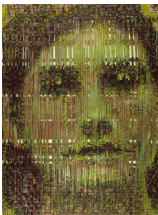


The Portfolio Project:

Helping students take more responsibility for their learning



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HHMI Education Group talk
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Koch Institute, 76-659

Abstract

A scientist and artist for her entire professional life, Professor Helen Donis-Keller is currently Professor of Biology and Art at the Franklin W. Olin College of Engineering in Needham, Massachusetts. For the past ten years she has taught the introductory biology course, SCI1210 Principles of Modern Biology, required of all undergraduates. Three years ago she implemented a portfolio project for SCI1210 in which students correct a subset of their assignments including quizzes, and write reflections on their learning with respect to a set of measurable outcomes and competencies. Dr. Donis-Keller will discuss the design of the portfolio, the rubric for assessing portfolios, illustrate responses with student work and comment on lessons learned using this educational tool. Dr. Donis-Keller received a Ph.D. in Biochemistry and Molecular Biology from Harvard University and an M.F.A. in Studio Art from the School of the Museum of Fine Arts and Tufts University. Additional information can be found at HelenDonis-Keller.com.

Handout on the Portfolio Project

Description and rubric excerpted from the Fall 2011 Semester of SCI1210-02 Principles of Modern Biology Syllabus

SCI1210-02 Principles of Modern Biology, The Portfolio Project

Portfolios in art and design are showcases of work whose main purpose is to help the artist or designer secure work or exhibitions. For us, the Portfolio in Modern Biology will serve a different purpose than an artist's/designer's portfolio. Your biology portfolio will provide a way for you to actively take responsibility for your learning and shape a collection of entries that demonstrates mastery of the course measurable outcomes. It will also provide a framework for reflection on problems encountered, a way to demonstrate improvement in learning, and a means for self-assessment. Some of the entries in your portfolio will be required (e.g. quiz results) but you will have the freedom to select other coursework and to develop one or more new projects of your choosing to include as entries. The portfolio will be a record of your personal experience in modern biology that represents your specific interests, accomplishments, progress and nuanced thinking about your educational path. In addition, the process of developing the portfolio should provide multiple opportunities to understand how to build life-long learning skills that can be applied to subjects other than biology.

The Portfolio project is being offered this year instead of a final exam in the course and it will carry the same weight as the final exam, i.e. 20% of the final grade. This should allow you to work over the course of an entire semester to further your knowledge, provide individual choices of topics to explore, and to improve your ability to think like a scientist without the time pressure of studying for and taking a final exam.

This is the third time a Portfolio Project has been offered in SCI 1210, so students in the course can provide valuable feedback and guidance for further development of the project for future classes. Throughout the course of the semester we will work together to monitor progress on this project and make modifications as needed so that the overall objectives are met given the constraints of time.

What must be included in your SCI1210 Portfolio?

A total of 7 entries are required (8 if you elect to do the Teaching/Learning Module).

You must include the following:

1. All four quizzes from the semester are to be included but portfolio entries must be done for only three (you choose which three to correct along with a self-assessment and reflection for each of the three)

Each entry for a quiz should include a copy of the graded quiz, a corrected version of the quiz on separate sheets of paper clearly marked as quiz corrections, and a self-assessment and reflection. In your self-assessment and reflection you should describe why you had difficulty with any of the questions and what you learned by correcting your work. What concepts did you struggle with and what seemed easy to understand? How well did the quiz assess your knowledge of the

topics and how did studying and taking the quiz further your achievement of the relevant measurable outcomes? Be as specific as possible. What lessons from the quiz experience can be applied to your future learning? It would be a good idea to choose quizzes that required substantial corrections and reflection, not ones where there might be just minor issues (unless all of your quizzes are of this type).

2. One In-Class problem "team" set, one Homework assignment, one "class opener" or the "Science in the News" discussion that you led.

The entry for an In-Class problem set should include a copy of the team answer sheet, a set of corrections on separate sheets of paper and a self-assessment and reflection. In your self-assessment and reflection you should comment on what questions were difficult or easy for you and the team to find answers, how the team process of addressing the questions was helpful or hindered your learning of the topics covered by the questions and how the questions and process of answering them contributed to achieving the relevant measurable outcomes. The "Science in the News" entry should include the news article, a list of additional sources and source material that you used to bolster the article, discussion questions and a reflection on the topic and the class discussion. The homework assignment or "Class Opener" questions should include a copy of the questions, your answers, corrections and a self assessment and reflection as described above.

3. An additional entry of your choice.

Be creative. This entry is entirely up to you but it should include a self-assessment and reflection and a reference to the relevant measurable outcomes for the course. For example, you could include a deeper investigation into a topic that was lightly covered in class, in the laboratory section, or in the text. Also, you could include an article in the newspaper or on the web that is related to biology and your response to the content. You could develop an iPad, iPhone or other smart phone application that is relevant to biology. You could also consider including your thoughts on some of the ethical issues in biology that were raised in class or that occurred to you from something you heard on the radio, saw on the internet, came as a result of a conversation with your peers.

Alternatively your additional entry could be an assessment and reflection on an invited speaker's topic, presentation and her/his engagement with the class.

Your assessment and reflection should include answers to the following questions: What did you find most interesting or surprising about the presentation, what was it about the way the invited speaker engaged with the class that furthered your learning, how did the readings distributed prior to the class help prepare you for the visit by the invited speaker and how did the content and participation in the class help you achieve the measurable outcomes for the course?

4. Your Teaching/Learning Module (Optional)

This entry should consist of a set of print outs of your project, i.e., your PowerPoint (or other presentation format) slides, student activity, notes for the teacher, notes for the students, assessment of student learning, and your reflection and self-assessment on the project. The reflection should include how you researched the topic and what problems or triumphs you had during the research phase, what you learned from the process of developing and presenting the module, and how this project contributed to the achieving the relevant measurable outcomes.

