

ARTICLE

The Use of Mock NSF-type Grant Proposals and Blind Peer Review as the Capstone Assignment in Upper-Level Neurobiology and Cell Biology Courses

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Although the use of grant proposals and blind peer review are standard in the natural sciences, their use as a pedagogical tool is rarely mentioned in the literature. As a consequence of dissatisfaction with term papers and literature reviews as the capstone writing experience in 300-level undergraduate biology courses, I have been experimenting with mock NSF-type grant proposals followed by blind peer review as the major assignment in my junior/senior-level classes. The improvement in

educational outcomes and competencies due to this assignment appears to be substantial and worth the additional effort on both the students' and instructor's parts. Here, I outline the mechanics of this assignment and its advantages and disadvantages as well as the type of curriculum that is required to support this type of capstone assignment.

Key words: grant proposal; peer review; capstone experience; intensive writing

Grant proposals and blind peer review are key tools used in the allocation of science funding in the United States and elsewhere. However, their uses as pedagogical tools for training of students appear to be far less prominent, especially as documented in the literature. To date, Evans (1991) has detailed the use of grant proposals in graduate-level geology courses while Bernd (2004) outlines the use of NSF grant proposal abstracts to teach aspects of critical reading and thinking to students in a non-majors biology course. In addition, Guilford (2001) writes of increasing the understanding of the scientific publishing process in his students by incorporating peer review in the writing of "term papers" in an undergraduate biomedical engineering curriculum. However, to date, there does not appear to be any discussion in the literature about using the entire grant proposal and blind peer review process as pedagogical tools.

In the course of teaching upper-level biology lectures for over two decades at Kenyon College, a private selective liberal arts institution of 1650 students, I have become dissatisfied with the standard "term paper" or literature review as the capstone assignment for my 300-level courses in Neurobiology and Cell Biology. The two major problems with these assignments, as I see them, are that the papers were typically synopses of the literature with little critical thinking and synthesis, and that the papers were often summaries of reviews with little use of primary literature and with little critical analysis of data.

In addition, despite my commenting on earlier drafts, the papers often did not show as much improvement as I desired, partly because of the inability of many students to see their own written work from the viewpoint of an outside reader. To address these deficits, I have been experimenting with the use of mock NSF-type grant proposals followed by blind peer review as the capstone assignments.

The advantages of this type of assignment are that: the students are required both to summarize and to be critical

about primary literature; the students need to be able to put their proposed work in both larger and more focused contexts; the students need to think creatively about what the next questions are in a line of inquiry; the students learn to design experiments to test these questions; and during the blind peer review, as they read other students' work as reviewers, they start to see their own work through a fresh set of eyes. With the peer reviews and their own re-assessment of their own proposals, the students then revise the proposal. This latter closing of the circle allows the students to write much improved revised versions of their grant proposals that are then graded. I believe that this is an improvement over the term papers I used in the past, and although the amount of work done by the student and the instructor is increased, indications are that the students get substantially more from this assignment.

Through informal conversations, I have heard of other professors using grant proposals as an assignment, but the use of peer review and the use of revisions in the process appear to be rare. Below, I outline what I've been using in these upper-level courses after a number of years of experimentation.

THE MECHANICS OF THE GRANT PROPOSAL AND BLIND PEER REVIEW

The Courses Involved

I have been using this assignment in my 300-level Neurobiology and Cell Biology courses: the typical class sizes at Kenyon College for 300-level Biology courses are 10-20 students.

The Assignment

The assignment is a 20-page mock grant proposal composed of a 10-page literature review (the summary) that sets up the experimental questions, followed by a 10-page experimental design section; references and figures are submitted as appendices and do not count in the page

total. I put few limits on the subject matter except that the topics are to be basic biological in nature, although it could be focused at different levels from the molecular to the behavioral, depending on the course. Many students pick topics related to some aspect of neurobiology or cell biology with a clinical bent (e.g., Alzheimer's, Parkinson's, stroke), but whose focus is on the basic biology. The proposals typically become focused on 3-4 questions that are to be answered by the proposed work. (A copy of the guidelines given to students can be found in Appendix I.)

