

# Molecular Biology Through Discovery (Fall 2018)

## Final Questionnaire

### **I. Goals of the course**

#### **Your thoughts on independence?**

Resp 1: Though I can't say I'm the most efficient I can be, but I do know my ability review literature and make my own conclusions regarding the subject by looking at the observations. I would say that, despite a mistake in my first exam, I've developed a great ability to find the research articles I want and learning how to connect them all. I also can withdraw information a lot better than before. I believe I've become much more independence in my ability to research and visualize experiments.

Resp 2: I think the biggest thing that stood in the way of my independence was that I did not trust myself to find answers on my own, meaning that I wanted someone to tell me if I was right or wrong. That type of validation does not and should not exist in this class. Throughout the semester, I became more confident in using evidence to justify my answers. Once I was able to answer how I knew something, describe the experiment step by step, and know why each step was taken I felt like I was able to come to conclusions on my own without needing someone else to provide me with an answer. I also became better at knowing what types of questions to ask in order to find the answers I was looking for; I thought being able to help guide the class through questionnaires was particularly helpful for this. The semester project also played a large role in becoming more independent.

Resp 3: I understand these goals and consider them worthy. I believe it is necessary for any Bioinformatics major student to have these skills in order to be successful in this field. I believe that I have made progress on independence towards understanding the basics of molecular biology. I think the biggest thing I have acquired from this course, is my ability to gain information from an article.

Resp 4: I enjoyed this class a lot even though I did not have a great foundation in biology. From my experiences in this class a good foundation of cell biology and some biochemistry is definitely required to grasp concepts or understand the fully research papers. I know how to analyze research papers better so than before.

Resp 5: I believe I have definitely improved in reading a research article. At the very least, I understand now that it is important to not get discouraged from confusion, and to look to the observations to try and understand the experiments that led to them.

Resp 6: I think that this was something that I had the most trouble with coming into this course but is something I have most definitely gained. Before this class most teachers tell is exactly what to do and how to do it. The assignments are not only extremely straight forward, but generally speaking, there is one right answer and once I have that answer, I know that I am correct. In this class,

however, I felt as though this was not the case. When I completed assignments in this class, there were many cases where I had no idea how to approach the question and did not know if my answer was correct or not. As I progressed throughout the course, however, I felt myself transition from not understanding what I was doing to knowing what sorts of information I need to look for (in terms of reading a research article for example). I also felt as though I became a much more independent learner. I was able to examine papers and resources from multiple perspectives and determine which perspective I thought was correct.

Resp 7: I do understand these goals and consider them to be worthy goals. These goals go far above the "what" and instead emphasize the "why" and the "how". These are skills that I feel I have developed much better over the course of this semester by this class. Reading research articles was not easy for me personally, and understanding them is not something that you can develop unless you motivate yourself with goals like these ones. Don't just accept what you read as true and read even further, but rather develop your approach in a way that really forces you to fully examine what is being said in the article with what they use to support it before continuing. Gaining independence in this field is of value to me because of the kinds of work I will be getting into in the future.

Resp 8: I do believe that I have a much better understanding of these goals and I do deem them worthy. I think all of these are imperative for understanding. I think the most important thing out of these goals is independence. Through this course, I learned that if I don't understand something, at the end of the day I suffer. I have to make the decision to continue seeking out help/ resources until I find an answer that I find satisfactory.

Resp 9: I've gotten better at reading and figuring out the information I need from articles. I've also started to learn how to search for articles and information I do not know. I tend to ask for help before of fully searching all of my resources; I know that I need to work on remembering to exhaust my resources before reaching out and using outside resources.

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

Resp 1: I struggle a little bit with observations and conclusions but not necessarily in the sense that I can't tell the difference. I feel like something can be both an observation and a conclusion depending on the level you look at it. The way I think I've seen it is if you observe a tree then you have to conclude that it's a tree to begin with. You have to observe its defining features (make a conclusion as to whether or not those features are in fact what you think they are) then you conclude that it's a tree. This is an issue I've been facing and would love to know if you have any comments. In regards to the experiments behind observations. I do find its difficult to piece together what actually happened in an experiment and even harder to connect them to the observations. Though I do eventually get it, I still want to get better at understanding what I'm reading at a more efficient pace.