5. Your PTC laboratory report

This entry should include a copy of your graded draft report with comments from the instructor, a copy of your final report and a self-assessment and reflection on the assignment. Your self-assessment and reflection should include an analysis of how the lab experience in general helped or did not help your learning in biology. Your self-assessment and reflection should also include comments on how the instructor comments on the draft helped your learning in developing the final version of the report, what was difficult for you on this assignment, what came easily and how working on this assignment contributed to your learning and achievement of the relevant measurable outcomes.

6. A final course assessment and reflection.

A. This assessment and reflection should include a short response on the eight measurable outcomes for the course (a few sentences for each) indicating the degree to which you achieved the outcomes, how you did so, and what parts of the course enabled accomplishment of the outcomes. Your final course assessment and reflection should also include suggestions that you may have for improvements in the course relating to the specific outcomes.

B. This assessment and reflection should also include a short response (a few sentences for each) on each of the five competencies addressed in the course, and which aspects of the course were particularly helpful in developing the competencies. Use specific assignments or class experiences as examples and be as specific as possible.

C. The last section should include any additional comments you may have on your own learning in the course.

How long should my self-assessments and reflections be?

Quality of the self-assessment and reflection is the issue not the length of the written response. Normally a single spaced page or somewhat less on this part of the response to the assignment will be sufficient. You should strive to make the response insightful and it should serve to further guide your learning in this course. There are several (anonymous) example self-assessments from previous SCI1210

portfolios that will be posted on the course website so that you can see what is expected for quality of self-assessment and reflections.

How do I organize my Portfolio and my thinking on this project?

1. You should purchase a 3-ring binder and a set of dividers to hold and separate the categories of your portfolio entries.
2. Include a printout of the course measurable outcomes and competencies at the front of your portfolio for reference purposes (a copy of the measurable outcomes and competencies that were stated in the syllabus is given elsewhere in this document - see above).
3. Work steadily on your portfolio entries so that compiling it adds to your learning. Cramming all the self-assessments and reflections in at the end of the semester will not be much fun and it won't serve the intended purpose.
4. Choose In-Class problem sets, homework assignments, or the Science in the News project primarily where you think that you really learned something, e.g. for problem sets or homework, either in the first attempt to work the problems or in reviewing and correcting your work.
5. For the additional entry of your choice, think of something that peaked your interest either in class or from your out of class experiences that caused you to think about biology and/or ethics related to biology.

What should be included in my draft portfolio and when is it due?

1. Your 3-ring binder notebook with the dividers and the Measurable Outcomes and competencies printout at the front.
2. One quiz (graded) with corrections, self-assessment and reflections
3. Either one In-Class graded assignment, one graded homework assignment, or the "Science in the News Project" with self-assessment and reflection,
4. **The Draft Portfolio is due on Wednesday, November 2nd, by 5 PM.** You must bring your notebook to my office in Milas Hall room 366. Alternatively, you can turn in your draft Portfolio at the beginning of Lab class on Wednesday November 2nd. *Failure to turn in your draft portfolio by the due date will result in a grade of F for the draft portfolio. Exceptions to this due date must be negotiated with the professor prior to the due date.*

How will the portfolio be assessed?

The following rubric will be applied to your portfolio. The rubric will be applied to the draft portfolio and will serve as a guide to the assessment of the completed portfolio.

Also: Please know that I would be very happy to review any of your portfolio entries with you prior to writing up the final version. If you have any questions about this part of the course please let me know and we can work on them together.

Rubric

Grade	Description
A	Entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment. Evidence for growth of learning by analysis of shortcomings and identification of areas of accomplishment. Thoughtful and personal response to the material being covered and level of learning achieved. Evidence of significant progress with regard to the measurable outcomes for the class are clearly presented and further reflections on achievement is included. Entries demonstrate a high level of professionalism in writing and neatness.
B	Entries represent a basic level of understanding of the content of the assignments. Basic requirements of the assignment are met. Evidence of achievement of the measurable outcomes is clearly presented. Entries are acceptably neat and professional in writing style. Submissions contain responses to material being covered and level of learning achieved. Non-specified entries are relevant to SCI1210.
C	Entries may appear to be hastily put together and fail to meet the basic requirements of the Portfolio. Reflections are vague, too general or missing for one or more of the required entries. Measureable outcomes are not addressed adequately. Little self-awareness is demonstrated in evaluating learning or assessing strengths and weaknesses in responses to assignments Portfolio entries are not well organized and sloppy.
D or F	Extremely low quality of work for the entries. Little attention to guidelines and low level of effort overall. No perceptible self-awareness of learning deficiencies or progress in the course measurable outcomes.

When is the final version of the Portfolio due?

The finished, final version of your portfolio is due no later than Monday, December 19th at 5:00PM. The Portfolio should be turned in to my office in Milas Hall, room 366. You can pick up your graded Portfolio at the beginning of the spring semester, 2012.

SCI1210 Eight Measurable Outcomes:

Measurable outcomes are specific statements that indicate what students should be able to do by the end of the course. To be successful in this course, i.e. to be able to pass with a grade of C or better, students should demonstrate accomplishment of the outcomes listed below.

1. Students have an understanding and ability to communicate effectively, by written and oral means, knowledge of the major principles of modern biology.
2. Students are able to demonstrate their understanding of the major principles of modern biology by applying their knowledge to solving quiz and homework problems, including some that require interpretation of primary data from experiments.
3. Students are able to produce a coherent laboratory notebook and demonstrate an ability to understand the design and be able to conduct and evaluate the results of a set of experiments.
4. Students are able to summarize and explain the results of their laboratory experiments in writing that demonstrates critical thinking and that is clear, professional, and that employs good language mechanics.
5. Students have an appreciation of biology as an observational and experimental science and an understanding of the meaning and importance of the scientific method.
6. Students develop adequate scientific literacy to interpret biological findings reported by the press and are able to research these and other relevant biological issues using primary and secondary scientific literature source material.
7. Students have an understanding and appreciation of the social and ethical implications of the use of scientific findings in the world at large.
8. Students have developed an accurate and insightful self-appraisal of themselves as learners.

