**Becoming a professional independent scientist**

* 1. Active Learning: Undergraduate academics frequently fosters dependent learning. During undergraduate education, students are given the problems, questions, and information needed to succeed in this very specific academic environment. Graduate school requires a transition to independence, with your learning becoming more self-directed. Success as an independent scientist requires the ability to identify critical problems and meaningful questions and gather the information needed to address them. This information gathering involves both the technical details associated with your experiments, but also an understanding of the scientific literature. This includes the literature specific to your field, but also the scientific literature more broadly to stay abreast of key advances in biomedical research. You will eventually become your best teacher, identifying problems and questions, gathering information, trouble shooting, and making progress. Your mentors will assist in helping you through this transition. To encourage professional independence and intellectual growth you should do the following prior to any research meeting with your PI/mentor:

* Understand the goal or hypothesis your experiment is designed to address.
* Clearly annotate the experiment, the data, and the expected outcomes, so that they can be quickly assessed without confusion.
* Identify key problems with the experimental approach/results. Did you forget controls that limit your interpretation? Share these thoughts with your mentor.
* If there are problems, identify potential solutions that can fix the problem prior to meeting with your mentor. Propose these solutions to your mentor.
* Make explicit conclusions about what your results mean. Write these conclusions down in your note book, and share them with your mentor.
* If your results are encouraging, what do you plan to do next? Come to the meeting with your plans for your next steps.
* If your results are not as expected, identify alternative possibilities, and propose experiments to decipher between these potential scenarios.
* Be proactive. If you are at an early step in a multi-step process, you should make sure that the reagents necessary for completing the subsequent steps are prepared prior to completion of the earlier step.
  1. Perseverance: The ability to persevere through adversity is critical for a scientist. Many hypotheses are wrong or, worse, prove too difficult to test. Many experiments give negative results, which with proper controls are informative, but can still be discouraging. Your reaction to such adversity will go a long way towards determining your likelihood of future success. Can you push through the problems that arise?
  2. Self-Assessment: Evaluation and critique are part of graduate school. Are you able to receive criticism? Combine critiques from faculty and your peers with your own self-assessment. What are your scientific strengths and weaknesses? Continually review them and work towards improvement.
  3. Communication: Being able to communicate your work simply and effectively is absolutely essential. Why is your work important? What are you trying to achieve? You should be able to do the following: 1) Explain in 3 min to your non-scientist relatives why your work is important; and, 2) Explain in 5 min the key aspects of your work to a non-specialist scientist. The themes in these short talks, once honed, will likely serve as the foundation for all of your grant proposals and scientific seminars.