I also put no limitations of the types of organisms or types of equipment that can potentially be used, so students will range widely in their choices, often using pieces of equipment or organisms that are not typically found at a liberal arts college. As such, these mock proposals have no (or unlimited!) budgets and allow the students a great deal of freedom to pursue their scientific interests.

The Schedule

In the first week of the 14-week semester, we spend part of a class going over the process of writing a grant proposal. We spend some time on how to pick a topic; how to read primary literature; how to begin formulating questions; and how to begin designing the experiments to test the questions. In addition, the students have a mandatory session with a reference librarian on the use of databases and the running of literature searches. After this initial introduction, the students have three weeks to do some database searches, to do some reading, and to start narrowing their focus. The schedule that has evolved is as follows:

- Week 4 Grant topic due
- Week 7 Grant outline and preliminary list of references due
- Week 11 "Finished" grant proposal due
- Week 12 Grant review panels meet
- Week 14 "Revised" grant proposals due

The students are given four weeks to come up with a topic for their proposal, then a further three weeks to do more intensive database searches and background reading, resulting in an outline of ideas to be covered in the proposal as well as a interim list of the supporting references. After another month, which typically includes a two-week spring break, the "finished" proposal is due. The students are then given a week to read three proposals written by their peers (the "PI's") and to write short reviews of these proposals. Finally, students are given a further two weeks to revise their proposals before the end of the semester.

The first several times that I used this assignment, I did not use interim deadlines and did not allow the revision of the proposal after peer review, just as the NSF does not allow revisions. This turned out to be a mistake on both points as many students left the work until the last minute and most wanted to improve their work by revising it. To address the former problem, the use of interim deadlines appeared necessary as most students were not disciplined

enough to spread the work out over time. In addition, the closing of the feedback loop by allowing revisions that incorporated comments from the reviewers and new ideas stemming from the students' own re-readings of their own proposals resulted in substantial improvements.

The assignments due at the interim deadlines are not meant to be substantial, but serve as reminders that the students need to keep working steadily on the proposals. At the first deadline, each student hands in a few sentences on the general topic of the proposal. At the second deadline, an outline of the topics to be covered, as well as a preliminary list of references that have been found so far are handed in. At the third deadline, the entire proposal is handed in. At one time, I called this the "draft" proposal and the revised proposal the "final" proposal, but I have since changed the terminology so that the students hand in a "finished" proposal at this third deadline, and a "revised" proposal at the last deadline; this has resulted in better initial work as the new terminology implies that what's expected is a finished product rather than a rough draft.

Support of the Students During the Writing Process

To help the students in what can seem a daunting process, I put on the course Moodle site and in a common reading area copies of mock grant proposals from past classes, with the names and any identifiers deleted. I typically use proposals that vary in quality and are from students who have graduated. I also put on reserve copies of my own past grant proposals to the NSF and the NIH, including those that were successful and those that weren't. The better students often study these past proposals quite intensely and pick up tips on how to structure their work as well as how not to do things.

In addition, I serve as a sounding board over this time, working one-on-one with students to refine their hypotheses, their experimental design, and their writing.

The Review Process

Submission and Sorting of the Proposals:

Initially, I asked for the proposals to be submitted as paper copies in quadruplicate (one each for the three student reviewers, one for me). I would then sort the proposals for individual reviewers in each grant panel, having removed all identifiers so that the identity of the student (the "PI") is removed from each proposal. More recently, I have been asking for the proposals to be submitted electronically after which I remove all identifiers before forwarding the files to the student reviewers. As Kenyon College has recently moved to the use of the Moodle course management system, I will experiment in the future with using the peer review feature in Moodle in conjunction with electronic submission.

The Grant Review Panels:

Before the "finished" proposals are handed in, I assign all members of the class to 4-5 person grant review panels that will each read a subset of the proposals. I try to spread the students so that there is a range of preparedness and accomplishment represented in each

panel so that not all the best students are in one panel and all the weakest ones in another. As an example, in a 15 student class, I will typically form three grant panels of five students each. I will first pick, based on previous performance, the three best students in the class and allocate one of them to each of the three panels. I will then go down the class roll, spreading out the students across the panels, based on previous performance.

