Abstract

In the Spring semester of 2014, I was a student teacher at Tahanto Regional High school located in Boylston, MA. This report will discuss my observations, learning experiences, and personal experiences while student teaching under the supervision of Lisa Sequeira. I instructed 3 different honors biology classes, standard level biology classes; as well as aiding in the management of Anatomy, and A.P Biology. Teaching has deeply altered my view of the educational system and the value of an educator. I was able to instruct and encourage students in science as well as develop many professional and personal skills.
Contents
Abstract ........................................................................................................................................... 2
Contents .............................................................................................................................................. 3
Chapter 1: Background ......................................................................................................................... 4
Chapter 2: Standard A- Plans Curriculum and Instruction ................................................................. 8
Chapter 3: Standard B- Delivers Effective Instruction ......................................................................... 13
Chapter 4 Standard C- Manages Classroom Climate and Operation .............................................. 17
Chapter 5: Standard D- Promotes Equity ............................................................................................ 19
Chapter 6: Standard E- Meets Professional Responsibilities ............................................................. 21
Chapter 7: My WPI Education ........................................................................................................... 23
Chapter 8: My Classes ....................................................................................................................... 25
Chapter 9: Conclusion ....................................................................................................................... 34
Appendix A: In class Work .................................................................................................................. 35
Appendix B: Open Response Lecture ................................................................................................. 43
Appendix C: Assessments ................................................................................................................... 53
Appendix D: Labs ............................................................................................................................... 61
Chapter 1: Background

The history of education is long, and an experience such as student teaching wouldn’t be complete without understanding the recent changes and trends in education. The Education Reform Act of 1993 was a major series of changes that were implemented over a seven year period.

The primary focus was providing a more equitable funding system that also awarded schools with increasing academic success. It brought districts with poor funding up to a level that was deemed as necessary for success. It also instituted a clear method for statewide testing that would allow each district to be judged according to the success of their students and producing an overall framework for teaching different courses. It also put more stress on the further education of the educators themselves. They would need to be monitored and continue their own learning to be able to more successfully provide assistance to the students.  

The main changes have been in a funding level and on an academic level. Funding for all districts is at what is deemed to be at least at the minimum of what is required. This has allowed for improvement through better facilities. There has also been an apparent increase in academic success. This is based upon the fact that students are taught and tested with the basic framework. The framework provides a comprehensive system by which a teacher can produce a lesson plan and students learn what is considered to be necessary their education in a standardized manner. The education system was less organized before the changes, and it is believed that the education in Massachusetts has begun to outpace other states due to this organization.
There are many ways that States can compare their education systems. The primary one that shows up in statistics is general funding and overall graduation rates. SAT scores or scores in higher level AP or IB classes can generally judge the overall academic standards. The American Legislation Exchange council puts out a report card of the different states based upon educational policies and the actual education quality. They rank Massachusetts as number one in quality, but give an average grade in general policies. Massachusetts has the 25th highest SAT score of all states. However, the state has the highest participation rate of most other states, and all states with higher scores. This may affect the overall. There is also a National Assessment of Educational Progress. The country performs with 82% above basic level, and Massachusetts performs at 90%. Massachusetts rates 14th in general funding, however the schools derive funds from local funding as well. 3, 7, 9

The TIMSS stands for Trends in International Math and Science Study. It is a general review of how different countries stand in Mathematics and Science. It not necessary to compare States, but necessary for comparing different countries. The United States appears 11th on the list in Mathematical achievement, 6th in reading achievement, and 7th in Science achievement. However, Massachusetts was only out achieved by Singapore in Science. Massachusetts also appeared within the top ten for Mathematics compared to other countries. 13

Curriculum Frameworks are standardized course layouts. It allows for an organized approach to a subject that keeps each school on a particular driven path. They were organized by teachers during the reform and are subject to change over time depending upon what is thought necessary for students to learn. It also allows for ease of standardizing testing. Students can be judged equally because they have learned about subjects in a particularly organized manner. 6
High school biology begins to focus on looking at life and biology on a more complete level including in relation to their own bodies and health. They learn about the cell, and basic anatomy. They begin to understand the chemistry behind the macromolecules of life and how genetics has an impact on life. This continues on to a discussion on evolution. The framework has developed over time and will continue to change with the Common Core that has developed over time.  