SCI1210 Competencies Developed and Assessed:

1. Communication
2. Diagnosis
3. Context
4. Qualitative reasoning
5. Life-long learning

Examples of Graded Portfolios with Student Entries

Student A Final Portfolio

Rubric with grade
Additional entry on film "Contagion"
Self-Assessment and Reflection on Quiz 4
Copy of some sections referred to from Student A's Quiz 4 Reflection
Final Self-Assessment and Reflection

Student B Draft Portfolio and Final Portfolio

Rubric with grade for Draft Portfolio
Self-Assessment and Reflection on Quiz 1
Rubric with grade for Final Portfolio
Final Self-Assessment and Reflection

Student C Final Portfolio

Rubric with grade for Final Portfolio
Self-Assessment and Reflection on Quiz 1
Copy of student's hemoglobin answers to Quiz 1
Final Self-Assessment and Reflection

STUDENT A EXAMPLE
Portfolio Rubric
Portfolio Final Assessment
 SCI 1210-02 Fall, 2011

Grade	Description
A	<p>Entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment. Evidence for growth of learning by analysis of shortcomings and identification of areas of accomplishment. Thoughtful and personal response to the material being covered and level of learning achieved. Evidence of significant progress with regard to the measurable outcomes for the class are clearly presented and further reflections on achievement is included. Entries demonstrate a high level of professionalism in writing and neatness.</p>
B	<p>Entries represent a basic level of understanding of the content of the assignments. Basic requirements of the assignment are met. Evidence of achievement of the measurable outcomes is clearly presented. Entries are acceptably neat and professional in writing style. Submissions contain responses to material being covered and level of learning achieved. Non-specified entries are relevant to SCI1210.</p>
C	<p>Entries may appear to be hastily put together and fail to meet the basic requirements of the Portfolio. Reflections are vague, too general or missing for one or more of the required entries. Measureable outcomes are not addressed adequately. Little self-awareness is demonstrated in evaluating learning or assessing strengths and weaknesses in responses to assignments Portfolio entries are not well organized and sloppy.</p>
D or F	<p>Extremely low quality of work for the entries. Little attention to guidelines and low level of effort overall. No perceptible self-awareness of learning deficiencies or progress in the course measurable outcomes.</p>

STUDENT A Grade and Comments from HDK: Grade A

It's very interesting that you tried several different study strategies, particularly the collaborative method for quiz #4. I agree with you that these new methods were probably more efficient and I'm glad to know that they have contributed to your life-long learning. The overall presentation is

very professional and the entries are detailed and complete as hoped. Your additional write up on the film "Contagion" was insightful and detailed, which made it a pleasure to read. As the grade A the description states - your "entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment" (etc. see above).

You have improved upon your draft portfolio by being more comprehensive with respect to the measurable outcomes and competencies. Your final reflection demonstrates maturity in assessing yourself as a learner and I'm so pleased to learn that you have a renewed interest in biology. Having taken biology as a freshman in high school and now returning to it as a more mature person especially with regard to thinking about the applications of science to society and the ethical implications of a range of products and services. You have achieved all the outcomes I had hoped for in this course.

Portfolio Entry --- Contagion

For the additional entry to my portfolio, I chose to watch *Contagion*, a film exploring the consequences of a highly contagious and lethal virus that has spread across the globe. While the intended audience is not scientific, the film covers rudimentary aspects of immunology and epidemiology, as well as a thorough investigation of the ethics of distributing treatment in a panic-stricken world. Compared to many movies that use a “scientific crisis” to drive the plot, I found *Contagion* to be refreshingly accurate and realistic (though, of course, this is a relative term).

I found it interesting to encounter terms that I had just studied for be used so liberally in a Hollywood film. While most of the scientific content devolved into long strings of jargon that explained little beyond the fundamentals of the subject, at least the terms were accurate and applicable. For example, one segment of the film dealt with the worldwide search for a vaccine. In it, they discussed attenuated viruses and potential harm associated with using them for a vaccine. Similarly, the dialog gave a brief overview how viruses interact with cell membrane proteins and begin the lytic phase. As a result of these inclusions, I found the plot line believable and well executed.

Contagion also introduced concepts from epidemiology that were foreign to me, such as the R_0 number that is descriptive of how many people one sick person will typically infect. This gives a good characterization of how “infectious” a disease is (from what I recall, typical influenza has an R_0 of 1, while small pox had an R_0 of 2). As they explain in the movie, this is largely determined by the mode of transmission. Since the disease depicted in *Contagion* could be transmitted through fomites, it had a very high R_0 value and thus quickly spread across the globe (though no doubt the age of international travel would aid any infectious disease).

The most important aspects of the film to my knowledge of modern biology were, however, its implied discussion of bioethics. Central to the latter half of the movie was the question of vaccine distribution: if a vaccine was developed, who would be the first to receive it? Should drug companies be allowed to profit from it? How should government agencies deal with false claims of cures? Again and again, characters were deeply afraid that a cure already existed and that they were denied even awareness of it (e.g. the kidnapping of the WHO doctor by a desperate Chinese village). The solution presented in the movie, a lottery based on birthdays, seems fair and equitable, but I doubt its practical efficacy. Those with power and the resources it entails will almost always find the means to receive earlier treatment. The idea that millions will sit contentedly while others receive the vaccine seems wildly naive. I would expect the masses to resist and incite more fear and conflict than was shown in the movie. Jude Law’s character exploited this wide-spread fear for personal profit, and yet, millions trusted his online endorsement of homeopathic forsythia. His character represented the all-too-human tendency to misplace our trust amidst a collapsing society.

