Molecular Biology Through Discovery (Fall 2017)

Final Questionnaire

I. Goals of the course

Your thoughts on independence?

Resp 1: The three points listed under "Make progress towards independence" are "define problems rather than have them handed to you", "gain comfort in reading research articles", and "take control over your own education". I have written my thoughts in detail for each of these points: 1. "Define problems rather than have them handed to you" This goal was definitely achieved by the research proposal. The purpose of the research proposal was to define a problem that had not been answered by the scientific community, and propose a way to solve that problem. I believe that this goal of being able to define problems instead of waiting for an exam or a paper to define a problem for you was a lesson I learned the hard way this class. My research question changed multiple times throughout the course of this semester. Many times I felt like giving up because every time I created a new question, I would find a week later that the question was already attempted and answered to some extent. This was not bad. In fact, this just helped my understanding of the field grow, to a point where I could ask my own questions about certain articles and wonder "Why did they do this instead of this?" or "Why didn't they want to understand this in a different perspective?" I was able to define problems within rese arch articles for topics that weren't fully explained in the article itself. 2. "Gain comfort in reading research articles" I suppose from my explanation of the first point above, it is apparent that I know how to read research articles to some extent if I find myself asking questions about their proposed research experiment and results. I learned more about reading research articles in this class than I have ever learned in the past. Before I walked into this class, research articles were an obstacle, a hindrance, an annoyance, because of its overwhelming jargon and the underlying knowledge required to even understand what was going on. The first paper we had to read, the Sanger and Tuppy article, was terrible for me. I hated it. I thought, if this was how the rest of the class was going to be, I can't wait for this semester to be over. As the semester progressed, I bettered this ability one section at a time and I came to appreciate the amount of knowledge a person can gain from even one research article. The hardest parts of any research article to understand are the most important parts: the experimental methods and the raw data. They go hand in hand: if you can understand the experimental methods and why each method was chosen, if you can understand what the question is and how the methods would answer the question, then the raw data automatically makes sense, and you can create your own conclusions. So to rephrase the above statement "gain comfort in reading research articles", I gained comfort in reading and understanding the research question, experimental methods (to a point where I could draw out the methods on paper), and the raw data so that I could come up with my own conclusions for the research article". 3. "Take control over our own education" There were many experimental techniques that I had taught myself for my research proposal. I did not know what the Thioflavin T Assay was, I did not know what plasmid cloning or transformation was. These all seem so simple now because I had to teach

myself these techniques and understand why and when each technique would be used in a scientific study. Taking control over my own education is something I have been doing since I was a child. I have always been the curious little kid that wanted to know answers to every single question in the universe, and Google was my best friend, my partner in crime, for all of this. In this class, this simple curiosity was taken to another level. I was forced to understand every little detail for every single experiment, and I had to understand why things happened the way that they did. If things happened differently, what do you speculate would have occurred? If you wanted to analyzed a different perspective in answering the question, how wo uld you approach it? I needed to know every single detail, I needed to see the full iceberg, which, in the past, I would have been satisfied with just scratching the surface. I believe that I took control of my education to some extent. There were many parts of my research proposal that I had taught to me. I was taught how primary and secondary antibody staining for SDS-PAGE gels worked; I was taught how the genes from a plasmid were transcribed using the E. coli RNA Polymerase. These are all questions I would never have thought to ask let alone figure out the answer to. There is still room for improvement.

Resp 2: I feel that I have become independent with my research goals. Through the exams and the research proposal I have learned to take initiative and search for information that is available on databases etc.

Resp 3: As the class progressed I slowly started understanding what was expected of me and how I could best proceed to identify and solve problems that were in assignments. Although I was annoyed with myself at first the assignments within the class really forced me to think critically and use knowledge from class and within the articles themselves. I started to relay more so on my own intuition as what needed to be done and how it should be done so in the regard of fostering my independence the class for sure succeeded.