- Resp 2: Before this class, I would accept conclusions as long as they came from an apparently credible source (textbooks, professors, the like), but now when I am presented with new information I find myself asking: How do I know? How did they know? These questions ultimately lead to understanding the experiments and the observations that come out of them. Most of the time, we are being told assertions or conclusions and not discussing the actual observation; this is especially true in molecular biology since we cannot actually see or observe things that occur on the molecular level.
- Resp 3: Throughout the course I feel like I've made a major move towards independence in my understanding observations from assertions, but that being said I still think I need to make more progress for me to be perfectly comfortable with the skill. I feel as though I can make my way towards making an observation from an assertion but I will still need some help. But with reading research articles I have learned to question everything because no information is static as more research is made that will change previous known information.
- Resp 5: I have a much better appreciation on the importance of observations now. They really address the question of "how do we know" for any conclusion and thus are the only justification behind an assertion. By focusing our understanding on the observations, and the experiments behind observations, not only do the assertions become apparent, but other potential interpretations can sometimes emerge that would otherwise not have been considered.
- Resp 6: Before this class, I did not think there was a difference between an observation and an assertion. When starting out in the class I also had some difficulty when we needed to distinguish between the two. However, I do think that understanding the difference between the two and practicing distinguishing the differentiation will help me going forward in the field of science. It will especially help me when looking at different research articles as I will be able to have a deeper understanding of the paper.
- Resp 7: Distinguishing between observations and assertions is also a skill that will help one go through an article and understand it better. At first I did not feel as if I could do it with ease, but it is something that we worked on a lot in class and now I feel as if I have a better grasp on how to do it. The experiments behind the observations in these articles should definitely be looked at as well. How do you know if what the article is trying to investigate is true if you don't analyze the experiment that created such results. Experiments can help to answer the "why" and the "how" that I mentioned earlier. I believe that it is very useful to go over the experiment behind an observation so that you know how that observation came about in the first place rather than just assuming what they did was efficient and true.
- Resp 8: If I do not understand an experiment, there is no way for me to understand how someone came to an assertion or conclusion. In understanding the experiment and the visible results, I can then understand why the experimenters did this experiment and how they came to their conclusion.

Resp 9: I've gotten better at figuring out how to understand the experiment behind the observations. I had to do a research project for my Cell Bio class (on chemotherapy); I went in depth trying to figure out how exactly the drugs worked in the body against cancer.

### **Your thoughts on molecular biology?**

Resp 1: The concept has been presented to me in a totally unique manner and I feel my understanding of the subject has had a really great development because of the autonomy we're given in this course. I have a much greater appreciation and interest in the subject because of it. The proposal was a really great example. I was able to develop a much deeper understanding in subjects that I never knew would be so useful in my scientific progress. These include learning about plasmids, DNA repair mechanisms and even some genealogy.

Resp 2: This class takes a different approach to studying biology than previous courses I have taken. The focus on understanding the experiments that lead to discovering the foundation of molecular biology made me have a greater understanding of molecular biology. Before this class I could have told you that genes start with AUG without even thinking about it, but now I know how to find that answer on my own without just relying on someone else telling me. Also seeing how many of the articles we read built off previous ones, impressed on me how collaborative science is. In this class, you are presented with many challenges that on your own may seem impossible to get through, but if you make it a collaborative effort with your classmates then this class becomes much more manageable.

Resp 3: From this solely this course I don't think I could have made enough progress towards understanding molecular biology. But with taking this course in junction with Genetics and Biochemistry I feel as though my understanding of this information was amplified so that I can make a decent understanding of the necessary information.

Resp 5: I still love molecular biology as much as I did starting this course, but now I have a newfound appreciation on the actual experiments leading to the knowledge we have learned in other biology courses. Before this course, I had never really stopped to consider how we would know various information, such as the genetic code. Having seen some of the observations that led to these concepts, I feel like I have achieved a much better understanding that I would otherwise not have obtained.

Resp 6: I think that learning about molecular biology was one of my favourite parts of the course. While I had been introduced to a lot of the topics we looked at, I had never gone so in depth and discussed the topics we did to the extent that we were able to in this class. I particularly enjoyed the various ways in which we were able to learn about molecular biology. Whether it be through class and having a PowerPoint be shown to introduce and teach the topic or through reading research articles that related to the topics, I think that I have a much deeper understanding of these topics now that the class is over. I also appreciated learning about these topics in detail through my translation.

Resp 7: Molecular biology is a very complex subject, one that involves many different processes in organisms. Learning about such processes is important to me and I find it very interesting. Growing up, I was always curious about how life came about and how our bodies work on a molecular level, so this class was very nice to take for me. Molecular biology is very important, considering all of the biological processes in our bodies and bodies of the organisms around us. It can give us insight on how to make ourselves healthier and it often times gives us a good vision of how diseases or disorders occur in our bodies. By understanding how diseases occur can spark insight for treatment, which is what millions of people in the world need on a daily basis. Healthcare and medicine is a path that I want to consider for the future, whether it is as a bioinformatician or doctor, and learning about molecular biology is definitely going to be useful to me and my career. I appreciate this class' ability to mold myself into a better scientist and take my curiosity to new heights.

Resp 9: Molecular biology is a very interesting subject; it never ceases to amaze me how complicated biology is and how many things have to happen in conjunction. It's also amazing to look into the experiments that result in the conclusions that are so fundamental to biology today.

## **II. The Means of the Course**

### **The classroom experience**

Resp 1: I actually have no complaints about how the class was taught. I felt everything that was explored in lecture was practical and relevant to our problem sets, exam and ultimately the proposal. As I had mentioned before, I had every intention of attending class and absorbing as much as I can, but I unfortunately failed to do so due to my overbearing work schedule. Upon reflection, I would've spoken to you more in regards to the subject and done more to try and accommodate.