Overall, I enjoyed the movie, and I think it contributed to my *appreciation of the social and ethical implications of the use of scientific findings in the world at large* (Measurable Outcome 7), in addition to my *understanding of the meaning and importance of the scientific method* (Measurable Outcome 5). I also find that it assessed my competency to place biological concepts within appropriate *contexts* in the non-scientific world (Competency 3).

Portfolio Entry --- Quiz #4

Similarly to Quiz #3, I tried a new strategy for studying. Before, I had largely relied on my own individual notes and a few brief group study sessions. However, on this quiz, a group of us decided to try a much more collaborative approach, where each would study a particular chapter or section in detail and then present it to the rest of the group. In this way, I think we had a much deeper understanding of a few sections and covered all of the topics in a more efficient way. I do not know how well the group performed, but I think that this studying method worked very well for me and I wish that I had used it in earlier quizzes, as it both cut down on the total time spent and increased my knowledge. This, along with Quiz #3, gave me a few opportunities to improve areas of my studying habits that have needed attention for a long time (Competency #5).

My mistakes in this quiz were, for the most part, very similar to those I encountered in Quiz #3. There were several instances of incorrectly linking a name with a definition, as well as a few where I devoted too little time on the question. In future classes, I need to slow down and keep an even pace as I progress through exams. Hopefully that will reduce the number of mistakes that I make when I brusquely push through portions of the quiz.

In questions 2-B-3, 2-EC, and 5-B-1 I repeated the mistake of linking an incorrect name for the right concept. With regards to 2-B-3, I could distinctly recall the diagram from the book that depicted enhancer DNA regions and how they function. I was able to copy the same diagram into the test, but I absolutely could not recall what the name of the phenomenon was. Instead, I picked a name that seemed apt to me ("activator region"), hoping that it would be close enough to be comprehensible. (In fact, I repeated this exact mistake twice throughout the quiz.) Similarly in the extra credit question, I wrote down what I could remember of the dog genome presentation, which included the three correct mutations and their mechanisms, but blanked when I attempted to name the respective genes. I wish that I had reflected on Quiz #3 before taking Quiz #4 so that I could see this pattern emerging and try to stave it off by modifying my studying habits.

My response to 1-C is a classic example of not taking the necessary time to fully read and understand a question. I looked through the list of options and saw that many were correct, though (4) seemed suspicious. However, my stress to finish the quiz on time urged me to press on, and I simply circled "all of the above." Had I bothered to read the question in full, I would have seen that I could have circled more than one answer and avoided the incorrect option (4).

Question 3 revealed my lack of knowledge on the lac operon. I was fully aware that this would be emphasized on the quiz, but I did not allocate enough time to studying it. As a result, I missed details on the role of CRP and completely misunderstood the distinction between positive and negative regulation. These should have been easy points since they were effectively guaranteed to be on the quiz.

I am satisfied with how this quiz went overall. The experimental procedure section and the long essay question in particular were important assessments of not just my rote knowledge, but also my ability to synthesize and analyze a fully detailed and realistic problem in biology (Measurable Outcomes 5 and 4, and Competencies 1, 2, and 4). As in the previous quizzes, this reflection improved my *self-appraisal*, *effective communication skills*, and my *understanding of major principles of modern biology* (Measurable Outcomes 8, 1, and 2, respectively).

Portfolio Entry --- Final Reflection

A. Eight Measurable Outcomes

1) Students have an understanding and ability to communicate effectively, by written and oral means, knowledge of the major principles of modern biology.

I believe that I increased my ability to communicate my knowledge of modern biology through a number of assignments. The technical reports that I wrote for the laboratory section of the class were the most direct means of increasing my written communication skills, since they gave me a sense for the appropriate vocabulary and style to use in formally describing biological findings. Similarly, the science in the news presentation gave me a great opportunity to improve my oral communication skills. I've had little experience prior to this class in presenting and guiding discussion of a significant subject to an audience of my peers. I think having more of such presentations would be a beneficial addition to future classes.

2) Students are able to demonstrate their understanding of the major principles of modern biology by applying their knowledge to solving quiz and homework problems, including some that require interpretation of primary data from experiments.

I found that the quizzes were very helpful in solidifying my knowledge of the major principles discussed in class. They gave me the motivation I needed to ensure that I knew each portion to the appropriate level of detail. Practice problems, especially those in genetics and inheritance, were critical to approaching the content of the quizzes and giving me adequate practical knowledge of the real-life problems faced in biology. I really appreciated the many discussions that we had about historical experiments. I found the subject presented in this manner to be much more engaging and highlighted their importance to our modern understanding.

3) Students are able to produce a coherent laboratory notebook and demonstrate an ability to understand the design and be able to conduct and evaluate the results of a set of experiments.

I found that keeping up a coherent laboratory notebook was surprisingly difficult. After the first assessment of my notebook, I think that I significantly improved my methods and wrote down more important aspects. (Before, I had devoted a lot of time to unnecessarily copying segments of the procedure that was available online). The formal technical reports, though, were the most helpful in learning to evaluate the results of my experiments.

4) Students are able to summarize and explain the results of their laboratory experiments in writing that demonstrates critical thinking and that is clear, professional, and that employs good language mechanics.

Our lab instructor's consistently detailed edits of our technical reports improved my critical thinking as well as my language mechanics while writing about biological experimentation. The combination of the PTC draft and final reports was the most critical aspect in meeting my expectations for improvement in explaining laboratory results.

5) Students have an appreciation of biology as an observational and experimental science and an understanding of the meaning and importance of the scientific method.

Throughout the course, in both the class discussion and the quizzes, there was an ever-present focus on historical experiments. This emphasized to me biology's observational and experimental nature. Being able to understand the great experiments (like Meselson and Stahl) after a single semester was very motivating! Having to be able to explain how they derived their results also underscored the meaning of the scientific method.