Resp 4: I think slowly but surely I did. It took me awhile to get adjusted to how the course was step up, and half way through writing my research proposal my mentor wasn't of much help, so I really had to work independently which also thought me a lot about the way I learn best, and how I come to my own conclusions and reasonings. This really impacted the way I move forward with research and learning.

Resp 5: I have an understanding of these goals as this class made me more independent in finding answers to my questions. For example, I was able to ask the right type of question in order to find the best answer to obstacles faced. In my research proposal, I was able to after some thinking and feedback from others, make an experiment that was easier for me to understand so that I can explain it to others. I was also able to differentiate between observations and assertions through this class. The biobike tool was helpful to me in answering the questions on the problem sets and helped my grasp molecular biology better. I consider everything I learned in this class worthy as I have become more independent in finding out answers to my questions rather than just asking others for help. I was able to do this by asking the question in the right way in order to be effective in getting a good response.

Your thoughts on observations/assertions (and paying attention to the experiments behind observations)?

Resp 1: This difference between observations and assertions was a fundamental objective that was grilled into our heads since the beginning of this semester from the assignment on results vs conclusions to the understanding of research articles required for the research proposal. We were taught how to take an experiment apart line by line and recreate the experiment as a drawing to show how the research question was answered. Every single assignment we did in this class was to better our understanding. I knew how hemoglobin's mechanism of carrying oxygen and releasing it to necessary tissues worked by reading a textbook before, but in this class, I SAW how it worked. I observed the mechanism, and developed my own assertions for it. I had a whole list of assertions that I had read out of a textbook coming into this class, and now, as I have completed this semester, I understand many of these assertions in more detail because I have seen why these assertions came to be in the first place. I read the research articles that discovered these very assertions. I was able to take raw data or observations given by scientists and create my own assertions instead of taking other people's assertions as fact.

Resp 2: I have developed better habits on understanding the difference between observations and assertions and the connection between them. Understanding the experiments behind observations was tough but I believe I have developed a better understanding that could definitely use some more help with on older research studies.

Resp 3: This class really taught me how to effectively read and extrapolate information in a research article. It was simply not enough just looking at the results or how they were obtained but it was vital that why and how each individual step in the procedure be understood very thoroughly.

Resp 4: There is so much that goes into experiments and what is really going on. Why we are doing certain things and from there what are we seeing happened through each step. This takes not a deep knowledge but the willingness to looking and investigate. This I learned first hand when writing my proposal and techniques such as Western Blotting needed to be explained.

Resp 5: Observations and assertions are different and must be distinguished. Assertions are made before an experiment and observations are made after the experiment has been conducted. Assertions are made based on past experiments, it is almost like a hypothesis. And the results are the observations. Sometimes, the observations may not reflect the assertions made and that is okay. A hypothesis can only be supported, it cannot be proven.

Your thoughts on molecular biology?

Resp 1: In the beginning of the semester, I had a larger focus on the articles we had to read, and understanding the molecular biology portion of this class. However, as the semester progressed, I ended up spending more and more time on the research proposal, and less and less time on the problem sets and the assignments. I learned the basic information

from each assignment, and this helped me do well on the exams as I explained my thought process in detail for each exam. Because there were two portions to this class, I was never able to give my 100% attention to either portion unless I almost entirely neglected the other portion. In the beginning this neglected portion was the research proposal because I was still on the hunt for a mentor that could guide me in my research question, and as the semester progressed and I needed more time for my proposal, I began having to neglect the molecular biology portion. Because of this, my thoughts on the molecular biology portion of the class is that I learned all the basic information necessary for biology as it is practiced today, and have a strong base going into higher level bioinformatics classes, but I wish there was a way to separate this class into two different classes, one that focused on the research proposal, and one that focused on the molecular biology. In this way, I would be able to give my 100% in both portions.

Resp 2: I have a better understanding on molecular biology. I have considered this one very worthy because modern day research builds on the basic research that was done earlier in the 19th century that, although they were a struggle to go through, they really did show the importance of those. Understanding the basics provides a base for future research and exploits the vastness of molecular research.