Resp 2: This is a difficult problem; one that I wish I could give you the answer to. I don't like the idea of two classes; I imagine that not many students would self select to take the class as it is now and would opt for the second option and as the attendance rates declined for the current version of the class and increased for the other at some point this class would completely disappear. That leaves us with trying to improve this version of the class. You mention that attendance declined after the October exam, but I think people had made up their minds about this class and how they would approach it (mostly avoiding it) before the first class. This class has a bad reputation and I think most of the bioinformatics students have decided its not worth their time and the more people who feel that way the more others will feel justified in that decision. I think if you attempted to address the stigma around this class that could help. It is also important to increase class attendance. Most people think that because you say attendance isn't required that means its unnecessary to pass. Perhaps you could point out at the beginning of next semester's class that although attendance is not required that

not attending leads to few P's and many F's. For me, this setup of this class worked well and I think it has a lot of value. I attended every single class and found that they were very helpful in understanding the experiments from the articles (though this might be because I submitted questionnaires). Admittedly there is a decent amount of content in the notes and companions and if you attempt to answer every study question then it might seem to be too much. However, a part of this class is learning to ask your own questions so after the first few weeks of class I stopped trying to answer every study question and instead focused on the ones that I thought were important. This allowed me to be prepared for class without being completely overwhelmed.

Resp 3: I feel as though if I had gone to the in class experience of this course I would of been able to succeed better. I know this is my fault as I felt that my time during this time slot could be used for other activities, but looking back I wish I had gone to more in class sessions for exams.

Resp 5: I believe that having this course be self-selected would be more in-line with the course goals and structure. While this is a course that anyone can learn a lot from, I think too many people simply enroll because it is a prerequisite and don't put in the effort to continue with it because they personally are not interested. By having this course open to just the people who want to take it, perhaps coupled with encouragement from other professors in the department, this course could potentially be enhanced in many ways. For one, the class size would likely be smaller, but full of students who are willing to learn. Feedback might be swifter and perhaps more thorough due to the amount of time that can be addressed towards them. More directed attention and assistance can be given for the semester projects so that they don't turn out to be last minute projects. In general, a lot more time is opened up to help students that want to put in their own time to learn from the course. A separate required course may be interesting, but I think it would have to be structured more similarly to a typical course and not cover too much at once. A semester project might be impossible, but some of the core concepts of the course can still be delivered, such as the focus on results vs conclusions. This way, students who do not want to put in too much time into the course can still manage the work load and learn a lot, while those who are very interested could move into the self-selected group. These are just a few thoughts but I think it may be worth trying. It may forsake a few of the course objectives from this course, but it could solve the problem of the low pass rate while retaining many key course objectives.

Resp 6: I think that without a mandatory attendance rule, most students will choose to not attend class. I do, however, think that it might be valuable to have two streams within the class. One for students who tell you that they believe they will benefit from an in class experience and another for students who prefer to read the notes online. By having these two streams, there will be two different learning environments, both of which will aid different students. I think it will be difficult to regulate how often students do the

online homework, but I think that is part of the choice students will have to make when electing that stream. Overall, I think this would be extremely helpful as it caters to both types of learners.

Resp 7: I really liked the exercises in class that we did with companions the most. I found them the most useful as far as reading and understanding articles, especially when it allowed us to develop skills we could use on our semester projects. The experiment simulations were also helpful in the sense that they allowed us to apply the skills we learned and use them on problems that we would encounter when understanding experiments. It forced us to think about steps that we would take if we were conducting the experiments in real life, and that to me is a good practice for future experiments we may conduct. I am not sure about splitting the class into two separate courses.

Resp 8: This is tough because if this class is all about independent discovery it's hard to do that by making things mandatory. I think something that could be helpful is making this course into 2 parts. Maybe one part could be research articles, problem sets, notes, etc.... while the 2nd part could be the actual research proposal. This could allow for the most absorption of what this class has to offer. Time is really lacking when all of this information is crammed into one semester. Im not really sure how this low attendance could be improved as everyone has to make this decision for themselves. Maybe in class activities that would be sent to you or the TAs after class would increase the attendance? I do think making this class into 2 parts (over 2 semesters) would be something to look into and this may possibly help with the attendance issue.

Resp 9: While I was working on the semester project in class, I didn't have enough time to also spend my time on most of the in-class preparation. Since I was not working on the outside of class (non-semester project) material, I committed myself to an hour and half of class time to try and attempt to understand what we were learning. I'm not sure if this is possible, but somehow it might be helpful to split the class into two-- one half for the molecular biology material (i.e the experiments) and the other half for the semester project. That way, we have enough time in our schedules to work on both aspects of the class, and it's not too hard and allows students to come in and actually participate.

### **Results vs conclusions**

Resp 1: I would say it did. Though I may have struggled in the past and still do to some extent, I feel like the strategies we practiced were a great way to develop our ability to review literature. I often find myself using the same tactics in subjects outside of class when interacting with family and friends.

Resp 2: I think my ability to tell the difference between results and conclusions improved greatly throughout this class. Having to go through the experiment for the different articles we read made understand what was actually being seen and not just the interpretation of those results.

- Resp 3: I feel as though putting me into the unknown was necessary for the development of skills necessary for making scientific research, but the lack of help from the TA's and instructor was not helpful for my development because I felt that any time I would ask a question I was left more confused than I originally came with which I understand will happen in real life but for the process of developing skills this was not vital.
- Resp 5: I hardly come across a conclusion anymore without immediately thinking about the evidence that led to it.
- Resp 6: I think this definitely worked. Without completing those activities and the semester project I do not think I would have understood how to read a paper and differentiate between the results and the conclusions
- Resp 8: I think that one imperative thing that this class has taught me is that confusion is inevitable but confusion does not mean that I will be stuck there forever. This class has shown me tactics in which I can work through confusion when it does arise. The amazing thing is that these tactics are not only for science, they can be applied to anything in life! I found that I would use tactics learned in this class for all of my other classes. The exercises in class were very helpful. I also thought that the in-class discussion of the article for that week were helpful, especially when you took the time to draw out the experiment on the board with us. I don't know if that was something that could be helpful for others, but nevertheless it was helpful for me.
- Resp 9: I have started to slowly try and figure out HOW a conclusion came about -- what experiments and observations lead to it. It has shown up in other aspects of my life, such as my cell bio class (as I mentioned in part I).