The Common Core is a set of standards that have been assumed by 45 states. It brings with it a new set of frameworks and allows for the standardization of education across the country. Massachusetts overall plans on producing new frameworks, and curriculums along with producing online sources for educators along the lines of the Common Core. Tahanto Regional High school is currently using the old frameworks until the system is more thoroughly implemented. However, the school system will begin to switch over to the new frameworks and restructure their curriculums as seen necessary.

Tahanto Regional High is a school located in Boylston Massachusetts. It is primarily white school with approximately 94% of the students identifying as white. There are approximately 1.5% each of students that identify as Asian, Black, Hispanic, or having multiple races. The majority of the students are of middle income. Very few students exist at low income. There are approximately 3-4 per grade that are at low income.

Overall, at least 99% of the students at Toronto Regional High school participate in MCAS. English has a 100% participation with 26% scoring in the advanced level, 58% in proficient and 13% in needs improvement, and only 2% for Warning.
Mathematics had more polarizing results for student scores in the MCAS. More students were in the advanced category with 33% of the students scoring, but only 36% of students scored proficient and an increase to 21% scoring in Needs Improvement with 10% being placed into the Warning Category. The science category showed similar results to English with 25% scoring advanced, 51% scoring proficient, 18% in needs improvement, and 5% with a warning. However, these results include all scored from Tahanto Regional Middle/High School. 

The 10th grade students show greatly increased scores over younger students. There were very few score in the category of failing. Only one percent failed in the mathematics category. In the English category, 65% scored advanced and 35% scored in the proficient category. Mathematics also had a disproportionate amount of Advanced scores with 67% of students scoring in this category. The proficient category made up 26% of scores, and only 6% of scores were in needs improvement. Science had the most mediocre scores with 43% of scores in the advanced category, 54% of scores in the proficient category, and only 3% in needed improvement. Every category of students has a similar profile of results. This includes students of different ethnicities or of low income. Students with educational disabilities do represent a lowered fraction of results, and fall within the levels of proficiency or needs improvement. The ELL students also experience slightly lower scores, but fall within the general range. 

An English Language Learner is a student that has not grown up speaking English and scores between 1-4 on the ACCESS exam. The ACCESS exam stands for Assessing Comprehension and Communication in English State-to-State. It assesses a student’s ability for English Comprehension. This includes language in many different subjects that are necessary for proper education. The test is broken up by grade level and tests at different skill levels.
Sheltered English Immersion is a style of education in which the ELL student is placed in a classroom with teachers that are specifically trained to teach the ELL students. Once they reach a point of comfort with the language, they can be moved to a more standard classroom environment.  

Throughout Tahanto Regional Middle/Highschool, there are only approximately 7 students that would qualify for being considered ELL or former ELL.  

Overall, The Tahanto regional High/middle school is representative of a highly successful school within the Massachusetts educational system. The school has followed the framework of the system set by the Massachusetts Educational Reform, and are making efforts to follow the core requirements.

While student teaching, I was able to experience many different classes but teach several different groups. I was primarily responsible for three honors biology classes. They will be referred to as period 1, 4, and 5. Occasionally, I would aid in the instruction of an anatomy class, and an A.P Biology class. My supervising Teacher took over for three lower level biology classes during the year so I had the pleasure of aiding in their courses as well during the two terms I was present. I saw all of the ranges of students from Freshmen to Seniors.