Resp 3: There is so much more to molecular biology then what I could fathom to understand and this was something I was not aware of when I started this class. understanding how biological machineries work and the complexities that arise from the various pathways present in biological systems is almost overwhelming but definitely should be understood to solve medical problems we face in current society. This was evident during the start of our research proposals. So much of medicine is based off of how molecular machineries work and thus having a firm grasp of molecular biology is important for the future. I think bioinformatics is a great tool to get us closer into understanding the subject of molecular biology.

Resp 4: Before I had a surface level understanding of molecular biology, but there is so much to the subject. Its such interesting yet so complex and there is so much to learn. But from reading many articles this semester and preparing for my presentation I think I learned a lot more than I did in any class I have taken. But reading and studying expanded the knowledge that I do posses on the very broad topic.

Resp 5: Molecular biology is important in many aspects, learning about biology in the molecular level can help in finding cures to cancer and other such diseases. It is very important to be able to think at this level.

II. The Means of the Course

The classroom experience

Resp 1: The number of online notes, companions, and experimental simulations given to us each week, along with the work done for the proposal, along with the work done for other classes was completely overwhelming. There were not enough hours in the day to do everything in the calendar to the extent that was required of us in order to fully understand the material. When I approached each of the simulations, notes, and

companions, I didn't just mindlessly sift through the information. I didn't just mindlessly answer the questions given in each assignment. I tried my best in understanding the material, doing the simulations, understanding why the question was being asked, and which path it was directing me towards. This took a lot of time, which as I stated in the first sentence was very scarce. I do believe that these assignments were very useful. I did the majority of these assignments in the detail that I described above, and felt that I learned a lot from each of them. However, the reason that I rarely came to class was because each class day was at least a few class periods ahead of where I was in terms of content. There were days I could not attempt the questions on the problem set that we were set to go over in class. I felt that I wouldn't benefit from going to class without having attempted any of the problems in the first place. I did attend at least one day of class per week, or at least I tried to. Each of the class periods that I did attend were attended because I had at least attempted whatever assignment or problem set problems we were set to go over in class that day. Combating this problem is going to be very difficult. On the one hand, the number of simulations, notes, and companions can be reduced to a much more feasible number. However, this would decrease the amount of information we learn, and take away valuable information that is required of this course. On the other hand, the class itself can be separated into two parts (a full year class instead of one semester) where the first semester is used for learning and understanding the molecular biology portion of the class, and the other semester spent on the research proposal. This would be very beneficial for those that are struggling on their research proposals even now. This would spread out the notes, simulations, and other assignments, and also give students much more time in completing these assignments because they can spend the time they would have spent on the research proposal in working on these assignments. This would also increase class attendance because students would h ave more time in completing assignments, and, therefore, would have reached a point in the assignment were they would get stuck, ask for help on the questionnaire, appear in class to have that question answered, and learn more about the material in this way. Another reason for the lack of class attendance was that most, if not all, of the topics to be covered in class were listed on the calendar. Many of my peers believed that they would not have to come to class because they could spend their own time completing those objectives before a problem set was due, or before an exam was due. They felt that they didn't have to come to class because they already knew what was happening in class down to the exact problems we would be attempting, and because of this, they felt they could do this on their own time without having to be in class. I think a way to combat this is to list out the assignments that you expect to be attempted each day, but do not include what exact problems we will be going over in class. This opens up discussion to all problems in the assignment, so that class attendance increases because students that have attempted question number 1 would feel as compelled to come to class as those that have completed quest ion number 10. As for the questionnaires, whenever I had trouble answering a question, I would first ask Jared or Thomas for help. If they helped me solve whatever problem I had, then good. If not, I would start to answer the questionnaire and state whatever problem I had along with my method of fixing the problem. However, as I wrote out my question in detail, I would better understand what exact information I was lacking, and then I would solve the problem by just asking the question. In this way, I ended up submitting very few

questionnaires throughout the semester. The TA's were very helpful in answering my questions.