If possible, each grant panel reads thematically similar proposals (e.g., those dealing with molecular topics) so that the students are not asked to read widely varying topics. Each student in a panel will read three different proposals out of those assigned to the panel (the number of proposals assigned to the panel will equal the number of students in the panel), with each proposal getting three student reviewers. For example, if five proposals A, B, C, D and E are assigned to a panel with five students, then one student will read A, B, C. A second student will read B, C, D and the third C, D, E and so on. If possible, based on a preliminary look, I try my best to give each student reviewer proposals that range in quality so that each student gets to see some proposals that are relatively strong and some that are relatively weak. To keep things as objective as possible, all the proposals from the students in a given panel will be reviewed by other panels. In addition to the student reviews, I read and review all the proposals. The proposals are read and reviewed double-blind: only I know who wrote each proposal and who wrote which review.

After being given a week to read the proposals and to write the reviews (see below), I have been convening each of the different grant review panels at a local café over coffee or tea. The best meeting times are worked out on-line via a Doodle Poll (www.doodle.com). I have found that having more than five students in a grant review panel makes it much more difficult to schedule a common meeting time.

Once convened, I ask each of the student members to take the lead in discussing one of the proposals that they read. Since only three students read each proposal, in a five-student panel, two of the students will not have read a given proposal. Typically, we take 10-12 minutes per proposal, so that for a five-student panel, it takes about an hour to go through all the proposals assigned to it.

The Grant Reviews:

At the time the proposals are sent to the reviewers, I attach to each proposal a grant review form, formerly in paper and now in electronic form (see Appendix II for a copy of the Grant Review Form). An electronic copy of the form is also put on-line on the course Moodle site. The reviewers fill out a form, either by hand or via word processor, for each of the three proposals that they read, bringing them to the review panel meeting so that I can collect them. After the meeting, the reviews by the students are stripped of names and identifiers and handed back to the writer (the PI) along with any copies of the proposal with annotations and comments that a reviewer is willing to hand back to the PI. My own review form and my own copy of the proposal with my annotations are also handed back to the PI at this time.

ASSESSMENT AND OUTCOMES

Grading

The grant proposal is a major part of the course grade, comprising 30% of the final grade in a typical course. I typically value each of the three grant proposal reviews at 2.5% each. I also usually have three take-home exams worth 15% each while the rest of the grade is based on class participation, attendance, and paper critiques and presentations.

In assessing the grant proposals, I look for understanding of the topic, the completeness of the initial literature review in the introduction, how well the questions stem from the introduction, how interesting the questions are, how well the questions can be answered by the experiments and techniques proposed, the amount of detail and understanding of the techniques, and the quality of the writing. Over the years, the students have tended to have the most problems with how to write the literature review so that the questions flow naturally out of the review, and then in the use of the questions to set up the experimental protocols. This is typically the part that shows good improvement in the “revised” proposal as they tend to see the gaps in their own writing after having seen this gap in the writings of others. On the other hand, the students seem to find the literature review and the outlining of the techniques relatively easy, even in the earlier “finished” proposals.

For assessing the grant reviews, I concentrate most on the substance of the review and its intellectual rigor as well as how constructive the comments are to the PI.

Recurring Issues

The use of interim deadlines has resulted in many fewer students handing in incomplete or substandard work, although about 10-15%, typically the weakest students, still struggle to do things in a timely way. The biggest issue that I still see is getting the students to make the literature review in the introduction segue smoothly into a natural set of questions, and in linking specific questions to a set of experiments in a clear and logical manner. That said, the top proposals are typically of very high quality, better than many proposals I’ve read in reviewing for national funding agencies.

The Advantages

One clear advantage of this assignment is that it treats students as working scientists, giving them a view into the process of doing science from critically reading the literature and formulating ideas and questions based on their reading, to designing experiments to test those questions. The proposal review and revision process then add the critical analysis of the work of their peers and the incorporation of the comments in the reviews into their revised proposals. However, I believe that the biggest growth in the students from this assignment comes from their own re-reading of their own proposals after having read the work of others. Being able to see their own work with outsiders’ eyes is the biggest change that I see in the students during the course, and I feel that this competency is one that will have the biggest impact on the students in

the future.