### **The research project**

- Resp 1: I thought the research proposal was an incredible opportunity. As people who are in college trying to develop real professional skills, it's good to be have the same standard placed on us. It was a great insight into how scientific research is approached. I felt the panel discussion was great because I had a constant worry about what I was lacking in my proposal. To have them pointed out and presented to me was a privilege. My ability to present had gotten slightly better but I will admit that the anxious nature of the assignment hindered my ability to be at my optimal level. After reading so many articles and wishing they were presented in a more understandable way, I was able to learn how to present my proposal in a way that most people could understand. I often presented to my friends and family outside of bioinformatics to try and see if my proposal was understandable. I think the sustained effort is totally appropriate but it does have some cons. The progression was great but some students who couldn't figure out exactly what they wanted to do were able to fall behind easier. My issue personally was that, with each assignment, it delved further away from being the individual assignment itself (like the proposal description and outline) and it started to slowly mold into the full on proposal, leading me to submit things at an inappropriate time. In terms of



meeting with my mentor, I had come into this class hearing from previous students that one of the biggest reasons why people fail to succeed is their over reliance on their mentors. There were many instances where I was prepared to request a meeting with my mentor to receive help but out of fear of taking the easy route and wasting my mentor's time, I opted to try and figure everything out by myself. This obviously wasn't the most healthy option both in terms of me and my proposal and I do wish I allowed myself to be mentored and not see myself as the needy undergrad.

Resp 2: I think translating an article helped me to understand how an experiment can be used to answer a specific question or problem; it was also interesting to see how my mentor viewed and discussed on her own work. We always talk about how research needs to be put in context of the bigger picture, but to hear my mentor discuss her work made me really understand that. I think my presentation skills improved, but what improved the most was understanding my target audience. Since I did a translation, I had to think of the best way to explain the experiment so that it was understandable at all levels and not rely on any shared common knowledge. Also since there were many different experiments in the article I was translating, I had to think about which parts were the most important and could convey the contents of the paper well. I enjoyed making the website. I like being able to have a finished product after spending a semester working on a project. It's also nice to think that my website could help someone else understand the article I translated and increase awareness.

Resp 3: I think with doing the translation I was able to properly understand how articles are written and what information can be obtained from the aspects of how an article is written. From the panel discussion I learned that it is necessary to know each aspect of your project even when you are only presenting a part of the project and with the things in your presentation make sure you are sure with the information you are giving when answering questions. My ability to give presentations definitely did improve, but I do feel as though I froze up when presenting in front of the panel. Learning how to make a website was a worthwhile experience in my opinion, as I feel as though it is a skill that may come up in the future for me. I think I am better able to communicate with different audiences with this project. I think I tried to do my project along the timeline, but ended up doing a burst every time I needed to turn something in.

Resp 4: Proposals are a great way to be included in this class. This class should just be focused on that instead of doing the classroom activities. Maybe chop up the proposal and have due dates for small portions of it. In class lecture how to write, research, go over different experiments and then have deadlines for students every month on writing, research, and leading up to their proposal presentation at the end of the semester.

Resp 5: I definitely think that my ability to give a presentation improved the most out of all of these components of the project. Comparing how I did in the mock presentation and the panel presentation, the difference is clear. Rather than using full sentences and figures

without context, it is much clearer (and not to mention easier to present) if the presentation proceeds in short segments with animations and less text, producing a story as opposed to a word vomit. I liked the overall structure of the project and I thought the timeline was reasonable enough to follow. I think the biggest jump was going from experiment summaries to an outline, since there was very little regarding the actual development of a research question. Perhaps another checkpoint could be provided here with guidance on creating the question?

Resp 6: I think that translating the article was one of the toughest learning experiences I have had while being in university. When I first started the project, I did not understand what I was doing at all. I read the paper countless times to simply try and understand what was going on and to break it down in such a way that I could begin translating it. The process was long and tiring to get to my final project, however I thought it was an extremely valuable experience. The panel discussion was also extremely valuable as I have never done something like that before. I think that this experience and being able to further develop the skill of presenting research and answering questions on the spot will serve me well in the future. I definitely think that creating a website was worthwhile learning. It was actually one of my favourite parts about the project and is something I'm hoping to learn more about in the future. I currently have a business and have created a website through the use of "Go Daddy". After knowing the basics of creating a website, I hope to eventually convert it to a site that I have coded myself. I think that putting myself in the shoes of my target audience was one of the more difficult aspects of this project. Having to take such a complex paper and explain it in such a simple manner was something I struggled with a lot. However, I think I am now able to understand how to effectively communicate with my target audience. I met with my mentor multiple times throughout the semester (at the beginning and end) and believe I was working on my project for a long period of time.