Resp 2: I think that the classroom experience was essential for answering the exam questions. However, although I was present during some of the group discussions, I still was not able to understand the experiments. I think maybe for the harder studies such as the one done by watson and crick should have a walk-through explanation of the observations and assertions. I think it was a struggle more because of the experimental method however it would have helped some more having a specific lecture on those overview topics. I did like the group discussions overall because they gave me a perspective on group work. These helped me with studying the experiments and developing techniques to reading studies.

Resp 3: Although I was victim of considering the class not to be always the best use of my time I did however still tried to attend just to make sure there was not any major lapses in my knowledge of materials and what I found was that the major problem with student lead discussions is that only a couple of us would actually read the articles and assigned prior to attending the class so therefore actual discussions really did not help me because there was not a really a variety of input rather it was from the few who read.

Resp 4: The idea of the course in theory would work out better than a normal classroom environment. But I personally did not like being put on the spot certain times when asked a question, due to being shy. But I think certain activities and simulations should be replaced by focused discussions about the research proposal and presentations. This would maybe increase attendance rates and overall class morale. But I think your strategy overall would have a greater impact if you also removed the questionnaires and let students speak during class.

Resp 5: I have come to every single class since the semester started except for two instances where I was sick and could not make it. I feel that attendance to the class should be mandatory as it is not possible to learn this material on one's own time without coming to class. The class helped me in my problem sets as the questions were went over in class. Since this class is different from other lecture based classes where the professor will post their notes on blackboard, and attendance may not be mandatory, I feel that attendance should be made mandatory in this class. I also feel that the questionairres should be made mandatory.

Results vs conclusions

Resp 1: It definitely worked. In Exam 3, Question 8A, we were told to take an experiment from an article and recreate this experiment in an image and explain how the experiment worked. This question took all the skills we gained throughout the semester from the exercises done in class, the experimental summary, and the research proposal, and applied them to a different research article to see if could take apart the methods done in order to understand the observations that were made. In this way, we could then take these observations and create conclusions of our own. Going back and looking at the way I answered this problem shows that I did learn these skills, I did learn the difference between results and conclusions and how important it is to view the raw data or the observations given in an article instead of focusing on the conclusions that were made.

Resp 2: I think that these exercises helped understand the differences between results and conclusions. Understanding the experiment is key to developing our own conclusions and interpretations for our own uses. I think the summary of an experiment and the research proposal definitely helped with that. I'm not so sure about the class exercises but I do believe in some group discussion this was definitely worked on.

Resp 3: I defeinelty as if the purpose of actually doing the reserach proposal was attained, however

Resp 4: Yes, it build and solidified my knowledge in certain topics and helped me build a better understanding of molecular biology.

Resp 5: The primary research articles helped in structuring the research proposal. I looked at the articles as a guide when writing my own proposal and they helped. I was able to see which is important and which is not important to include in my proposal and made sure to keep my proposal to the point. All the exercises done helped me better prepared to write my own research proposal, for example, the summary helped me better able to understand my experiment as it synthesized an important part of my experiment.