Chapter 2: Standard A- Plans Curriculum and Instruction

The start of student teaching is an astonishingly scary hurdle to overcome. I observed for several days, and after the first week began to plan my first major lesson. Ms. Sequiera had yet to cover the structure of viruses or cancer, and it was a small side topic that needed to be slipped into the
curriculum. I started my journey much like a virus, and just crept into the class and began to take over. This first lesson would influence how I created and handled every subject in the future.

As describing a virus is an information packed and image heavy, I realized that a presentation was a necessity. This realization would influence how I would handle many lessons that involved lecturing. Tahanto High has projectors in all major classrooms so is set up to support a teaching style based upon mixed text, image, and video presentations. Having determined a practical method, I began the more difficult aspect of organization and planning.

To plan Instruction, I took a straight forward and simple approach to assessing the appropriate information to present. The framework helped to define a general sense of what was necessary knowledge to include. From this, I was able to create a skeleton that was then supplemented by the Pearson Biology textbook used in class, as well as MCAS questions on the subject. This process lead to a concise body of knowledge. I also sought out instruction from Ms. Sequeira on additional information, or what information would be superfluous and at a difficulty level that would be detrimental to the lesson. With an outline of information, I began to build a presentation.

Presentations would be organized by learning goals, and then the topic at hand organized around the book and framework. The information was presented through concise text, and accompanying images and videos. During the presentation I would break monotony through asking questions on the information or answering questions. After presenting the first time, I learned an important lesson. The best situation is to have the primary lecture run under time, and then be stocked with excess material. The basic lecture went short, but I had extra material that I had researched and prepared. I was able to discuss the topic further, and bring in knowledge from my WPI education as well as . I would repeat this lecture not only for the honors students, but a standard level biology class as well. I understood this would be a slightly different experience, and so altered the plan and prepared a
worksheet for the students so they could follow along. I also found videos that would be helpful for visual learners, and had other activities or demonstrations so that the lecture was timed perfectly. This first true experience would set a precedent for how I would design a lesson.

Over the course of student teaching, I was responsible for teaching multiple aspects of the framework including Cell biology, Genetics, Evolution, Anatomy and Physiology, and other topics. Each one of these particular topics had their own specific activities and labs that are intrinsic to the subject itself, but planning for these subjects took the same path. There were several phases necessary for planning out each individual subject.

The first phase involved was gathering up together pre-prepared work, and possible activities as well as setting up a rudimentary schedule. For all of the different subjects, there were pre-prepared materials. These included the worksheets that paired with the book, and other gathered over years. This provided a substantial foundation on which I could build and augment. I would then discuss with Ms. Sequiera how much time we should spend on each section as a general guideline that would change depending upon the circumstance. This allowed me to tailor lectures so that they would fit over the time schedule, and plan on days for specific group activities or projects, along with homework. Previous to beginning a subject, the students would be instructed to go through the book and define necessary vocabulary. This process gave the students a head start into the material and prepared them for the coming lectures.

The second phase involved producing lectures, and other materials such as lab write ups. The lectures were usually presentations intermingled with different class activities, relevant MCAS questions, and other materials necessary to prevent the boredom that arises from pure lecturing. The first lecture was usually an overview of the subject chapter and sections we would begin covering, and then following lectures would build off of this first outline. As the students completed sections, lectures
may be intermingled with group activities to help solidify the material they had learned. One particular example was a project to assemble a paper model of a DNA strand that was in the process of replication. They had the enjoyment of general arts and crafts while becoming more familiar with the individual components of a nucleotide and the anti-parallel nature of a DNA strand. The students saw the lecture, and were able to apply the knowledge. During this project, I was able to correct any misunderstandings as it became apparent where they struggled to understand the structural aspects. Group projects and work produced discussions that were essential as informal assessments.

The third phase of designing lessons was the production of assessments. Throughout a subject, the students would have small quizzes. The quizzes were used to judge the students understanding and some material would be covered again if the classes were seemed weak on the material. Many students would use these quizzes as a study tool. Eventually, as the students moved through the particular chapter I would begin the design of an exam. The exams contained different types of questions and many of these questions would be derived from the MCAS itself. Exams would contain multiple choice, True/false, and Matching type questions. This assessed their general knowledge. The exams would also contain MCAS open response to prepare them for the writing process, and were graded on the same basis as the MCAS open responses. These questions were formed to judge application of knowledge and critical thinking skills. The exam would mark the end of a section, and the process would repeat.

