Research guidelines

1. **It's your research!** To succeed as a scientist you must be driven to do research; not because you have to, but because you want to. As a graduate student you will be transitioning to being an independent researcher. Ultimately, it will be your thesis you will have to defend. It should reflect your ideas as to what are interesting scientific questions and good ways of addressing them.

2. **Goals.** Set short and long-term goals. Periodically evaluate your progress toward these goals. If you are not making progress, do your best to figure out why, and do something about it.

3. **Self discipline.** Carefully set out research priorities and make them your focus. You'll find it is very easy to get lost in the trees and lose sight of why you are doing a particular set of experiments. Make sure you keep track of the aim of a given section of work, if experiments don't address this, they should have lower priority than those that do. Please don't read this to mean that I don't encourage 'just because I'm curious' experiments. But do make sure that you design all experiments in such a way that you'll learn something, positive or negative (that means controls, controls, controls).

4. **Research should be hypothesis driven.** For better or worse, research is now on a time limit. Try and develop a central hypothesis for your thesis early in your graduate career and be sure that what you are doing is working toward clearly testing this. Choosing a hypothesis requires a lot of careful reading and imagination. Like the paper clip, simple, good and elegant experiments are usually obvious only in retrospect. At the time they require perspiration and imagination. In many cases a substantial part of your work will be to make genetic and computational tools for use in subsequent experiments. This is a necessity for research, but remember that the goal of scientific research is to develop and test hypotheses.

5. **Read.** Research doesn't stay still. You need to read to broaden your intellectual background–aim for at least one paper per week though reading more will pay off. Don't be disheartened if it takes you a long time to get through papers initially, with practice you'll speed up. Reading will help you choose and develop good experiments and hypotheses, and, not least, be an interesting and vital scientific colleague and lab member. Also, reading widely can only help when it comes to writing for yourself. It is easy to stay up to date with free email alerts containing journal table of contents. Start (but don't stop) with: Nature, Science, Proc. Natl. Acad. USA, PLoS Biology, PLoS Genetics, Evolution, Genetics, J. Bacteriol.

6. **Publish.** Publishing your research is very important. Writing manuscripts forces you to organize your experiments into rigorous 'units' and will help you see areas where additional experiments are necessary while you still have a chance to do them. It will also give you a very helpful head start when it comes to writing your thesis/dissertation. Finally, it is the primary way for you to get known; thousands of your scientific colleagues will read any paper you publish. How many papers should you publish during

a PhD? A rule of thumb is that after 2-3 papers have been prepared/submitted/accepted for publication you are ready to start organizing your thesis document.

7. **Communicate science.** The best way to do this is to present your research at scientific conferences and group meetings. Practice makes perfect–take lab meetings seriously, they provide an opportunity to try out ways to present ideas and data effectively to a friendly audience. The quality of feedback will depend proportionately on the effort you put in to present clearly the work you've done.

8. **Back up.** Computers break – all your important files should be backed up to an external drive or network based storage.

Responsibilities and expectations

Guidelines as to what I consider as reasonable expectations for your scientific and lab progress. Each category includes earlier responsibilities. **Everyone should read as much as they can – and share what they learn.** All lab members should take seriously the responsibility to mentor junior members.

Undergraduate students.

- Attend lab meetings whenever possible.
- Be able to present your work in lab meeting – including an introduction that places your work in context and explains to other lab members why you are doing it, and a concise and supported interpretation of your results.

Early career graduate students.

- Write an abstract covering your work that introduces the topic and puts your work in context, accurately presents and interprets your main results, and provides some indication of future questions.
- Write and organize a poster covering the same points as above and including proper statistical analysis of results. Remember, it is your data – it is your job to evaluate it. Whenever you show anyone figures (or spreadsheets), you should be able to summarize what you think it means.
- Generate a draft manuscript that covers at least bullet points of Introduction, Materials and Methods, Results and Discussion sections.

Late career graduate students.

- Write a paper with minimal supervision – especially with respect to the overall logic and structure of the paper.
- Write a competitive student grant proposal (e.g. the NSF Dissertation Improvement Grant).
- Identify interesting research questions. Propose, design and implement independent projects with minimal input from senior lab members.

Post-docs.

- Write a full NSF grant – identify an interesting research topic, propose and design suitable experiments.
- Carry out (or know how to seek help to perform) all statistical analyses necessary for a comprehensive interpretation of all experiments.
- Write a paper suitable for submission to a peer-reviewed journal with minimal editing.
- Begin research collaborations with internal and external researchers.