The research project

Resp 1: The written research proposal taught me how to ask questions that had never been asked before, and taught me how to come up with a viable method in solving this question. From the presentations, I was able to improve my communication skills in that I was able to take all this information I had learned over the course of the semester, and focus on just the important information with regards to the audience. Because the presentation was only 7 minutes long, I had to find a way to say everything I wanted to say in such a short period of time without leaving out anything that was crucial to understanding the experiment or the research question. This was very difficult, and after running through the presentation twice (once as a mock panel, and once in front of faculty) I still have not been able to narrow that down to 7 minutes exactly, but I have come very close. From the panel discussion, I learned how to analyze experiments in different perspectives. I was asked questions I never considered asking myself, and that opened my eyes to how many different ways my experiment could be changed to answer the same question. I spent the majority of my semester coming up with a solid research question. As I dug deeper into Parkinson's research, I found myself getting further and further away from all the research that my mentor was doing. My focus was more on prions and inhibitor studies, so I sought to look for a mentor that could help me with that. I also looked for a mentor that could help me create an experiment that had a larger molecular biology focus. I asked my biochemistry professor, Dr. Hartman, for help in this and that is how I came up with the anion exchange chromatography for protein purification as well as the transformation of bacterial cells with a plasmid containing the human gene. In the beginning, I wanted to use post mortem tissue and gain access to the human protein directly. Jared helped me come up with the Thioflavin T Assay as my aggregation assay for my inhibitor study. I already knew I would need to use an aggregation assay, but I was still determining which one I would want to use. In this way, I ended up meeting with my mentor less and less, and spent more time talking through my proposal with Dr. Hartman and Jared. I still engaged in scientific dialogue

with a mentor, just not the mentor that I assigned myself at the beginning of the semester when I had a different research question.

Resp 2: I gained a much needed individual perspective on research from the proposal and the presentation. I learned how to express my thoughts on paper and in person better. The panel discussion taught me the importance of being thorough and thinking through every possible issue that can occur and to understand the whole research process. I think that sustained effort was not really possible for me only because finding a mentor was a tough project in itself. I was able to meet with my mentor somewhat regularly as he was also my professor for another class however his meetings definitely helped me think more along the lines of a seasoned researcher. This opportunity brought about many questions for me about research that was done previously and picking out what to say to further the scientific dialogue occurring in the community. Having a mentor was excellent because they were very intent on nurturing my understanding of science.

Resp 3: Personally this research proposal project gave me a new perspective and appreciation on how science actually works. I gained the skill of analyzing various complex research articles and extrapolating only the data that was relevant to my own project. I thought the panel discussion was difficult but something we definitely needed to experiments as it gave us professional feedback on our projects. It was a cool experience but definitely extremely stressful. The biggest thing I took away was being able to present under pressure in front of a panel who knew much much more than you. Ill be honest at first I did not put as much effort but as soon as I began to get feedback on the weaknesses of my proposal i realized how much effort this class would require. I began to talk to my mentor a lot more frequently as time went on and it helped.

Resp 4: I think I gained confidence, in myself and in my work. After doing all that work to learn and understand I really believed in my knowledge and what I learned. Then having to do it in front of complete strangers and my peers I became a little less shy and trusted my research, and being asked questions made me see certain flaws and place I needed to work on but further than finishing the proposal, but spotted a trend in my understandings. This course is meant to take a semester and that time needs to be utilized. My mentor became little help when it came time for focusing on the proposal, so I think its best that in a way you are the only mentor for students because you understand the ins and outs, and is more readily available to students.

Resp 5: I was able to experience what it is like to present to a panel of research doctors. I have never done this before. This class made be able to go out of my comfort zone to find a research proposal mentor. I thought I would never be able to find one because I know they would all be busy. I learned the way to approach them so that I would get a yes from them. I learned that if you want to get a mentor you have to get to the point and show that you are interested in their topic of research. I also learned that first impressions are important. I gained the ability to write my own experiment from my written research proposal which I find to be an important skill in the field of research and when you write your thesis for a PhD. program.

