

NSF Graduate Research Fellowship Program

(insights)

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II- Research Proposal

Target criteria: plan and conduct research; communicate (scientifically and informally); to work independently or as a team; enhance scientific understanding; benefit society

This is your most important essay. You must **specifically** address the *target criteria* above. Most important of which is the ability to **plan and conduct research**. Here we will focus on how to propose winning research projects.

Here's what makes a strong research proposal:

Transformative research. Never ever propose an incremental improvement from existing techniques or your previous research (i.e. Jones *et al.* solved the problem for X, and I will solve it for X+1). In the "publish or perish" world of academia, by the time you enter graduate school Jones *et al.* will have several publications on X+1.

Innovative approaches to known problems. We cannot emphasize creativity enough.

➔ You are only judged on the creativity of your idea given that you have no results to argue

However, if we got \$1 every time someone told me they weren't creative we couldn't write this because we would be living on my dream island which has no electricity or internet. Innovation comes in different forms, in your case you only need to be creative in one manner: look at the same problem everyone is looking at and think something "different". This should be especially easy for undergraduates who have not been boxed by the curse of knowledge. If everyone is thinking of a problem as an addition problem, rephrase it so that it can be approached as a multiplication problem. Another approach to creative research is to look at other fields how they tackled a given problem and try to apply that approach to your domain.

Interesting proposed results/outcomes. Remember these are "expected" outcomes, they need not to actually happen but you want to show the reviewer that you have a thorough thought process and, based on your due diligence, these are the expected outcomes. You should aim for outcomes that challenge conventional wisdom and push people to think about the problem from a different perspective.

Provide multiple returns on investment. The majority of the time, poor proposals tend to be too optimistic, e.g. "my research will bring world peace." While this is very honorable,

what would the NSF have to show for if you fail? Nothing. World peace is a high risk, high reward kind of investment. Those types of investments are not made by the National Science Foundation, they are made on Wall Street with a sub-prime mortgage. You should definitely articulate your project's big picture "world peace" type of impact but you should have *other* impacts as well. Propose a new methodology, a new experiment, develop an open-source library that others can use, design a course that will prepare future researchers for the new challenges of your field, etc. If the only benefit of your research is to answer your specific narrow question—and excite a handful of experts in your field—it won't cut it.

- **Spreading knowledge.** Here you must do two things. First, you need articulate the impact your research will have on the broader society? And how will you integrate your research expertise/findings into your teaching? To address these 2 questions, you should think about the following: If you are successful how will you spread your findings? How will the society at large learn about your research's impact? How will you leverage your findings to excite a new generation of researchers? How can you use novel teaching techniques to transfer your expertise?
- **Realistic.** The proposal must be realistic in both scope and timeline. You must balance the creative nature of the proposal (see points 1 and 2) while demonstrating that it is still a *feasible* project. In this case, the term "feasible" is relative. For instance, if you are proposing to join a lab that just purchased an MRI machine for their exclusive use, then a project involving numerous human subjects and several MRI runs is realistic. If your proposed institution doesn't even have an MRI machine, well your project isn't. Your project should be a 3-5 year project with clearly articulated expected outcomes. Therefore you should abstain from proposing to cure cancer in 5 years.
- **Deliberate.** Success never occurs by chance. Yes you might get lucky, but overall success is always a deliberate process. Therefore you must never write "I can't guarantee anything, but if I am lucky I will have great results and change the world." Instead, show the reviewers that you thought about what it will take to be successful. Provide logical arguments why you selected the university you plan on attending, why did you chose a certain lab (see point 5 above), what are the steps you will take to ensure that you develop the expertise required for success, and what other unique opportunities/collaborations does your proposed institution provide you.
- **Honest.** Creative research ideas don't exist in vacuum. Acknowledge previous research (avoid claiming your project will be the first ever to do xyz) and propose how will your contributions fit in the big picture of your field and create opportunities for other upcoming scientists. Also never attach the name of a scientist to your research proposal unless (s)he has read it and explicitly gave you permission.

Now, your mission, should you chose to accept it, is to take these steps and turn them into a clear, focused, coherent and flowing essay. Have non-expert academics read it to provide feedback on clarity. Have field experts read it for feedback on originality, logical reasoning, and reasonable timeline.

Below is a template you may follow. The NSF has a suggested format in the guidelines, you could follow it as well: Title, key words, hypothesis, research plan, anticipated results or findings, literature cited, and a statement of originality. If you want to go that route, you could add a specific Broader Impacts section.

Outline:

- 1 Why should the review care about your project? Why should the NSF fund you? Think big picture!
- 2 So far, what has been done to solve this problem?
- 3 Based on previous research what is your proposed hypothesis to solve/gain insight into the problem?
- 4 What exact steps, experiments, collaborations, guidance will you undertake to (dis)prove your hypothesis
- 5 If you successfully accomplish everything in step 4, what would the outcome(s) be?