It is clearly a challenging assignment for most of the students (see *Student Assessment of the Assignment* below), though an assignment that is doable with sufficient effort and time, leading to much intellectual and personal growth. There are those who dislike the assignment (see *Student Outcomes* below), but for many students, it is an assignment that defines their abilities and gives them a distinct sense of accomplishment. Also, as the reputation of the assignment has spread throughout the students, I have tended to get only students who are serious about these 300-level courses. Although some of the students are required to take Biol 358 (Neurobiology) for their Neuroscience major, for most of the students, the courses in question are electives so the assignment has led to some self-selection among the students, leading to more stimulating discussions, better-prepared students, and in general a more serious tone to the class.

In addition, past students who have gone on to graduate school report that this assignment was one of the most useful that they had in college as it is the type of assignment often used as part of qualifying exams or in a grad school course. These students felt that they got a “leg up” from having done this before they went on to graduate programs. As well, these alumni report that the assignment gave them a better idea of what life will be like in grad school and as a working scientist.

The Disadvantages

One clear disadvantage is in the amount of time and work involved in this assignment, from both the student's and instructor's points of view. The amount of organization by the instructor that's required is substantial, from working out the review panels and its assignments to sorting the reviews and the annotated proposals for return to the students.

I think the assignment works best in a semester-based schedule, as we have enough time to fit in all the components of the process. In a quarter-based schedule, the timeline will be probably too tight to do all the elements that I outline here. One possibility would be to do a shorter assignment where a student proposes just one question after a review of the literature, but this will not reduce the work involved much, especially if peer-review is part of the process. Based on the data and comments from the assessments (see below), the peer review process is clearly a critical part of the assignment.

I don't know if the assignment will work with classes larger than about 25 students as the amount of administrative and clerical work involved will increase with size. For courses with much larger enrollments, the question becomes whether TAs can take on the workload for this assignment. I think it depends greatly on their competence and how the course and the assignments are structured, as well as how well-prepared the students are going into the class.

It's also clear that the success of this type of assignment depends to a great deal on the type of courses that precede the 300-level courses in question. For one, this assignment requires facility and comfort in dealing with

primary literature. In our case, we require our students in biology to begin reading primary literature starting with the 100-level courses. This is further enhanced by the attention paid to close reading of primary literature in our 200-level courses, which typically include 4-5 short critiques of primary papers. To this end, one of my colleagues, Chris Gillen, has pioneered the use of on-line tutorials on the reading of primary literature (Gillen et al., 2004); he has also written on the pedagogical uses of primary literature (Gillen, 2006) as well as writing a primer for students on reading scientific literature (Gillen, 2007). If the reading of primary literature has not been routine for students at the lower levels of the curriculum, I believe it will be substantially more difficult to make this assignment work well.

It is also highly desirable that the curriculum emphasizes the formulation of scientific hypotheses and the design of experiments. For example, our year-long 100-level introductory biology lab emphasizes experimental design and data analysis in conjunction with intensive writing. The course covers a diverse range of topics from enzyme kinetics to muscle physiology to restriction mapping to ecology and anatomy such that the students get experience with a wide variety of instruments, including: thermal cyclers; strain gauges and computer interfaces; centrifuges; microscopes; spectrophotometers; gel boxes, transfer cassettes and power supplies. The capstone experience in the lab is a six-week independent project late in the second semester whereby pairs of students read the literature, formulate a hypothesis, design and conduct a simple experiment to test the hypothesis, and then analyze the data and present the work in both written and oral forms.

This intro lab is followed by the 200-level lecture courses (described above) that emphasize the critical reading of the literature. In the literature critiques in these courses, we often ask the students to come up with some possible questions and experiments that extend the work presented in the paper that was critiqued. The 200-level labs that complement most of these lecture courses often expand on these themes by having a large experimental component where the class, having learned some fundamental techniques, then use the techniques to test some hypotheses in the second half of the lab course.

From the perspective of the students, the rigor of the assignment discourages students who may not be willing to work hard from taking these courses; it may also discourage students who might be intimidated, but could do the work. I do not have any data on the numbers who may fall into the latter category, but I think the numbers are quite small. This is because all the students in the class are science majors, and as such, they are self-selected from the general student population. As well, since at least one other 300-level Biology course and the Senior Exercise in Neuroscience, and to a lesser extent, in Biology, use this type of assignment, the Biology and Neuroscience majors understand that a mock grant proposal is something that they will have to grapple with as upper-class students.