Help and feedback

Resp 1: The TA's were absolutely amazing. Jared and Thomas helped me with every single assignment that I had questions on, and their advice was impeccable for my research proposal. Thomas' feedback on my problem sets, and Jared's feedback on my research proposal is what helped me advance in this class this semester. They did an amazing job, and after thinking long and hard about what feedback I can give them, I cannot think of a single negative thing to say or constructive criticism to give. They performed wonderfully. My meeting with you for the second exam was not as productive as the meeting for the third exam, and that was entirely my fault. For the second exam, I had no questions about either the exam or the proposal because the exam was very self explanatory, and I was not that far with my proposal - I was still in the process of finding a research question that had not been asked or attempted. My meeting with you for the third exam was absolutely amazing. You helped me understanding primary and secondary antibody staining for the SDS-PAGE gel, and helped me understand the mechanism of how the plasmid's gene (our target gene) was transcribed using bacterial RNA Polymerase, and why the certain E. coli strain and certain plasmid was used. Understanding these mechanisms was not the only thing I learned during this meeting. You helped me realize that there were so many loose ends to my research proposal, so many questions I had not answered. I had left the story half finished, and I didn't realize this until our meeting. This meeting was most beneficial to me because I was able to take another look at my proposal, and ask myself questions that I predicted would be asked during the faculty panel and find answers to them myself. One such example is the speculated mechanism of the Thioflavin T stain. Overall, the feedback and help I received from my TA's, you, and my peers was very valuable, and helped me progress very far in this class.

Resp 2: I think more than the feedback for the course, I appreciated feedback on the proposal and presentation. Again, the classwork was a bit more complicated for me to understanding however, the feedback from Jared on my presentation did help guide my edits and your comments on my draft helped me concentrate on the missing pieces of my proposal and possibly what questions I haven't addressed just yet. I think maybe the draft should be due a bit earlier in order to attain some more in depth feedback on our papers. This way it gives some more time on structuring our papers better based on feedback from you.

Resp 3: I personally loved the feedback. Especially after the first exam I saw myself really focuwsed on addressing a lot of the small concerns that were pointed out. The feedback on my proposal and summaries, I thought, propelled me to really dial in on learning as much as I can about my topic

Resp 4: I appreciated it, and it was quiet helpful in the long run. Even through email they were able to answer my questions fully. Then the feedback they sent me on my presentation really made me take a second look at what I was doing wrong and how I could do it better. Overall they were amazing and very knowledgable

Resp 5: I benefitted a lot from the feedback I got from my peers in my mock presentation for my research proposal. I was able to know what I should do to fix it and make it better. As a result of my feedback, I made my proposal easier to understand and removed

unnecessary information. I also got a lot of clarity as to how I should be approaching my proposal.

III. Bottom line

What advice would you give someone entering the class?

Resp 1: Come in with an open mind. Be ready to ask questions that you never would have considered asking, and be ready to put in a lot of hard work. Learning how to read research articles or recreate experiments or even come up with a viable research question for your proposal will NOT come easy. You have to be willing to put in the time and effort to make it happen. Come in with the ability to take constructive criticism, because in this class, you will not be spoonfed. You will not be given the answers. In fact, you won't even be given the questions to answer. But you will be given advice, and most of the time, this advice will be harsh. You need to be able to take this harsh advice and grow from it instead of letting it bring you down.

Resp 2: I would say come to class and focus on the task at hand. Definitely spending time with mentors is key to developing a good proposal and a better understanding of molecular biology. I would also advise to take the advice given with a grain of salt because ultimately the choices are individual with regards to exams, proposals, and panel presentations.

Resp 3: Do not take this class for granted just because it is Pass/Fail. This class will demand a lot of time and focus to do well and understanding all the goals that are expected to be addressed in the syllabus. However do have fun with it because all the stress aside I thought it was a really interesting class since the way it is structured is so much different than what we are used too.

Resp 4: Start working on the research proposal in the begin, so that when you run into bumps in the road which you will, it won't have to scramble for time to finish it.

Resp 5: I would give others entering this class that they have to be prepared to give presentations at the end of the semester and that they have to start looking for a mentor early on so that they do not fall behind.

Three things you'd advise that this class never to do again?