Resp 7: I liked how the semester project was spread out over the course of the semester with the weekly deadlines and neat outline of those deadlines. It helped me manage my time and keep up to speed with the steps I needed to take to translate my article. I also enjoyed having a mentor to talk to about my article and I think it really did help me in understanding it better. Emphasizing that this is our own independent project allowed me to take responsibility for translating the article rather than going to my mentor for that purpose. I understood quickly how to use my mentor's advice to shape my own translation rather than letting him shape it for me. Having a mentor really gave me insight on the outside science world and he was able to teach me a lot not only about his article but about science in general. My mentor was also almost always readily available by email and phone, and these quick responses were highly appreciated. Translating this article really motivated me to become scientifically independent, and it allowed me to ask questions that I might not have wondered before this class as much. The panel discussion was a very new experience for me, as I have never had to present to panelists like that and never got the chance to answer

the types of questions they asked in previous classes. It forced me out of my comfort zone and I appreciate the push that it gave me to really think about the experiment's significance. My ability to give a presentation definitely improved from before. I was nervous beforehand, but I was also confident that I would take away some good skills and lessons from a presentation like those. Learning how to create a website was worth it for me, and I liked that all of the work we had completed would be organized in one area. It was easy to refer to my website to see what my progress was at any given point in time. I also think it was a good way to update the panelists on what we were trying to explain before our presentation. I now feel like I know the kinds of questions my target audience would want to ask, and what kind of background I need to provide for them to understand the biological processes related to the experiment.

Resp 8: As I said in my Exam III, before this semester project and meeting with my mentor, I didn't realize that I would hide behind large words because I did not actually know what I was talking about. Through this project, I was able to improve in many ways. I've always been afraid to talk to professors, but in looking for a mentor I pushed myself out of my comfort zone. I definitely think that my presentation skills (and presentation creation skills) improved tremendously. At the beginning of the semester, I often struggled with explaining topics to others in a way that made sense. I think that through this class I have been able to improve in this regard. One way I practiced doing this was by practicing my presentation with peers who are not studying anything related to science. I found that this really helped me to figure out what could cause confusion for someone who was listening to my presentation. Likewise, the panel discussion helped me extremely. I was terrified going into the panel and found that I had prepared for any questions they had. After the panel, I realized that the panelists were not there to hurt/scare me but to help me because presenting to my peers in a way that they will understand is something mandatory in the field of science. I think that I did not start off on solid ground for this proposal--it took me too long to start working on the project. I think this was due to my feeling of overwhelm at the start of the semester. This could have also been due to a feeling of loss as I didn't know where to even begin. Once I was able to get through this feeling and find Dr. Barton I was able to begin forming my proposal. After this happened, I believe my effort was sustained to the end of the semester.

Resp 9: I gained skills on how to work closely with my mentor, and I know I need to work on communicating more with him. (I have some social anxiety issues that I am slowly working to overcome, including being able to properly communicate.) Although the process was hard, I found it fun to learn new things, and each new idea I learned, I had 5 questions that spun off on it. Unfortunately, this put me in a position where I was overwhelmed with the scope of the information around me, and could not figure out a way to narrow down my search and come to one single molecular aspect that I wanted to look at. The panel was helpful as it helped me overcome pre-presentation anxiety and it forced me into a public speaking sphere. Although at first, I thought the time limit was a little short, I realized that

it was an opportunity to look at each individual aspect of my presentation, and debate if it was important or if I could do without it. After spending a full semester researching this topic, I explained all of the background information that I had learned in depth as I was not sure how much of it the panel would know and how much of it they wouldn't. I didn't know how to communicate with my mentor properly. He didn't like my proposal as it was different from what his idea of a proposal was; I'm not sure he understood the project. (I'm not sure if he read the instructions sent to him, and I didn't know how to tell him to do so.) Because of this, because I was overwhelmed, and because I may have expected him to reach out and ask me to meet, we only met twice. I did ask him many questions over email.

### **The exams**

- Resp 1: I felt the exams were definitely a great way to help us grow as molecular biologists. I understand that the problem sets prepare us completely for the exams and I believed it would lead to the exam not being too difficult, but I think what makes them so difficult is the fact that everyone is simply so terrified of the class and so concerned with doing the right thing that they over think and spend too much trying to do one simple thing. For example, the last question on the second exam was really quite simple but the fact that I feared I hadn't looked at the material properly lead me to not complete the problem in a timely and non-stressful manner. I'm sorry to hear about the cheating in the class, I would have very little input to give regarding the subject as I don't have experience in education and I don't personally associate with people in the class that much (even though I should've found a group to work with in class assignments and problem sets).
- Resp 2: I thought the exams were very close to the problem sets and other activities we did. I also appreciated having a week to do them instead of trying to fit it into a class period. Overall, I think they were worthwhile in showing me what I had gotten out of the class and what subjects I still did not understand well. As for the questionnaires, I imagine some people forgot or later decided it wasn't worth while. Overall I think we like to see the best in ourselves and believe we will do the right thing even if that is not the case. For the people collaborating on the test, I think that probably those people did not keep up with the problem sets and the other work and then found themselves very overwhelmed and did not want to ask you for help because they knew they had gotten themselves into this situation, so instead looked for help among themselves. They probably assumed that they would be punished for this collaboration if you became aware so they chose to lie.
- Resp 3: I feel as though that if the above information was given to me more clearly at the beginning of the course I would have attempted to come to class more often. But with that being said I felt as the exams were fair mostly with the questions, the main problem i had with the exams was the use of outdated software where I would have to do work arounds with my laptop that could mess with the software of my laptop. The exams were interesting with being relevant but the

questioning and method of what was expected for an answer was never clear and always not clear to me. With the honesty aspect I am guilty of this as I always believed that with any class confessing that I somewhat worked with someone, I expected that I'd get in trouble and fail that assignment but in hindsight I see that it's better to be up front than hide anything and be caught later.