Student Outcomes

The mock grant proposals have clearly improved the critical analysis and the synthesis of ideas in the capstone papers. By having the students first summarize and critically analyze a scientific topic before designing experiments, it splits what appears to the students to be an insurmountable task into two more manageable parts. Indeed, many students really engage and take ownership of the proposal, such that about once a semester, a student will come storming into my office saying that she or he has just been "scooped" by a paper in *PNAS*, *Nature*, *Science*, *J. Neuroscience*, etc. In this case, I empathize with the student, but I also point out that after only a few weeks of working on this topic, that the student managed to figure out the path of the next series of experiments, meaning that she/he should take heart from the progress. All the student needs to do now is to extend their work to the next series of questions and experiments.

It's also clear that the peer review is as vital as the grant proposal itself as the students see how well (or badly) their peers' proposals work, and they tend to see their own work with a different, much more critical eye after the process. Typically, the revised drafts of the grant proposals are substantial improvements on the "finished" draft.

Range of Topics Chosen by Students

Examples of some recent topics chosen by students for their grant proposals include:

Neurobiology (Biol 358)

- Effect of peptide YY on dopamine levels in the *nucleus accumbens*.
- Regulation of microRNAs in myelinating oligodendrocytes of multiple sclerosis lesions.
- The role of ocelli of a nocturnal ant in landmark and polarized light navigation.
- Calcium currents and store-operated calcium entry in astrocytes and neurons in a rat model of epilepsy.
- Selective loss of ZnT3 in hippocampal cells and the attenuation of synaptic plasticity.
- Gene therapy cocktail for the treatment of MS.
- Isoform specificity of Na-channel blockers.

Cell Biology (Biol 366)

- Influence of hepatitis B viral infection on hepatocellular carcinoma
- Regulation of tight junctions by zonulin protein
- Protein folding and oligomeric assembly of secretory proteins
- The role of lipids in the conformational change of PrP^C to PrP^{Sc}.
- Obligatory steps in the proper folding and assembly of a hetero-oligomeric protein,
- The role of the centrosome in the determination of cell polarity during interphase.

Student Assessment of the Assignment

As the assignment has evolved, the student reaction has improved (Table 1).

Academic Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2003 - 2004	1	2	2	5	4
2004 - 2005	1	0	3	6	0
2006 - 2007	0	2	1	7	2
2007 - 2008	1	2	0	9	3
2009 - 2010	0	0	3	4	10

Table 1: The responses over time to the question, "Did you like the grant proposal and peer-review as the capstone assignment to the course?" (These 300-level courses were not taught in some years.)

The students in these courses pretty uniformly find this assignment challenging (Table 2),

Academic Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2011 - 2012	0	0	1	3	17
2012 - 2013	0	0	0	2	6

Table 2. The responses to the question "Did you find the grant proposal assignment challenging?" in the academic years 2011-2012 and 2012-2013.

In addition, they found the process of peer review useful in improving their own work (Table 3).

Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2011 - 2012	0	0	1	5	15
2012 - 2013	0	0	0	1	7

Table 3. The responses to the question "Did you find the grant review process useful?" in the academic years 2011-2012 and 2012-2013.

Sample comments from students in the course evaluations include:

- "An amazingly important learning experience..."
- "I loved the grant proposals."
- "The grant proposal and review process were extremely beneficial."
- "Peer review process: absolutely awesome. Should always be done."
- "I think it's a great, challenging assignment. Peer review process very helpful."
- "Seeing other students' work and talking through their strengths and weaknesses helped me to critically evaluate my paper."
- "I didn't like either. It was just very time consuming and got me nowhere."
- "Too challenging. It's a demanding project that is just too much."

As can be seen, a minority of the students, typically at the bottom of the distribution, finds the assignment to be too challenging, but most appear to have gained substantially from this capstone assignment.