6) Students develop adequate scientific literacy to interpret biological findings reported by the press and are able to research these and other relevant biological issues using primary and secondary scientific literature source material.

The GFP, protein analysis, and PTC laboratory reports gave me an opportunity to go beyond what was presented in class and pull knowledge from the very broad body of biological literature. In each case, I read and incorporated details from several professional papers published on similar topics.

Also critical to this outcome was the "Science in the News" discussions that we held throughout the semester. As we accumulated more and more articles from these weekly discussions, I felt that I was better able to parse and temper press news stories about scientific findings. Comparing these secondary sources to the primary sources in the discussion that I lead was also a highly beneficial exercise.

7) Students have an understanding and appreciation of the social and ethical implications of the use of scientific findings in the world at large.

The thread of bioethics ran throughout the course and was especially prevalent in the discussions ran by Dr. Seeley. I found that this discussion (and those like it in *Contagion* and in "Science in the News") was instantly approachable to anyone with a rudimentary understanding of biology. I came away with the impression that the tools of science are growing more powerful year after year and that this only increases our need to have intelligent discussions about the ethics of their application. One of the most important issues that we face is the ability to alter ourselves both physically and mentally (though this Cartesian is less and less applicable) through neuroactive drugs.

8) Students have developed an accurate and insightful self-appraisal of themselves as learners.

This portfolio is the most direct method through which I improved in this outcome, since it gave me the opportunity to reflect on which studying and learning strategies worked best for me. This was especially

evident when I compared my reflections on quizzes 1, 2 and 3. My studying strategy definitely improved over time, as I spread out my work, avoided late-night cram sessions, and effectively used study groups.

B. Competencies Developed and Assessed

1) Communication

The most important assignments that improved my communication skills were the “Science in the News” discussions (oral), the PTC laboratory reports (written), and the experiment essays in each of the quizzes (written, in a test taking environment). I think after completing this course that I have a better scientific writing style and a much improved biological vocabulary.

2) Diagnosis

Again, the experimental questions posed in the quizzes were critical to developing the analytical skills required to diagnose and “debug” biological problems (the most apt example that I can think of is the quiz question in which we were asked to determine what went wrong in a DNAze reaction, Quiz #1, question 6 A). I really enjoyed the experience of working through such open-ended problems that were not just recanting memorized principles. It forced me to engage in critical thinking, while still cementing my knowledge of the rudimentary facts.

3) Context

The lectures on cancer and neuroethics made by external lecturers were very helpful in establishing a context for what we were learning in biology. Being able to see the real-world outlet to the concepts we were learning in class was fascinating and helped shape how I interpreted my knowledge. This was also manifested in my additional portfolio entry, where I saw some of the immunological concepts that we learned placed in a non-scientific context.

4) Qualitative reasoning

The practice problems and experimental questions that we went through in and out of class were very helpful in improving my qualitative reasoning. I had know the subject well enough that I could reason about it, at which point it became a critical thinking problem. One such example was the question of identifying what mutations disabled specific enzymes in the metabolic pathways of auxotrophic bacteria.

5) Life-long learning

Many aspects of this course are applicable outside of biology. The presentation and writing skills that I learned through the laboratory reports and in-class discussions are helpful in nearly every academic subject as well as in non-academic contexts. Furthermore, I think that the study habits that I picked up in this class (see reflections on quizzes 3 and 4) are going to be very beneficial in the rest of my

academic career.

C. Additional Comments

I really enjoyed this class! It has significantly kindled my interest in the subject (which had been lacking since freshmen biology in high school). The use of historical experiments and the outside lecturers were my favorite aspects and, in my opinion, contributed the most to my learning.

STUDENT B EXAMPLE
Portfolio Rubric
Portfolio Draft Assessment
 SCI 1210-02 Fall, 2011

Grade	Description
A	<p>Entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment. Evidence for growth of learning by analysis of shortcomings and identification of areas of accomplishment. Thoughtful and personal response to the material being covered and level of learning achieved. Evidence of significant progress with regard to the measurable outcomes for the class are clearly presented and further reflections on achievement is included. Entries demonstrate a high level of professionalism in writing and neatness.</p>
B	<p>Entries represent a basic level of understanding of the content of the assignments. Basic requirements of the assignment are met. Evidence of achievement of the measurable outcomes is clearly presented. Entries are acceptably neat and professional in writing style. Submissions contain responses to material being covered and level of learning achieved. Non-specified entries are relevant to SCI1210.</p>
C	<p>Entries may appear to be hastily put together and fail to meet the basic requirements of the Portfolio. Reflections are vague, too general or missing for one or more of the required entries. Measureable outcomes are not addressed adequately. Little self-awareness is demonstrated in evaluating learning or assessing strengths and weaknesses in responses to assignments Portfolio entries are not well organized and sloppy.</p>
D or F	<p>Extremely low quality of work for the entries. Little attention to guidelines and low level of effort overall. No perceptible self-awareness of learning deficiencies or progress in the course measurable outcomes.</p>

Student B Grade = B

Your Science in the News reflection was very complete in terms of your preparation, the content itself and your additional reading. You did an

excellent job with your presentation and it was clear that you had gone beyond the class reading to pull in additional information. However, your reflection would have been more complete had you commented on the response of the students to your choice of article and what the discussion was focused upon – just one or two examples would have sufficed. Also you need to comment on what Measurable Outcomes were addressed in the assignment (e.g. #1 understanding and ability to communicate effectively, etc. #5 appreciation of biology as an observational and and experimental science, and especially #6 develop adequate scientific literacy to interpret biological findings reported by the press etc.) and which of the competencies were addressed (e.g. Communication, Life-Long learning). Had you looked at the examples from previous years that were posted on the course website a little more carefully and as noted in the rubric for the portfolio that would have been obvious to you as necessary components.