Resp 4: A lot of people collaborated in this class esp for the Exams. I find it discouraging sometimes when other students exclude you from trying to meet up outside of class. Sometimes going to office hours or TA sessions dont work because of time conflicts. But with that being said, maybe the exams should be a team research project due at a certain deadline. Then the final exam being an independent research proposal.

Resp 5: I found the exams to be very interesting, with exam 2 in particular having the most interesting content. I would say they were difficult, but not to the point where I would have no idea how to approach a problem (which I guess matched my expectation for difficulty in this course). I think they were worthwhile and the 1 week time limit is reasonable (although the prolonged stress that comes along with it is very exhausting). As far as the honesty concern goes, I am not too sure what to think because I don't believe I personally made a false assertion. I met up with a classmate at one point during exam 3 but all we did was complain about not being able to discuss exam material. However, I think that people who made these assertions did so primarily because of the fear of potential consequences in stating otherwise. Assuming the collaboration has already occurred, self-reporting would result in a 100% chance of getting caught and having to deal with the perceived consequences, so lying becomes an appealing option with the potential of getting away. Given these conditions, I'm not too surprised, but it does raise an interesting question of how we could address this issue, since the most common ways to prevent collaboration (time limits, working in the same room under supervision, etc.) would actively work against the nature of these exams.

Resp 6: I think that the exams were a good learning experience. While they were definitely challenging I think I learned a lot from them. I think the most difficult aspect of the exams was being able to take what we have previously learnt in the class and apply it in a new way. There were many similarities between previous problems we had done, however, I still found some difficulty in applying that knowledge to the new questions.

Resp 8: I think the exams were worthwhile but still very time consuming. Because we never went over problem sets in class or we got feedback late on the problem sets, it made it hard to know if the tactic I used for the problem sets was correct or not. I think that was why it was so time consuming for me personally. They were definitely interesting but I wasn't able to enjoy it as much as I could have due to the amount of time given. Maybe, more time for the exam would be something valuable? For me, I would often have exams in other classes that I had to focus on as well so I would not have as much time as I would have liked dedicated to the bnfo exam. For the post-

exam questionnaires, maybe it just slipped people's minds? Not quite sure.

Resp 9: The exams were interesting, however, they were had to figure out on your own, especially if, like me, we prioritized our time on the semester project instead of the problem sets, notes, and companions. They were very stressful, and I pulled my first ever all-nighter finishing the last exam (and I didn't even finish one problem).

## **Help and feedback**

Resp 1: I felt I received adequate feedback on all fronts except the mock proposals. When I proposed one of my panelists wasn't present and the other had no questions for me. I overall did feel a bit like I was swinging in the dark at a certain point with my proposal because it was hard to get much critical feedback. That was mostly my fault though and my mentor did give me a lot of really great feedback.

Resp 2: I think I received adequate feedback. The mock presentation was especially helpful for preparing for the panel. It made me think about my target audience and how best to reach them.

Resp 3: I feel as though I had adequate opportunity for help, but I wish this class were on blackboard as this website is not organized well enough for me to easily navigate through the course as well as I would like to which impeded my knowledge discovery.

Resp 4: I didnt like the problem sets. It consumed way too much time. Maybe shorten the lengths of the problem sets.

Resp 5: I do think that feedback was a little lacking, but understandably so due to how thorough the feedback is for each student (particularly exam 2). However, it may be helpful to receive a very general and brief feedback first, followed by more thorough feedback later. This would help a lot so that we can get a general sense of how we did early on, instead of prolonged periods of dread and anxiety from not knowing how we did or when we will get feedback (for a long time I thought that perhaps I had submitted my exam 2 incorrectly and that perhaps it was never received).

Resp 6: I do think that there was plenty of feedback, however, I think the time frame in which we got the feedback could be improved slightly.

Resp 8: The feedback on the problem sets did not help me. Simply telling me to explain why I think something is true was not always helpful feedback. Help was always available to me but the feedback was not always helpful. The feedback on Exam II was so hopeful. I wish I was able to have feedback like that more often through this course. Also, going over problem sets in class after they've been submitted would be helpful as those questions would always pop up on the exams. Meetings with Jeff were always very helpful. I think that people should take advantage of these meetings, not just the ones that are scheduled during the exam periods.

Resp 9: I didn't get too much feedback from the problem sets, and what I did get I did not use. The meetings during the exams were helpful, as was the feedback I received for my semester project.