Planning a single day involved very similar strategies, but involved a much greater amount of variability. Usually, I would design a lecture so that it would last several days and removed time constraints. I would attempt to keep the classes together and would use individual, or group work to prevent one class from getting to far ahead. The extra materials, and activities were kept in store for this purpose. The plan for a day was based entirely around the design of the lecture. The lecture plan was directly influenced by what the time span was for the information, and the nature of the material. Genetics and the Anatomy physiology lectures involved very different styles of planning. I also created
an MCAS open response lecture to discuss the proper way to answer an open response. That particular
day required the most structured format as there was only a singular goal in mind.

I developed one particularly interesting lecture to discuss pedigree charts, while discussing
genes and diseases. The beginning of the lecture was primarily used to introduce the concept of a
pedigree chart. This primarily consisted of family trees showing the particular genotype or phenotype
for a singular gene. We then moved on to discussing how one may use a pedigree chart to track a
disease throughout a families genetics. These portions were fairly straightforward, and the class soon
understood the basic concept of how to design a chart and how genotypes can be determined through
the patterns. To more thoroughly test their abilities, I created a pedigree chart tracking the “magic”
allele for the different families found in Harry Potter. I treated it as a recessive trait, and only those with
both magic alleles could use magic. They created pedigree charts for the magical and non-magical
families, and answered questions about the activity. This was an entirely effective lesson as by the end, I
was able to see that all the students were actively involved with the lesson. Many topics, such as
genetics, required active problem solving and short activities for the lecture to have any worth.

Understanding the

Some of the last lectures I gave while teaching were on basic human Anatomy and Physiology.
These lectures were done under an extreme time crunch before MCAS and involved condensing a large
amount of information into easily consumable packages. There was much less time for activities besides
pure lecturing. The students understood, but it was still difficult for both parties at times. These lectures
were developed after having taken into account all of the suggestions that had been made by the
students. There were minimal bullet points per slide, and designed to be . There were more diagrams
that demonstrated the topic at hand, and I had created worksheets showing the main diagrams and
included spaces for labels and notes. This allowed for me to explain multiple different body systems in
an incredibly short period of time. The presentations had taken into account many of the individual
suggestions from students. Developing effective lessons is made much easier by understanding and taking into account the suggestions of the students and working to their preferences.

The most defined class lecture I created was a one period instruction on how to answer MCAS open response questions. I had given a test that included open responses, and it was clear that there were small changes that could be made to radically alter the scores of the students. We began by examining the scored answers for a particular MCAS question. As a group, we looked at scores 1-4, and discussed the scoring. The main lessons I wanted to teach were that every part of the question needed to be answered concisely and that the answer should accurately reflect the question. The students that had scored poorly were often overly wordy, and didn’t provide the information that was necessary to answer the question. As a group, I asked the students to dissect the questions, and understand the different meanings of the words identify, analyze, or explain. After we discussed how to answer these questions, the students were given a worksheet to complete that included several MCAS open responses. The scores on MCAS open responses questions were drastically improved once they had been taught these skills. Many students improved on the next test from 1’s to 4’s. This was a particularly interesting lesson to develop as it was not based upon teaching subject material, but teaching a necessary skill.

Preparation and Lesson planning are entirely necessary for the smooth operation of a classroom. A proper lecture should be thought out and well scripted, as well as being overly prepared. Things can change at a moment’s notice and alter an entire plan. Technology can fail, and activities can fall apart. It is better to be overly prepared to deal with any situation. This requires being prepared with extra work, and prepared mentally to be able to handle a situation going off script.