For your reflection on Quiz #1 you did a solid job on analyzing the deficiencies in your answers and in determining which types of study strategies need strengthening. However, you also need to address the measurable outcomes and competencies more thoroughly. In this reflection the only measurable outcome you addressed was #1 and you just mentioned it in passing. You might consider how certain questions included in the quiz addressed your understanding on the topics, how some of the practice problems that were identical or nearly identical to the questions on the quiz assessed learning on the chapter topics, why some basic knowledge questions were included in the first quiz etc. as a way to understand what was being assessed with this quiz and how it relates to the measurable outcomes. With respect to your reflection on Quiz #1 you have provided the essential detail on what you missed, how your preparation was inadequate in some respects and that you have learned from making the corrections to the question missed. I understand that you think that you did not memorize enough facts but you have not indicated why it is important to have some knowledge in your mind in order to solve problems and recall basic facts as answers to questions posed on these quizzes. I made it pretty clear that the practice problems distributed were questions asked on previous quizzes but you apparently did not notice what types of information and level of synthesis was contained in the practice problems. Even open book exams and completely problem-based assessments assume a level of knowledge beyond glancing through the text and notes. Working all the practice problems and perhaps timing yourself might have revealed the solidity of your learning in preparation for the quiz. I also indicated that students could use the entire class time for the quiz – and that should have indicated to you that this would not be a superficial, quick exercise.

Re professional presentation: Your portfolio would look more professional if you typed a cover sheet with the course name/number and your name rather than a handwritten note and if the notebook cover was clean. The tabs that you use also look unprofessional (e.g. the torn off one for quiz 1 could have been done better).

I can see that you care about your learning in this course and that your grade improved for quiz #2 but my guess is that you would like to do better than a B-. I would be happy to review your final portfolio or any of the entries before you add them to your portfolio so that you could make adjustments before I grade them. Also, I'd be happy to work with you on your special project to go over your reading and presentation materials before they are submitted for a grade and before you make the class presentation.

Student B Quiz 1 Reflection

Quiz 1 Reflection

(Corrections and reflections on individual questions follow this general reflection)

I thought this quiz was a complete train wreck for me. On most questions that I answered incorrectly, I was wrong for 1 of 3 reasons- either a definition/fact that I couldn't recall, a misunderstanding of what the question was asking, or a simple lack of time. On some questions, a combination of these factors came into play.

On question 3d, I was able to recall that mitochondria were similar to chloroplasts, but couldn't remember the reason for this. Similarly, on question 4a, I knew that carotenoids and chlorophylls gave some plants their colors, but could not remember their more important role. In both of these cases, correcting the quiz reminded me of facts that I'd forgotten. Other questions in which I forgot (or only partially remembered) facts included 5a, 5d, 7, 9a and 10a. I think that in these cases, doing the test corrections helped to solidify my understanding of the major principles of modern biology, helping me to fulfill measurable outcome #1.

On question 1, I thought that my answer was sufficient, because I considered water's two hydrogens to be 1 feature of H₂O, and its ability to form 2 hydrogen bonds to be a separate feature of H₂O. I knew that water was polar, but didn't think I needed to mention it in order to have a complete answer. There were several other questions that I did not fully answer, either because I misunderstood the question, or because my answer was not specific enough. These questions included numbers 4c, 5b, 5c, 7, and 10b. By doing the quiz corrections, I was able to better fulfill measurable outcome #2, by demonstrating more of my understanding of these areas of modern biology.

I tended to skip the questions that required more thought than simple recollection, because I was worried if I stopped to think, I wouldn't have enough time to finish the quiz. Some of these questions I later went back to, but others I did not. Question 2 is an example of one that I would have been better off skipping- I spent a significant amount of time trying to figure out structures that worked for each definition, and ended up not getting most of them. The idea of connecting the 3 carbons into a chain did not occur to me, even though I know that's extremely common in organic molecules. I now realize that if I'd had a better understanding of some of the major principles of biology (outcome #2), these questions would have been easier for me.

One of the lessons I got out of the test was the importance of studying. Because I took detailed notes while I was doing the readings (~7 pages/chapter), I assumed that I'd learned everything while doing the readings. So, my studying consisted entirely of looking at the notes on hemoglobin/PrP, and briefly glancing at the worksheets and notes from class. I didn't study the chapters in any detail. I also assumed that because it was a quiz (and not a test), it would be neither long nor detailed.

STUDENT B EXAMPLE
Portfolio Rubric
Final Portfolio Assessment
 SCI 1210-02 Fall, 2011

Grade	Description
A	<p>Entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment. Evidence for growth of learning by analysis of shortcomings and identification of areas of accomplishment. Thoughtful and personal response to the material being covered and level of learning achieved. Evidence of significant progress with regard to the measurable outcomes for the class are clearly presented and further reflections on achievement is included. Entries demonstrate a high level of professionalism in writing and neatness.</p>
B	<p>Entries represent a basic level of understanding of the content of the assignments. Basic requirements of the assignment are met. Evidence of achievement of the measurable outcomes is clearly presented. Entries are acceptably neat and professional in writing style. Submissions contain responses to material being covered and level of learning achieved. Non-specified entries are relevant to SCI1210.</p>
C	<p>Entries may appear to be hastily put together and fail to meet the basic requirements of the Portfolio. Reflections are vague, too general or missing for one or more of the required entries. Measureable outcomes are not addressed adequately. Little self-awareness is demonstrated in evaluating learning or assessing strengths and weaknesses in responses to assignments Portfolio entries are not well organized and sloppy.</p>
D or F	<p>Extremely low quality of work for the entries. Little attention to guidelines and low level of effort overall. No perceptible self-awareness of learning deficiencies or progress in the course measurable outcomes.</p>

Student B Grade = A

You have been responsive to the comments on the draft portfolio entries and your portfolio is neat and professional looking. Your innovation to make study guides that were taken up by several other students as projects speaks to

your dedication and willingness to explore learning strategies and to work collaboratively even when it is not called for.