### **III. Bottom line**

#### **What advice would you give someone entering the class?**

- Resp 1: The thing that makes this class as difficult as it is, is people's perception of it. I often found that most of the people who don't believe they'll do good often don't and that's almost entirely because they lack confidence in themselves. Jeff is one the best teachers in this university and letting clouding yourself with doubt prevents him from being able to get you to a place that you're fully capable of.
- Resp 2: Do not be afraid; this class is not the monster it is made out to be. There are two ways to pass this class, one of which is through significant effort with some movement towards independence. Everyone is capable of significant effort and if you put in significant effort then you will make some progress which means everyone can pass this class. You need to give this class time; most topics will not come naturally so you need to allow yourself time to think about them and then rethink them and then rethink them again and again until you can start to see your way out of the confusion. Your classmates will be of great help in this process, so talk to one another.
- Resp 3: Go to class Do all assignments on time Don't wait til the last moment Start looking for your mentor immediately
- Resp 4: Go to class ask questions, get in contact with the research mentor before the semester starts, Chose your research mentor carefully.
- Resp 5: Actually attend class, but also actively listen and try to understand the material despite confusion. Clear answers in this class will rarely ever be given out like in other classes, since the purpose of the course is less about knowing the material, but more about gaining the independence to address confusion. Because of this, it is imperative to take the initiative to understand the material.
- Resp 6: Start early. Even if you think you're starting early, you could've started earlier.
- Resp 7: For someone entering the class, I would say that you need to be ready to read and you have to go beyond the words that are presented to you on your screen/paper. Think about why things are and how they came about, beyond what they are said to be. This class is very challenging and it forces you to reach goals that you might not have thought of in the past, which is good. Solely answering questions isn't enough, explanations are very important and useful for a viewer rather than the answer by itself. You need to explain your reasoning and support the answers you give. You need to find a mentor for your semester project, I suggest you start searching as soon as possible so you do not have a hard time finding one later in the semester, it takes time.
- Resp 8: This class WILL take up more time than any other class you have been in. Prepare by allocating that time before the school year begins. If you don't think you will have enough time, take the class another semester. In order to get the most out of this class, you

need time! Likewise, start looking for a mentor now and get to work figuring out what your proposal will be. My proposal subject changed often so giving yourself enough time to allow for this to happen would be helpful. Don't wait to the last minute to start working on things. Look over the calendar and plan your time accordingly...the earlier the better. Also, do not let the fear of others pertaining to this class scare you. If you put in the time and effort for this class you will see results.

Resp 9: Go to class for the material and make sure you work on the semester project. Make sure you ask questions when you have them. For the semester project, get started early and make sure you contact and meet with your mentor multiple times. Make sure you and your mentor are on the same page.

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

Resp 1: The class needs to be more coherent on the significance of all the assignments. In many ways the class acts like a recently discovered phenomena with everyone spending more time trying to figure out what they need to do to pass the class and less on trying to develop as scientists.

Resp 2: I don't think I have three things the class should never do again. I think the class would go more smoothly if people regularly attended class, completed questionnaires and worked through the companions before coming to class.

Resp 3: Use BioBike Use Protein Finder program Rely on outdated technology

Resp 4: Attendance should be mandatory, problem sets should be shorten.

Resp 5: 1. For the class-wide process of piecing together the amino acid sequence for insulin, while I understand the purpose was to set us up for failure to describe the importance of peer-review, few individuals actually participated in the peer-review process, greatly hindering progress. It was kind of frustrating. 2. The exhaustive bibliography, while interesting in theory, I don't think worked in practice. After building the set of resources, I found that the list became too overwhelming, and I rarely went back to actually read the resources I found. 3. Protein explorer was very time-consuming to get set up, especially with the differences in each student's computer. Perhaps there is an alternate program somewhere or maybe one class can be done in a computer lab with computers that have it already set up.

Resp 6: 1. Having optional deadlines. I think that having mandatory deadlines allows for students to learn in a more regulated manner. 2. I can't think of anything else that should never be done again.

Resp 8: 1) Only 1 week for exam 2)??? 3)???

Resp 9: Questionnaires with such intense and hard questions, and no help from other students. Talking through questions helps me a lot, and I know Jeff and the TAs are not always available.



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

Resp 1: The use of BioBike is a priceless activity and skill to develop in this class. As we learn more and more about molecular biology and BioBike, the program becomes more of a blessing.

Resp 2: 1) The what is a gene assignment. This was the first time I felt like I started to ask and answer my own questions. 2) Questionnaires; it was nice to see my suggestions for the class be implemented; however, they would probably be more helpful if more students completed them. 3) Problem sets; these were very helpful in preparing for the exams. They also helped me to know whether or not I understood the articles and topics we had been discussing in class.

Resp 3: Translations Mentors Exams

Resp 4: proposal but not transnational.

Resp 5: 1. The observations vs conclusions exercise on Mary had a little Lamb was very helpful in getting us to distinguish the two in a simple context. It was especially helpful in taking that experience and applying it to reading research articles later in the course. 2. The note sets and companions always had a lot of good information in them, often providing us with missing information that authors expected us to know beforehand. They were probably the most helpful resources for understanding an article. 3. The problem sets were helpful to confirm whether or not I actually understood material or not, and where I was still lacking information. I would definitely not get rid of these, but perhaps they could be shortened?

Resp 6: 1. Having the option to translate a paper or do a proposal. 2. Problem Sets 3. Mock panel and the panel

Resp 7: The companions, the mentorship for the semester project, and the website for translations.