Chapter 3: Standard B- Delivers Effective Instruction
One of my biggest fears of student teaching was that I wouldn’t be able to properly express myself, and deliver effective instructions to the students. I worried continuously, as I felt deeply responsible for everyone’s ability to understand the information and acquire the appropriate knowledge. I still feel justified in this fear because it was the case that not everyone understood right away. However, I realized that is the nature of education and went on to use different methodologies to teach groups of very different learners.

As previously mentioned, the main method for disseminating the necessary facts to the students was through the use of a presentation. I was already aware that handwriting notes would hinder understanding, as well as take up valuable class time. Having a large presentation with necessary notes and diagrams allowed for clear for of speech. Primarily, the notes were left to necessary facts, and I would discuss these once the students had taken down the notes while using any images, or diagrams provided as further discussion points. I learned early on many of the younger students were unable to write and listen effectively at once. Waiting while the students began to process the information was a change that drastically increased their understanding. I would gauge the faces of the students to see if there was any real confusion over what was being discussed. It was generally apparent if there was confusion and meant that I needed to slow down. Once I slowed down, the confusion would often abate. Throughout the lecture I would stop to ask the students questions about what we had just discussed. In anatomy, I would often ask about diagrams and have the students explain the process, or structure being shown. This provided me with a function assay of the classes overall comprehension and aided in the formation of a clear explanation for the class as a whole.
For some of the topics, such as DNA replication, the students became confused because they were looking at still image of a very active process. I would supplement discussion, and images with short videos of the process so the students could see the process and better understand how things are moving. I would then pause the movies and use it as a series of still diagrams to better discuss the process as a whole. Some movies acted as quick summaries, and were effective in providing an outline for when starting a new subject. One movie in particular used a metaphor involving recipes, and a baker to discuss the process of creating protein from DNA. The movie, metaphor, and discussion of the movie were effective in providing all the students at the different levels with the basic concepts.

Once the students had a grasp of the basic concepts, then they often found working in groups on activities helpful to comprehension. They would finish basic worksheets that forced them to use the fact they were just given to answer the questions. This was necessary to just solidify the facts in their memories. While they did this, I could go around and discuss in these small groups more in depth about the meaning of these facts. This was where I learned where every student stood on the material. Many students would be confident about not just the factual information, but were able to explain and answer questions about the process. If a student was unclear, I could take the student to the side and being to understand where they were stuck. Often times they knew the information, but required the proper questions for the information to fall into place. Other times I would have to re-explain a concept. The one-on-one nature of the interaction provided instant feedback on the confusion, and I could more easily explain the concept with this in mind. The other benefit to the groups was that students that easily understood the information were often adept at explaining it the other students. I would
often walk by two students discussing a concept to see the confused student begin to piece the facts together.

I found that repetition was also key in making sure I provided a clear explanation. Every class period, I would summarize what had been learned previously. Every time we went over the information, the students would become more confident not only in their understanding, but ability to recall terms and definitions. One method that was popular was creating a mantra for remembering some sequences of facts. During the lectures for protein synthesis, the class began by chanting DNA to RNA to Protein. The students eventually added on with further information. They students enjoyed the activity, and it was continuous repetition of the information.

Creative projects also helped many students understand. In some instances physically handling a model, or drawing a process cemented the principles of the subject. In this regard, I tried to supplement lessons by having them draw and create diagrams, models, or other necessary supplementations to the lessons.

Labs were also a necessary aspect in understanding different subjects and required their own clear explanations.

In the end, true formal assessments became necessary to have a clear cut idea of where a student wasn’t connecting the dots. Small quizzes were very useful for knowing if a student may just not be studying, and doesn’t know the facts. I would often give relatively easy quizzes so that I knew where I needed to go back over particular information. Usually it helped the students themselves know exactly “what” they didn’t know. They weren’t aware they didn’t
understand a simple fact that was undermining their understanding of a much more complex topic.