Resp 1: 1. Questionnaires. I thought having questionnaires due before every single class period was slightly useless. Having questionnaires is good because it allows you to see where each student is having trouble, and you can spend class time in a useful manner but many students will not have attempted the problems that you will be planning on going over during a certain class period because of all the other commitments we have made such as all the other classes we are taking. This doesn't mean we will never attempt the questions, it just means that we haven't attempted them by that class period or by 5 AM that morning. Because of this, I think it is important to have a questionnaire due by the end of the week, just one questionnaire each week that asks us what questions we have, if any, on anything we have discussed in class or outside of class (via notes, simulations, and companions) throughout the entire week. By the end of the week, we will definitely

have atte mpted these questions, so we will definitely have questions to ask. 2. Remove the questions on Exam 3 regarding your favorite quote or the multiple choice asking what the quote means. It seems useless to include questions like those on our last Exam of the semester. Go straight into the questions about the material. These first few questions were already asked, answered, and put to bed on Exam 2, where it should be asked. I cannot think of a third thing that this class should never do again.

Resp 2: 1. Do not procrastinate, it is the worst thing to do 2. Definitely plan work in pieces so that its easier to put them together for exam questions or for proposals 3. Don't be close-minded that science only works in certain ways because there is a lot more than just what we know from lecture that we find in actual studies done in the field.

Resp 3: I cant really think of something that should never be done again because taking away particular aspects of this class would deviate from the purpose of this class itself since it is so independent a lot of it is on you and I feel as if the balance between the independence and the guidance given by the professor and the T.A's and when allowed fellow students makes everything in the class doable and should be available.

Resp 4: Questionnaires Exams with such intense questions Simulations that require downloads software.

Resp 5: I would say the questionairres should me made mandatory for all students and that attendance should also be made mandatory. I also think that research proposal drafts be due sooner so that people can have time to work on them and fix them if need be.

Three things you'd advise that this class keep doing at all costs?

Resp 1: 1. The length of the exams and the questions asked were perfect for testing the skills we gained throughout the class. This should not be changed. The timing of the exams was OK as well. 2. Keep the problem sets going. However, make them mandatory. These problem sets are how people gain the skills necessary for the exams as well as the class as a whole. Many people don't do the problem sets because they are considered optional, and then they suffer on the exams. Problem Set 5 and the feedback I received from Thomas was the reason I understood how to do one of the problems on Exam 3. 3. Keep the notes, companions, and simulations going, but decrease the frequency of them. Spread out these class materials throughout the semester in a more feasible fashion, by determining which materials you believe will take more time than others. These were very, very helpful in understanding the material, and I don't want any one of these materials to be taken out just because there is not enough time to complete them. However, I do believe that the frequency of assignments per week is overwhelming.

Resp 2: 1. Think out of the box, not all the answers are easy and maybe you won't come across the answer at all 2. Definitely seek out advice from the TAs and Jeff 3. Put your best effort all the time even if you don't know the answer

Resp 3: 1) Research Project 2) Problem sets but maybe "grade"/require to complete a couple so it makes us more committed to doing the work 3) Proposal feedback from TA's and Students along with a small focused review by you as well

Resp 4: Feedback Peer/mock presentation first BioBike

Resp 5: I think due dates for assignments should continue to be flexible like for example the due dates of problem sets.I think questions on assignments should continue to be answered during class time and in class assignments should continue to be done.

Three ideas that would make the course better for those that come after you?

Resp 1: 1. Combine the proposal description and the proposal outline into one assignment due at the time of the proposal outline. This gives students an extra week to get their proposal together enough to hand in this assignment, and combines these small assignments into one, saving time for everyone. 2. Instead of having one questionnaire per class period, have one questionnaire per week. This is gone into more detail in a previous question above. 3. You have discussed earlier, briefly, that many students don't truly begin to make progress in their research proposals until the very end. To combat this, make more assignments related to the proposals due throughout the semester. Maybe an update on how the proposal is going each week in the form of assignments. A mentor update (already done, keep it going), a research question update, an introduction paragraph, an experiment summary, a revised experiment summary, etc. Make these required. 4. Make more assignments required in this class. If you leave all the assignments, except for the exams and proposal optional, less and less students will complete it, as sad as this sounds. By making these required, you will also get more of an understanding of how people are progressing in this class, which will also reduce the number of incompletes and increase the amount of people leaving this class with the skills they should have and will have gained.

