1. Conduct a literature review
    a. In order to gain this skill, I looked at papers that my mentors provided to me during the program in addition to searching out more literature that would be relevant to the research I was doing. I then looked over the papers, jumping around the sections until I got as much information as I needed. In a source organization app that I downloaded on my laptop, I saved each source and wrote down the information within the article that was pertinent to my research.
    b. In acquiring this skill, it helped me learn through each article that science literature can be very dense, which means it's important to go into it knowing what information might be important for me to know. By reviewing it, I could also keep tabs on the sort of information I found interesting, and what was relevant to my project.
2. Keep a detailed lab notebook
    a. I acquired a notebook from one of my mentors and immediately made a table of contents on the first few pages by counting the lines on the page and comparing that to how many pages were in the notebook. I could then number the table of contents by page and allow me to keep the book organized in chronological order. After each day that I took notes or did work within my notebook, I could turn to the first page and write in a brief description of the work for that day
    b. I figured that while I would have loved to have my work to have been organized by topic, this would leave more of the notebook unused, but if I didn't reflect on the work I did in a day, I would definitely lose the information. I was proud to actually keep up with the table of contents and knowing that I can use this book for future work

3. Read and Understand Journal Articles
    a. To read and understand the articles I read, I started by reading the title and abstract. If the information there was relevant, I then jumped to the conclusion and results to understand what the numbers looked like, helping me understand the article and dive further into my own experiment. I then saved relevant articles and reviewed them, as stated above.
    b. I learned to read through articles quicker and to sort through articles that could actually provide information on the things that I am researching, instead of taking a full day to read one single, dense article that sometimes ends up not being relevant.
4. Develop a Research Question
    a. I met with Nick about the directions my research could take this summer, and he had a few suggestions about what I could do in addition to the sort of material and cultures that would be available to me. Once I chose a direction (comparison between tropic and Antarctic bacteria), I could then narrow down specifications and make a neat question that could be answered by an experiment.
    b. By creating my research question in this way, I realized that the background information on a project isn't solely about the topic as a whole, but also one must delve into the sort of questions that can be asked. It showed me that the observation point of experimentation can be about phenomena and logistics
5. Defend an Argument when Asked Questions
    a. It was important for me to understand the information that I was working with during the summer to answer questions that came along the way. This was to people that both understood and did not understand the background of bacterial

growth and adaptation. This meant continuously taking my experiment and breaking it down into simpler terms, and explaining it to different types of people, including my family that don't have a science background.

   b. I learned that in order to explain science well and to be certain of the work one is doing, any sort of snob attitude needs to be dropped. There is always a way to describe things that doesn't include jargon, even if said jargon is beneficial. It helps with understanding of what I'm doing and with information accessibility.

6. Use Statistics to Analyze Data
   a. In order to analyze my data, I had to find a method to compile that data into more simple numbers that could be graphed. By putting my data into Excel, I could use the tools on there to average out my data and compare other portions of it. By averaging out numbers, I could find a way to create something like a normalization that would allow me to compare the data I had. I then put that data onto graphs which showed the patterns that would help me answer the question I had proposed.
   b. I learned that data analysis is hard when you're the first person to process it, which can make you feel overwhelmed. However, I figured out that by grouping data in different way, there is a lot of information that can be gathered from the same numbers if they're moved around and put onto different graphs.
7. Calibrate Instruments Needed for Measurement
   a. Over the summer, I used lots of different machinery. I did a lot of cleaning and UVing of work locations in addition to processing controls for PCR and DNA amplification. In order to make some of the material for my experiment, I also had to learn to use a digital pH meter that needed calibration prior to each use and

then I had to add compounds to the liquid being measured to get it to the correct pH.

   b. I learned about how touchy technology can be, and then how to adjust the pH of a liquid. It also showed me that controls have to include what we can't see because that can affect the product of an experiment

8. Conduct Observations in the Lab or Field
   a. Most of my observations for this experiment were visual, both on a day to day basis and ultimately when analyzing data. Each day I would look at the cultures and ensure they weren't being weird (which some were and they had to be redone), and then closer once in images. By taking a moment and looking at the colonies, we found that some of the bacteria was in co-culture which then taught me how it was important to observe quietly each day.
   b. I have moments in which I want to skim over observations, but if as much is done, data can become skewed because of information that is overlooked.
9. Conduct Database or Internet Searches
   a. To do so, I had to figure out what sort of database I needed to use. I used Google Scholar and BLAST to do different searches. Google scholar was great for helping me acquire articles that aided in my research. After sequencing the bacteria I worked with, the BLAST database helped ensure the species that I was working with.
   b. This became an exercise in observation, again, and the understanding of how much information there can be to sort through. I feel I've learned to skim more effectively in a way that I slow down enough to understand, but I don't get stuck on information for hours on end.

10. Identify Limitations of Research Methods and Design

a. While some limitations were obvious from the beginning, I found that there were more than I could have accounted for during each portion of the project. In research, I could find what other variables change the growth rate of bacteria. I knew at the beginning time would be a huge limitation. Also, once I reached out for another look at my presentations, other brought up questions that further showed me that there were ways where my research had its limits, such as within tested temperatures, and the complete replication of an environment, and the idea of total growth vs growth rate.

b. I learned that a project doesn't have to be perfect to provide beneficial information but that it is important to keep that in mind, because it can impact the question that one is trying to answer and how the data presents itself.