Student B Final Reflection

Final Reflection

Students have an understanding and ability to communicate effectively, by written and oral means, knowledge of the major principles of modern biology.

I felt like my understanding of biology increased over the semester. I came in feeling like I knew biology, because I'd taken honors biology and AP biology in high school, but this class made me realize how little I actually remembered- and helped me to fill in those huge gaps in knowledge. I felt that on tests, I was able to demonstrate my knowledge- for example, the immunology essay at the end of the semester, and the homework essay about hypotheses, theories and facts.

Students are able to demonstrate their understanding of the major principles of modern biology by applying their knowledge to solving quiz and homework problems, including some that require interpretation of primary data from experiments.

I think that I was able to demonstrate my understanding of biology- particularly later in the semester, as I got better at preparing for the quizzes.

Students are able to produce a coherent laboratory notebook and demonstrate an ability to understand the design and be able to conduct and evaluate the results of a set of experiments.

My lab notebook was neat. I felt like all of my lab reports- pGLO transformation, SDS-PAGE, phage isolation and PTC analysis- demonstrated my achievement of this outcome. My PTC lab report especially demonstrated my ability to understand the design of an experiment- the procedure contain many sub-procedures, and I addressed each of these and its purpose. In most of the labs, I was able to evaluate the results from the given set of experiments. The one exception is the SDS-PAGE lab, where I tried to interpret the results in terms of what I was expecting, instead of evaluating what I actually saw. I had some trouble interpreting the images, which is why I wasn't able to evaluate the results. In every other lab, I was able to evaluate the data I obtained, and reach a conclusion.

Students are able to summarize and explain the results of their laboratory experiments in writing that demonstrates critical thinking and that is clear, professional, and that employs good language mechanics.

All of my lab reports had writing that was clear, professional and had good language mechanics. Even the SDS-PAGE lab, which had problems with how I evaluated the data, contained writing that was clear and professional, with good writing mechanics. I think that some of the quiz questions (such as 1d on Quiz 4, about a PTC experiment) also enabled me to demonstrate critical thinking with regards to laboratory experiments.

Students have an appreciation of biology as an observational and experimental science, and an understanding of the meaning and importance of the scientific method.

The famous experiments we learned about in class definitely gave me an understanding of the meaning and importance of the scientific method. For example, learning about Hershey and Chase's experiment (which prove that DNA is the genetic material), and the documentary about Rosalind Franklin (who played a crucial role in discovering the double-helix structure of DNA), helped me to understand the importance of the scientific method. Furthermore, the experiments we did in class gave me an appreciation of biology as an observational and experimental science. I realized that biologists have to pay meticulous attention to detail, and that even 1 microliter can be the difference between success and failure.

Students develop adequate scientific literacy to interpret biological findings reported by the press and are able to research these and other relevant biological issues using primary and secondary scientific literature source material.

I think I achieved this outcome, as demonstrated by my science in the news presentation, and the readings I did for the class- such as the ones in preparation for Richard White and Bill Seeley's lectures. I also read primary sources to enhance my understanding of the lab experiments, and used this information to enrich my lab reports. Also, when we were discussing the dog genome in class, I was able to relate it to a New York Times article I'd recently read online. This is sort of related to this measurable outcome- I probably would have read the article if I wasn't enrolled in biology, but the in class lecture increased my understanding of background information that the Times had glossed over. I appreciated being able to make the connection between things I read on my own time, and material that we cover in class.

Students have an understanding and appreciation of the social and ethical implications of the use of scientific findings in the world at large.

I believe I accomplished this outcome very well. Throughout the class, biology was discussed with regards to social and ethical implications- for example, the implications of being able to easily sequence a person's genome. Bill Seeley's lecture further helped me to understand the social/ethical implications of biology, as he used examples that delved into grayer territory. Furthermore, our "Science Friday" discussions, and reading that I did on my own time (dog breeding in the NYTimes, and the influenza article from Gizmodo) gave me a greater appreciation for these implications.

Students have developed an accurate and insightful self-appraisal of themselves as learners.

Working on these reflections helped me to develop an accurate and insightful appraisal of myself. Furthermore, this helped me to improve my performance over the course the semester, as I was able to better recognize study strategies which work for me.

Competencies Developed and Assessed

Communication

Paragraph-style quiz questions, lab reports and essay assignments all helped to improve my written communication, as did writing reflections. I think I also improved my verbal communication skills, by staying after class several times to talk with Professor Donis-Keller about my questions/concerns. (Usually, when something academic is bothering me, I don't approach the professor about it... I feel more comfortable doing that now).

Diagnosis

Quiz questions about lab experiments, and actual lab experiments all helped to improve my competency at diagnosing biological issues. For example, the PTC question on quiz 4 demonstrated my ability to diagnose reasons for PTC non-tasting, beyond the obvious (genotypic) explanation.

Context

Lectures and movies that went beyond the textbook gave me a better understanding of the context in which biology occurs. For example, the documentary about Rosalind Franklin helped me to understand the pressures of being a female biologist in the mid-1900's, and the documentary about intelligent design helped me understand the issues that biologists must deal with beyond their labs. The immunology essay on quiz 4 also helped me understand how biology relates to other scientific domains.

Qualitative reasoning

Quiz questions and lab reports demonstrated my ability at qualitative reasoning. For example, question 4 on quiz 3, about MEN2A, relied heavily on my ability to think logically and use qualitative reasoning.

Life-long learning

To be honest, I'm not sure how "life-long learning" can be assessed. It seems like something that requires literacy, curiosity and access to information. Given that I possess all 3 of these qualifications, I think that I am highly adept at life-long learning. Given my love for reading, and the fact that I check the NYTimes website every day, I will likely continue to read about biology on my own time, as it appears in popular media. I'll definitely stay intrigued by the ethical implications of research, particularly as things like DNA sequencing and biological warfare become more pertinent to day-to-day life.