Testing was the real indicator of whether or not I had properly disseminated the information. I created several tests for the students that had a mixture of fact based questions, and critical thinking questions. I knew I provided an accurate explanation when the students were able to properly answer them to the best of their abilities. The most critical questions often times took the form of MCAS open response. I taught the students how best to answer them, and I believe that I provided effective instructions when every student was able to achieve a 4/4 score on each question. It required that they knew the necessary facts, as well as able to apply them in an appropriate fashion. Exams for the students were as much a test for them as they were for me. I knew I provided effective explanation by seeing students rise up in grades from B’s to A’s, and seeing students enjoy succeeding.

Chapter 4 Standard C- Manages Classroom Climate and Operation

I felt quite lucky to be working with the students that attended Tahanto High. They were all extremely well behaved and intelligent students that I had very little trouble managing. The honors biology students all wanted to learn, and I used that a tool for managing the class.

My main tool that I used to keep the classroom in control was my enthusiasm to help them learn. They knew I didn’t want to waste their time because I wanted to teach them and they truly respected that. If I didn’t waste their time, then they didn’t waste mine. That was told to me on my first day of teaching, and I tried to live by that rule. I tried to portray enthusiasm and seriousness to the students. This kept them under control and willing to learn.
Each class the students would come in, and at the bell I would have them sit and immediately pull out assigned work. Attendance was taken rapidly so as to not interfere with day to day plans. Homework was checked by myself, or a TA. Incomplete or missing homework was taken as a mark and the student let known that they must complete it and submit it. These were general operational procedures that are necessary for each and every classroom. This also helped to assess the attitude of the class on the particular day, and I could begin to adjust my behavior accordingly.

A major aspect of controlling a group is the attitude overall and acting accordingly. There is no promise that a classroom will always be eager to learn, and it is occasionally necessary to get them excited. I would increase my enthusiasm and try and get some energy out of the apathetic students. This sometimes required no more than just discussion about their day so far, or starting to act excited about the lecture about to be presented. Other moments, a class is much too eager and overly excited. In these cases, I would often wait silently until the behavior subsided before I would begin. They quickly understood that I was waiting on them, and that they needed to settle down. It was an effective tactic that would settle a class and allow for me to proceed as planned. These students did want to learn so were willing to settle down for a lecture. If a class was being particularly difficult, I would merely address all of them and explain that they were being loud and disrespectful. Classroom control was a constant balance between jovial and serious.

Individual digressions against proper behavior were handled as they needed to be handled. Chatter would happen, but it usually did not take more than me merely noticing the students in question for them to realize they had to stop. In extreme cases, I would break up students and move them to a different spot if I felt like they were having a particularly talkative
day. Phones were very rarely an issue and I did not confiscate them but would politely suggest they be put away. If I felt some people were being particularly inattentive, I would be asking the class questions. Students began to pay attention as soon as the possibility of a question would appear. Students were careful with language, but I would address the situation if it arose. There was very little use of swears in an obvious manner.

Overall, classroom behavior is about mutual respect. I respected my students and knew they were all good students. They understood I wanted to teach them so went out of their way to learn. None of the students I had were disrespectful. We did just around with one another, but overall it was a professional environment that was lighthearted and productive for learning.

Chapter 5: Standard D- Promotes Equity

Equity is a natural and necessary component for effective education. All of my students were equal in my eyes, and I treated them as such. I didn’t encounter any issues with equity within my time during teaching. The students respected me, and I respected them. The students also got along incredibly well with one another. The environment was naturally productive for equity.

A major part of promoting equity was providing many different ways for students to show their values. Some students understood the material well, and could easily answer questions. However, I made sure that every student had the opportunity to answer questions and encouraged all students to answer.

This did become difficult as I had some students that were naturally shy and quiet. I took every opportunity to give them the chance to answer, and support them when they did. In some cases, students would answer a question incorrectly. I used two different strategies in this
situation. I would reward the question and prompt them with a slight hint to try and stimulate the memory. This was effective much of the time and I believe raised the confident of the student answering. Other times I would use an incorrect answer as a jumping off point for discussion as many times it would be quite close to the actual answer. Overall, I tried to dissuade against anyone feeling less confident about answering.