SUMMARY

I believe that despite the work that is involved, that this assignment is better than the term papers that I assigned earlier. Indeed, students seem to like the proposal and peer review as a challenging but rewarding assignment that pays off in a number of concrete ways, most importantly in improving the competency of students in looking at their own work with a fresh set of eyes, and in preparing a good proportion of the students in the class who will be heading to graduate school. In addition, aside from another 300-level course in the department, both Kenyon's Department of Biology and the Department of Neuroscience now use a modified form of the grant proposal as part of the Senior Exercise required for graduation; hence, this assignment has become more common in our curriculum.

Based on the feedback from the students over the years and the intellectual growth that I've seen in the papers after the peer-review process, I feel that this type of assignment is worthy of consideration by instructors of upper-level biology classes. Clearly, this is a time-intensive assignment that requires more administrative work by the instructor. It also requires a curriculum that introduces the reading of the primary literature and the design of experiments early in the course sequence so that the step to this assignment is not too big. However, the mock grant proposal and peer-review process do challenge the students in a way that most have never been challenged before, leading to a better understanding of both the science and the communication of science to others.

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APPENDIX I**Biology 358: Neurobiology****Fall 2012****The Grant Proposal and Review Process:**

Aside from the writing of articles for publication and peer-review, the other major place where scientists put their ideas to the test is in applying for funding to do the **next** series of experiments that they want to do over the next 3 years (the typical duration of a grant). This process really tests our abilities to summarize previous work and to outline what we believe are interesting lines of investigation. In essence, we're trying to make a sales pitch for our ideas and our work in the space of about 10-12 single-spaced pages.

These proposals are submitted to one of the funding agencies (for neurobiology, typically NIH or NSF) by a certain deadline. They are sorted by the field of inquiry and assigned to different "programs", which are subdivisions of the fields. In my case, I send my grants to NIH to the Chemical Senses Program of the National Institute of Deafness and Communicative Diseases (NIDCD), while at NSF, they go to the Sensory Biology Program. Once in the programs, the proposals are assigned to different grants panels, which are groups of specialists from different universities and institutes who pass judgment on the different proposals. In many cases, outside opinion from experts not on the panel will be solicited as well.

For each proposal, panel members and the outside reviewers read it critically to see:

- If the scientific ideas follow logically from the background information;- If the work is interesting and useful and doable in the time frame;
- If the investigator has the background to be able to do the work;
- If the investigator has the equipment to be able to do the work;
- If the amount of money requested is reasonable for the proposed work; and
- If the investigator has been productive in the past.

Each panel member and outside reviewer then writes a one-page, single-spaced assessment of the proposal touching upon what they consider to be the good aspects and the bad aspects of the proposal. Then, at the NSF, they each rank the proposal as being Excellent; Very Good; Good; Fair; or Poor. These scores are tabulated, and the highest scoring proposals are proposed for funding. Typically, in recent years, about 5 to 15% of the proposals are funded, depending on how well-funded the field is and the stiffness of the competition.

The Assignment:

The Grant Proposal: As writing a proposal really tests one's ability to understand a field and to think about the next series of interesting experiments, it's really a great way to challenge your understanding of biology and your ability to think creatively about it. Topics must deal with the basic biology of the nervous system, although there may be applications that are clinical.

The assignment is to write a 20-page double-spaced proposal (equal to a 10 page single-spaced proposal) on any topic in neurobiology that interests you.

NOTE: It is not permissible to use all or parts of other proposals that you may have written for other purposes (e.g. NEUR senior exercise, Biol./Mol. Biol. Senior exercise). Clearly, you can use the knowledge you gained in other courses, but the topic must be new to you and rely on new readings that you do for this course. A part of the section on Academic Honesty in the Course Catalog states:

...Submitting the same work for more than one course also constitutes plagiarism, although of a special kind. Kenyon faculty members assign papers, research topics, and other work in order to facilitate students' academic development, and they expect to receive original work in return. Submitting the same work in whole or in part for two separate courses without prior consent of both instructors circumvents this aspect of your education. And such conduct is manifestly unfair to other students, who will receive an equal amount of credit for doing substantially more work. In a particular case in which you nevertheless feel it is justified to use all or part of a work for one class in another, you must first obtain permission from the instructors of both classes.