STUDENT C EXAMPLE

Portfolio Rubric and Final Portfolio Grade

SCI 1210-02 Fall, 2010

The following rubric will be applied to your portfolio. The rubric will be applied to the draft portfolio and will serve as a guide to the assessment of the completed portfolio.

Grade	Description
A	Entries provide an in-depth understanding of the content of the assignment and recognition of strengths and weaknesses of the initial response to the assignment. Evidence for growth of learning by analysis of shortcomings and identification of areas of accomplishment. Thoughtful and personal response to the material being covered and level of learning achieved. Evidence of significant progress with regard to the measurable outcomes for the class are clearly presented and further reflections on achievement is included. Entries demonstrate a high level of professionalism in writing and neatness.
B	Entries represent a basic level of understanding of the content of the assignments. Basic requirements of the assignment are met. Evidence of achievement of the measurable outcomes is clearly presented. Entries are acceptably neat and professional in writing style. Submissions contain responses to material being covered and level of learning achieved. Non-specified entries are relevant to SCI1210.
C	Entries may appear to be hastily put together and fail to meet the basic requirements of the Portfolio. Reflections are vague, too general or missing for one or more of the required entries. Measureable outcomes are not addressed adequately. Little self-awareness is demonstrated in evaluating learning or assessing strengths and weaknesses in responses to assignments. Portfolio entries are not well organized and sloppy.
D or F	Extremely low quality of work for the entries. Little attention to guidelines and low level of effort overall. No perceptible self-awareness of learning deficiencies or progress in the course measurable outcomes.

STUDENT C

Grade and Comments from HDK: Grade = C. I expected to see improvement from the draft portfolio but the reverse occurred. The requirement of dividers was ignored and, more importantly, there was scant or

no attention paid to measurable outcomes and competencies. This is particularly surprising since it was clearly stated as a deficit in the draft portfolio grade sheet. The work on the special project was well done but that is the only shining star in a very dark night for your learning in biology. The self-assessments demonstrate an awareness of what went wrong with your learning but there is no apparent self-awareness on what could be done to obtain an educational benefit from the course. I appreciate your recommendation for a class that segregates the bioE majors from the non-bioE students but for a variety of very good reasons that is not a good idea. I would be pleased to discuss why the idea has not worked in the past with you.

Student C Quiz 1 Reflection

Quiz 1 Reflection and Self-Assessment

I am disappointed with my grade on this quiz, and feel that it does not accurately represent my knowledge of the material.

I lost only one point on the entire first section of this quiz, which dealt with key concepts like organic chemical structure, the properties of water, the structure of DNA, the role of lipids in organisms, and the details of the different monomer units.

My test completely fell apart in the second half. For the lab question (#6), I correctly calculated the amounts of the stock solution to add, but couldn't think of a specific reason that the experiment wouldn't work. Obviously the additional heat did something to the reaction to make it not work, but I couldn't pick out specifically which component would be affected, especially since my chemistry background tells me that reactions are *more* likely to take place at higher temperatures. In the end I hedged my bets and wrote an answer that was too vague.

For the question about the Redi and Pasteur experiments, I simply didn't study them enough. I expected the question to be about the implications of their work, and not on the specific details of their experiment. I knew I was going to lose points here when I finished. In the future I will try to know more of the details of important experiments like theirs.

For the prion question I got the details of PrP-sen and PrP-res slightly mixed up, but other than that I did fine.

I completely trashed the hemoglobin question. Going into the question, I had a cursory understanding of how the process worked, but the extent of my knowledge was actually given as part of the question. For example, one of the things we were specifically told to know was that in fetal hemoglobin there is a substitution of serine for His143. That's what I expected an answer to be, but instead that was part the *question*.

Basically, I have no excuse for not doing better on this quiz. I understood the fundamental concepts but completely messed up the extra stuff. I only lost significant points on the lab question, where I choked, and the experiment and hemoglobin, where a bit more studying of those specific concepts would have turned my 80 into a 94.

Student C Final Reflection

Reflection on the Course

I am satisfied with my level of learning as a result of this course.

Measureable Outcomes

1. From our discussions in class and the written homework assignments, I feel that I am able to effectively communicate through written and oral means the major principles of modern biology.
2. I understand the major principles of modern biology from the quiz and homework problems. I think the quizzes would have been better if they were less about memorizing facts and definitions and more about our conceptual understanding of the material.
3. I've learned how to keep a good lab notebook from this class.
4. From the lab reports and notebook, I've learned out to summarize and explain the results of our experiments.
5. I enjoyed the wide range of guest speakers, so I've gained a greater appreciation of biology as a subject.
6. From our discussions in class about current topics in biology, I feel like I know enough to research primary and secondary scientific literature source material.
7. I enjoyed the ethical discussions we had in class, and from that I have a greater appreciation of the impact new discoveries in biology have on the world.
8. I know more about myself and how I learn from this class.

I ended up doing only OK in the course. (I think I'll end up with around a B). One thing that might help in the future is stratifying the classes based on their prior Bio experience. Unlike a lot of my classmates I didn't have AP Bio in high school. The only Bio I had was a high school freshmen level class that didn't go nearly into the depth that our class did here.

Also, full disclosure, I've never really enjoyed Biology as a subject. The subject matter itself is interesting, but the way Bio is taught never really clicked with me. I learn best by figuring things out until they make sense, so subjects like Physics, Math, and Computer Science come naturally to me while Bio does not.

A cool thing that might be worth trying is having the two sections of Bio focus on different things. One section could teach Bio in the traditional way like this class, while another ("Bio for non-BioE's") could touch on cool Bio related ideas and how they can be applied to other disciplines of engineering. I would remember a lot more from that class than I will from this one.