The application is fragmented and disjointed. Different parts were obviously written by different junior colleagues and then hastily assembled by the applicant.
- "I don't have to go into detail. Trust me and examine my track record. Rely on my reputation". This no longer works.
- The proposals tend to be too cautious and do not venture into new and unexplored areas. They tend to be "more of the same".

5. APPENDIX

Outline of the Review Process

Granting agencies differ in the processing of applications. The following general scheme applies to most.

The cycle begins with the deadline for receipt of applications. Most agencies will reject applications that arrive after the deadline.

The secretariat then examines each application, looking for obvious irregularities including:

- Missing critical information or signatures
- Inappropriate format (type size, spacing, margins, etc..)
- Number of pages exceeding that allowed
- Application does not "fit" with the mission / objectives of the agency
- Missing sections
- Applicant does not qualify
- Extra (not required) information is included.

Depending on the seriousness of the irregularity, the application may be rejected, or further information will be solicited.

The applications are then assigned to external reviewers. These are chosen from names recommended a) by the applicants, b) by members of the review committees and c) from the database in the agency. The external reviewers are asked to submit extensive written reviews, which are made available to the members of the appropriate review committee. Both the external reviewers and review committee members (see below) are asked to follow a format such as this in their reports:

- A concise summary of the proposal (no more than a single paragraph) emphasizing the significance of the proposed research.
- An evaluation of the work done previously as presented in a progress report (if applicable).
- An assessment of the strengths and weaknesses of the proposal, including your opinion regarding:
 - originality of the hypotheses presented and the significance of the questions asked
 - feasibility
 - relationship to the previous work done by the applicants
 - appropriateness of the critical review of the literature
 - scientific and intellectual environment
 - applicant's knowledge of the field as reflected in the literature reviewed
 - appropriateness of the research plan and methodology
 - significance of the work conducted previously and the potential of the proposed work to elucidate new and important knowledge
 - appropriateness of the budget
- Most agencies aim for at least two external reviews for each application.
- Each application is usually assigned to two members of the review committee for detailed analysis (the primary reviewers). They may or may not be experts in your field. They may not be required to submit written reports. Only the two primary reviewers may be required to study the entire application. The other members of the review committee may not receive the entire application. They may only receive the abstract/summary pages.
- At the meeting of the review committee:
 - Each application may receive no more than 15 minutes of discussion.
 - The two primary reviewers introduce each application and give their evaluations. The external reviews are analyzed and comments made. The others on the committee then participate in discussion. A Final Score and/or Rating is made, and a rank order decided on the basis of scientific excellence.
 - All then participate in the discussion of budget and a final recommendation is made.
 - The members may know the global budget available to their committee. Demands for funding often far outweigh the funds available. Thus many very good proposals will fall below the cut-off. There will be painful discussion concerning the "trade off" of size of budget per application vs. number of applications funded.
- The recommendations of the review committee are then reported to the "higher body" which usually accepts the rank order decided by the review committee but argues further about budget. This becomes most difficult when it is seen that the cut-off is too high, with many very good applications being rejected.

6. ACKNOWLEDGEMENTS

"Stealing from one source is plagiarism, while stealing from many is research"

I incorporated ideas freely from a number of sources:

1. Reif-Lehrer, Liane: Grant Application Writer's Handbook, Jones and Bartlett Publishers, Boston MA, USA, 1995. This book contains excellent advice for both new and seasoned grant application writers, some of which has been incorporated herein. Although aimed primarily with the National Institute of Health and the National Science Foundation in mind, much of the advice can be applied universally.
2. Profs. Tutis Vilis and Jane Rylett in the Department of Physiology at the University of Western Ontario have prepared guidelines for applicants based on their extensive experience. Many of their suggestions are incorporated.
3. Colleagues both in Europe and North America have examined this document and have provided useful criticisms.
4. A number of applicants, external reviewers and members of review committees have provided (inadvertent ?) fodder.
5. But I take full responsibility for all errors, omissions, opinions, and recommendations.

A FINAL REQUEST

This is a work in progress. If you have any criticisms, suggestions or items to be added or deleted, I welcome your comments.

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