The proposal should be divided up in the following way:

Cover Page: Has name of investigator, title of the proposal, and the research institution. This will **not** count in the 20 page limit.

Abstract: About a **200 word** statement summarizing the background and the proposed experiments and the approach(es) that will be taken in the work. This will **not** count in the 20-page limit.

Summary: About a **10-page** summary that introduces the reader into the field, with enough detail to be able to put the field into context. This section lays down the background for the proposed work, so if your background is shaky, then it undermines the rest of the proposal. Use subheadings to divide this section into discrete topics.

Research Methods: The rest of the proposal (**approx. 10 pages**) will deal with outlining the experiments that you propose to do, and how you will go about doing the work. This is the place where the proposal will be judged on how reasonable your experiments are, and if they are doable. This part should have the following sections:

- An overview of the research;
- Details of the techniques and the protocols to be used;
- Data analysis;
- Possible problems that could be encountered, and how these problems will be overcome; &
- What you believe will be the sequence of the experiments.

Appendices: Figures and the list of references are appended at the end. These will **not** count in the 20-page limit.

The Writing Style: The writing should be in standard non-jargon English as much as possible. The citation format should be the standard Dept. of Biology format used in Biol 109-110. If you are having problems with organizing this assignment, see me **and** the copies of grants on reserve in the Bio Reading Room or on the class Moodle site. No grants proposals or reviews will be accepted unless they are word-processed. As in much of life, neatness and precision counts in writing a grant proposal; sloppy proposals with misspellings, errors of fact, *etc.* typically do not make it very far.

The Grant Reviews: Each student will be assigned to a grant panel that will review blind 3-5 draft proposals from other students in the class. Each student will be asked to write a 1-page summary of 3 of the proposals reviewed by the panel, and give each of those proposals a grade. The reviews will be graded by the instructor. The grant reviews, with the name of the reviewer deleted, will be given back to the investigator (the student) for incorporation into the revised draft of the proposal that will be graded by the instructor.

Grant Proposal Schedule:

Grant proposal topic due - Thursday, 9/20

Grant proposal outline and references due - Tuesday, 10/16

Finished grant proposal due - Tuesday, 11/13

Revised grant proposal due - Thursday, 12/13

Some tips on how to approach this assignment:

1. Pick a topic that is of interest to you. People tend to do a much better job on a topic that is inherently interesting.
2. To get a good entry to a topic, start by finding a good recent review paper on the topic to get your bearings – the *Annual Review of Neuroscience* (and others in that series) or a recent review in another journal is often a good first place to start. Then, using database searches, find even more recent papers that flesh out the recent developments in the field. This will take more time than you anticipate, so start early and use the library's resources to help you in doing the searches.
3. Often, just a few labs are prominent in a given sub-field, so once you figure out who the main players are, you can also search for papers coming out from those labs.
4. Once you've done sufficient background reading, you can start to synthesize and write the first part of the grant proposal: the summary. **This is especially a place where you need to be sure that you are not plagiarizing what others have written. Be sure that you are summarizing but not using direct quotations or cutting and pasting!**
5. Write the summary.... then, think of 3-4 major questions that are still unanswered. Often, the major players in the field do not agree, so this disagreement may be one place to start thinking about what questions to ask.
6. Once you come up with a set of question, think of how you would try to test those questions scientifically. To help in the design of the experiments, think about other experiments you've read about that are trying to do similar things and use/modify the procedures used there. You will be much more convincing if you test a question using multiple different experiments that come at things from different angles. Be imaginative!
7. The hardest thing for most students comes in the linking of the summary to the experiments. Write the summary such that it leads naturally to the sets of questions that you want to pose. Then, use the first part of the Research Methods section to connect the questions to the experiments that you will do.
8. Use subheadings and subsections to organize the paper into logically distinct parts. This makes things a lot easier for all concerned.
9. This will be challenging, but have fun with the assignment. One of my goals for you is that by the end of the assignment, you will be the campus expert on this topic.

**APPENDIX II
NEUROBIOLOGY GRANTS PROGRAM REVIEWER COMMENT SHEET**

Name of Reviewer: Itagaki

Review Panel:

Proposal Number:

Title of Proposal:

Overall Rating: Excellent Very Good Good Fair Poor