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Graduate Research Plan Statement

TITLE

Succinct, comprehensive, and easy-to-understand.

- You should use a title that is easy for the reader to comprehend, regardless of their research background. The title does not to be extremely detailed, but **should provide enough key words to conceptualize the project.**

*My only critique of my title is that **I did not use active enough language**. Upon review, I would use the word **"investigate" or "elucidate**" instead of "understand".*

BACKGROUND & SIGNIFICANCE

Established the model system: honeybees

Established the broad question: What can the study of development in eusocial insect (i.e. honeybees) tell us about the impact of epigenetic mechanisms of regulation?

Defined more specific area of research under investigation: DNA methylation, supported by background knowledge that emphasizes what it is and the importance of this mark in gene regulation, genome stability, and development across organisms (including the honey bee).

Provided study significance & rationale: Previous studies suggest that DNA methylation is likely very important for honey bee gene regulation, development, behavior, and eusociality. In addition, DNA methylation appears to be a dynamically regulated epigenetic mark, thus suggesting the importance of DNA demethylating enzymes such as TET enzymes.

The functional importance of honey bee TET enzyme has yet to be determined (no functional studies have been performed).

Clearly defined study goal and central hypothesis:

- *"the goal of this proposal is to elucidate more about the role that TET enzymes play in honey bee germline and brain demethylation."*
- *"We hypothesize that AmTET KD will result in changes in DNA methylation that will affect the expression of genes important to brain and germ cell development by preventing proper erasure of methyl marks."*

Make sure your central hypothesis is clearly defined, bolded and/or italicized to make sure the reader can see it.

EXPERIMENTAL DESIGN

Rationale: My hypothesis calls for ablation of *AmTET* expression in honey bees to investigate its function. My goal in this section is to demonstrate how I will do that and what my functional readouts will be (approach)?

Statement of Aims:

- Aim 1 - what are the effects of *AmTET* loss in honey bee germ cells?
- Aim 2 - what are the effects of *AmTET* loss in honey bee brain cells?

Approach:
How? - RNAi
Rationale: Already successfully done in my system. Easier and "safer" to do than a full deletion

Readout?

1. **Did the knockdown work?** → Gene expression analysis (i.e. RT-qPCR, etc.), methylation analysis (e.g. western blot, sequencing, etc.)
2. **What are the downstream effects of *AmTET* loss?** → the effect on gene regulation, morphology, behavior, etc.

Alternative approaches, controls, and experimental details:

- **Alternative approaches:** CRISPRi (gene expression), Mass Spec (methylation)
- Included controls including assessing off-target effects, potential confounders, & replicates.
- Described: **system** (honey bee), **when experiments would be performed** (larvae stage, early embryonic stage), and **what tissues would be used in analysis** (germ cells, whole brain, etc.)

I did not include an expected results, pitfalls, data interpretation and analysis, or future directions sections. These are good to include if you have room (I didn't). *They may or may not be critical to the success of your proposal (it wasn't for me). Figures are generally useful in proposals but not needed for this particular fellowship.*

I tried to frame my experimental design as to **make it appear feasible** through use of standard molecular biology techniques and well established assays and approaches.

INTELLECTUAL MERIT

The major goal of this section is to demonstrate what academic qualifications you have that will support your ability to carry out your proposed graduate research.

- I addressed **what relevant knowledge and experience I've accumulated** and **how that will allow me to successfully carry out my proposed graduate research.**
  - Example: "Took multiple courses in epigenetics, took a course on honey bees (with hands on experience with the model system), and conducted research in a lab that studies epigenetics and DNA methylation."
- **I specifically propose an institution and a lab/mentor** that will allow me to successfully conduct the proposed research.
  - This demonstrates that you've thought deeply about the broad feasibility of your proposed work and available mechanisms of support.
  - When you apply as a graduate student, you don't have to speculate on a mentor or an institution. You can list your institution and thesis advisor.
- I also **mention resources such as core facilities that can assist me in my work** as well as research communities and programs that can provide feedback and discussion on my work.
  - Provides more evidence of feasibility.
- I also **emphasize that the project has the potential for collaboration** and I suggest potential collaborators.

BROADER IMPACTS

The major goal of this section is to demonstrate what potential impacts your proposed graduate research will have for you, society, and the broader scientific and academic communities. This is a key section in modern NSF GFRP proposals. It helps to distinguish you from other candidates and demonstrate that you've considered how you can contribute to the NSF mission of becoming a leader in scientific innovation and teaching.

- **I emphasize the significance of my work to the scientific field.**
  - "My studies will contribute to the current body of knowledge in the field of epigenetics, such as the role of epigenetic modifications in insect systems, and provide evidence supporting the use of honey bees as model systems to study epigenetic concepts."
- **I suggest how my research could potentially improve society.**
  - "My studies may provide insightful information for the study of honey bee colony collapse disorder which directly affects our agricultural system and economy"
  - "Findings may be broadly applicable to studying epigenetics in humans"
- **I emphasize my desire and plan to disseminate my findings** to multiple communities including scientific, policy makers, and the general public.
- **I emphasize my desire and plan to teach** future generations of students on my area of research.

GENERAL COMMENTS

- **Overall statement:** Clearly written, succinct, and easy-to-understand. I use short sentence structure as much as possible to make reading, attention-keeping, and comprehension easy for the reader.
- **I judiciously use text alterations** such as bolding, underlining, and italics to highlight and emphasize key points.
- **I provide just enough critical background informatio**n to understand the scope and rationale of the project. I summarize major published findings in the field without providing too much detail on what was done and how those findings were achieved.
- **My aims are cohesive but not interdependent**, despite employing some overlapping approaches.
- **Minimal to no grammatical or spelling errors**
- **I address both intellectual merit and broader impacts in clearly defined sections.** *THIS IS KEY TO A SUCCESSFUL STATEMENT.* Both statements should address these two major concepts in a thoughtful manner. A paragraph should be dedicated to each of them.
- **CITED PUBLISHED WORK!** It's always important to give other scientists their due credit for published work you use in the crafting of a research proposal.

NOTES

- Remember, **the NSF GRFP is similar to a condensed version of a standard NIH or equivalent proposal.** You will have to forgo details normally found and expounded upon in those types of proposals (and that's ok to do).
- Certain common techniques you do not need to explain in detail (i.e. RT-qPCR)
- **You are not bound to the work you propose, however, you must demonstrate to the reader that you have mastery in the basic concepts of proposal writing** (background and significance, using sound rationale, developing questions and hypotheses, and experimental design (employing controls, logical use of appropriate tools, considering confounding variables, considering alternative approaches, having good readouts that directly help you prove or disprove your hypothesis, etc.)