Resp 2: 1. A bit more clarity on the harder research studies -- kind of like lecture 2. Maybe make more specific questions for class discussions to understand the process 3. I'm not sure.. maybe have more specific class day agendas

Resp 3: 1) Modified teacher facilitated student led discussions where you assign groups and have each of us present in front of the class sections of the article we were assigned to encourage reading of the article before hand. 2) Spend more time discussing one article rather than moving on to make sure we fully understand the article before the exams. 3) I think the pre class questionnaires should be spaced out maybe on a weekly basis so that it would encourage more responses because I think what discourages students is the fact that there is so much work from other demanding classes that we overlook the questionnaire. By making it a weekly thing that still encompasses the entirety of what needs to be covered we can be better prepared for class and encourage questionnaire response.

Resp 4: Make sure to provide a little bit more support for students when writing the proposal. Focus more class time on the proposal over reading articles to discuss at least during a few class periods. Move the peer mock presentations a little bit earlier in the semester so that it allows for more time to edit and change certain aspects of the proposal if necessary.

Resp 5: This course is fine as is, maybe just make the questionairres mandatory and attendance to class mandatory because the material in the class cannot be learned by skipping it as it is not a lecture class.

Did you get what you wanted out of the course? If so, what? If not, what did you miss?

Resp 1: "Did you get what you wanted out of this course? If so, what? If not, what did you miss?" Coming into this class, I didn't fully know what I wanted out of it. All I knew was what I heard from other students that had already taken this class, and that was that the class was a lot of work, and I should not be taking 18 credits with this class - which is what I was doing, and did anyway against the advice I received. So to answer the first part of this question, I didn't know what I wanted out of it, so I can't tell you if I got that. But, I can say that I gained a lot of skills that will continue to help me years from now such as the ability to fully read a primary research article, and gain insights from the raw data or the observations instead of just accepting the conclusions that the scientists had come up with. "Do you feel more proficient in some way? If so, how?" I do feel more proficient, yes. I am now able to take an experiment defined in a research article, and recreate that experiment. I am now able to ask questions that have not been asked, and create some viable method of answering the question. I am able to ask and answer for myself the question "Why?" for any part of my research proposal as well as any research article I read because I can now take my education into my own hands. "What if anything do you think will still be with you from the course in five years?" Everything I have discussed in the above paragraph will stay with me five years from now, as I will be in medical school, and I will require all of these skills in order to be a competent doctor. Thank you for a wonderful semester. I have learned more in this class than I have learned in any class I have taken. This class has pushed me harder than any other class before. I'm glad I took this class, and I'm glad it is required for this major. I believe this class should be required for all majors as these are skills that every student should have gained before leaving with an undergraduate degree.

Resp 2: I did get what I wanted out of the course. I feel much more proficient in conducting my own research and being thorough in the information required to support the novel aspects. I think my ability to separate observations and results will still be with me 5 years later as well as my critical thinking skills that I developed reading the studies.

Resp 3: Overall I am very satisfied as to what this class gave me. I have a newfound appreciation for the complex subject of molecular biology and also a work ethic that I can take with me as I move on in the future. It was a very demanding class and although I don't feel as if my knowledge in one particular area (apart from my proposal) has expanded but rather it is the small techniques of understanding and formulating my own questions and understanding how to read research articles which will be carried with me through the foreseeable future.

Resp 4: Yes, I really learned more then I expect in an environment that I say I would prefer to a regular classroom environment. I became confident, and learned so much from what I was reading, discussing, and hearing in class. I will taking what I learned past five years and into my career. Because what I learn is extreme valuable because not only did i grasp certain things about molecular biology but about myself, and how to be independent with my work.

Resp 5: Something that will be with me from this course is being independent and finding answers to own questions which is an important skill for a researcher. Discovering things on one's own is very rewarding experience and this is what happens when one

asks the write questions and devises a way to answer the questions on their own. This is the first time in college I have taken a class like this and I appreciate the way that is is structured. Thank you.