Resp 8: 1) Mock Panels/Presentations 2) Problem Sets 3) In-Class Discussions of Articles/Notes

Resp 9: 1) the Research Project 2) feedback from TA's (especially the proposal/presentations) 3) flexible deadlines

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

Resp 1: Though there's already plenty feedback being given, the class could still use plenty more. The problem sets and exams, along with everything leading up to them, should be much more coherent on what is wanted as answers so that students can spend more time on developing their solution and less on what the question is even asking.

Resp 2: 1) I would adjust the timeline for the translation option for the semester project. I think it would be helpful to start working on building the actual website earlier to account for any problems that students might run into. 2) For the first test, you asked us to describe how we thought we should prepare for each class. Perhaps you could tell students how you prepare for each class as well. 3) Try to introduce more student led discussion; if a student

submitted a questionnaire you could have that student start the class by explaining their confusion.

Resp 3: Group Semester Project for proposal only not translation Use Blackboard More Mandatory Class sessions

Resp 5: 1. OK yeah, shorter questionnaires, especially after exams. The length of the one after exam 2 was discouraging to complete, but I felt comfortable completing the one after exam 3 despite staying up late. 2. Shorter problem sets. I'm not entirely sure how I feel about this idea, but I'll put it here anyways. For me, the most discouraging factor to not working on a problem set was not their difficulty, but their length. Very often I would look through a problem set, understand what I would write or how I would approach the problem, and then just not write it down because it would be very time consuming. I think part of this is due to my bad time management skills, but I do think that submission turnout would improve if these at least appeared more approachable. 3. Perhaps have a guide to using BioBike. There are a number of important functions or set of functions that we used frequently to address specific tasks, so having one accessible location for a description of these functions would be helpful, rather than having to look through past assignments to remember what was used for each task.

Resp 6: 1. I think it would be valuable to have answer keys to the problem set questions. 2. Having a group project or exam. 3. More extensive lessons on creating a website.

Resp 7: Maybe shorten some of the problem sets or extend the due dates by a couple dates, as some took an extensive amount of time on top of our semester projects.

Resp 8: 1) Class broken up into 2 parts (over 2 semester). 2) More Time for exams 3) In class discussions of Problem Sets after they are submitted

Resp 9: Give the students less work, we did not have enough time to finish all the work we had. (With the rest of my work-load, I prioritized sleeping 4-6 hours a night instead of doing the problem-sets, companions, and notes.

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

Resp 1: The course is a bit of an enigma and I'd say most people don't know what they're getting into until they're in it but I would say yes, this course has been the best educational endeavor I've ever been a part of. The proposal and development of practical skills have been a great privilege to be a part of. In five years (and likely forever) the mindset and the methods we've used to learn about everything we have will be a significant part of how I approach problems and solutions.

Resp 2: I think asking "how do you know" and "visualize the experiment" will be with me long into the future. Along those same lines, separating observations and conclusions was one of the main things I took from this class. I know feel like when given a research article I can start with the experiment and the results, instead of relying on the conclusion section to tell me what the results mean. I also

feel more proficient in determining which specific questions will help me to answer my overall question that relates to the bigger picture.

Resp 3: I feel as though I got what I wanted from this course from getting a basic understanding of molecular biology based off of the fact that I can read research articles and understand more about the article rather than blindly reading the article not knowing anything as I did in the beginning of the course. I feel more proficient in my writing ability and my ability to gain information from assertions. I think I will keep the lessons on making sure any assertion has backed up information pertaining to it in the next five years.

Resp 4: I understand how to find/read research articles better now

Resp 5: I think this has been one of the most learning I've done as a student at VCU so far, not just with knowledge, but with understanding how to think. I feel more proficient in finding research articles, and also interpreting these articles despite the initial confusion. In the future, I don't think I will be able to stop asking myself for the observations behind an assertion, and the importance of focusing on these results rather than conclusions will stay with me as a result.

Resp 6: I think I got a lot more out of this course than what I wanted. I didn't really know what to expect coming into it, but I definitely learned a lot more than I thought I would. I have never thought of myself as an independent learner and after this class I definitely think I am. This is what I think will still be with me in five years. I will also take away my increased curiosity to learn and my ability to explore aspects of what I am learning even when I have not been asked to do so.

Resp 7: I did get what I wanted to out of this course. I feel as if I gained a lot of independence as a scientist by taking on research articles much stronger and critically than I used to. I also gained a good connection with my mentor as he provided me with a lot of scientific insight for the research world, something this class also helped me with. I think I know how to approach experiments better and use the resources in the article itself to understand the motives/methods of the experiment, along with other resources. I think my instinct to ask "why" and "how" will be with me forever, and the instinct of just believing what people are telling you diminished.

Resp 8: Honestly, at the beginning of this semester, I did not know what to expect from this course. Now that I am at the backside of this class, I think the major thing that I have learned is the fact that knowledge is something I have to want for myself because truly understanding something does not simply come from someone telling you what THEY think. This class has helped me to realize that I have been spoon-fed information my entire college career, but no longer! Another thing that this class has taught me is patience. Patience with myself. I have learned to welcome in confusion because I know that that is just step in furthering my understanding.

Resp 9: In five years, I will probably still be asking the question 'how' and 'why' to almost all information I come across. ("How did this happen / Why did this happen?").