I also promoted equity by trying to incorporate a variety of activities into the curriculum. Creative activities often allowed for many of the more artistic students to express their abilities. A wide range of activities allowed for most students of different learning styles to show their own abilities within the class.

I did not experience a singular moment at Tahanto High where there was any issue with race, or background. I did deal with students of different background and attempted to follow all school policies as it came to promoting American civic culture. I also did not experience any issues with language proficiency. Jinchao was one of my students to whom English was a second language. However, his language skills were impeccable. He wrote and spoke very well and there was never a moment where it interfered with his ability to express himself. Many students had a slightly different background. I did have a chance to learn about some of these backgrounds. I believe the main differences in backgrounds would be religious. The school did have a large Greek Orthodox population, and I had the opportunity to speak to one of my students about her participation in a scholarship opportunity through her church. I was even able to listen to part of her speech in Greek.

Part of religious tolerance did come into play during the discussion on Evolution. As some students were quite religious, Ms. Sequeira took the opportunity to explain how evolution is in no way attacking religious views and that belief in one is not mutually exclusive to the
other. She herself had worked in a school that thought otherwise so was more able to express the concept. It provided me with an example and background on how to discuss evolution in a culturally sensitive fashion, and treat everyone respectfully while promoting equality.

Chapter 6: Standard E- Meets Professional Responsibilities

Student teaching is not only an opportunity, but a responsibility. The student teacher has been trusted with the education of a group of young minds and thus must be handle it as employment. Professionalism is required at all times.

The primary responsibility of a teacher is to educate the students. To be a professional, an educator must provide accurate information, and must continuously check themselves so as not to provide false information. This is done by studying the material in depth.

A professional must also be able to properly assess their abilities. I would test myself on the material to make sure I knew what I was saying. I would also regularly ask others teachers if what I am saying is clear, the correct way of saying it, and for overall feedback. They may give suggestions, but asking the students is key as they will always have suggestions. They understand where they do not understand things, or how things could be improved. I would alter my explanations and lectures on the suggestions of the teachers and students. Once I made these changes, I began to feel and act much more confident in my abilities, and being confident in the material and not hesitating in its presentation is a professional responsibility of education.

Confidence in presentation of material is as important as confidence in the presentation of oneself. One of my first questions concerning student teaching was how do I present myself to these students. This is not only in terms of dress, but also general manner. The dress concern was easily fixed by asking the other teachers what their opinion was on the proper dress code. I was instructed that a
button up with jeans was the Science department wings unofficial dress code. This was much more relaxed than what I was first expecting. However, due to the nature of the lab work and other activities in the class, this was the preferred attire. I followed this each day, and it was clear that this was the professional attire of the department. Other than physical appearance, it was necessary to create and maintain a professional attitude and aura. The students require enthusiasm and a sense of humor to be interested in the material, but I also tried to maintain some seriousness so that the students knew I not only was interested and enthusiastic about science but I did in fact take their education seriously. This also aided in discipline as the students understood I wanted to have fun, but wouldn’t tolerate disrespect or a situation becoming out of hand.

Professionalism in student teaching was not only about teaching, but taking control of all aspects of the teaching position. In addition to teaching classes, I also performed all of the roles of a teacher. There were many situations where I did more than merely teach to the class. There were many assemblies where I was responsible for leading the class down and aiding in organization of not only my class, but other classes and being able to keep my students as well as other students in line. This may be as simple as instructing students to put away a phone, or refrain from using particular language. I also acted a chaperone during a field trip into Boston, and took over the full role of being a teacher during that day. I had to take attendance of the students and help organize them into the buses, and watch over them. I was also interacting with parents and so had to maintain a professional attitude so that they understood I took their children’s education seriously. Taking over all aspects of teaching was put to the test when Ms. Sequeira wasn’t able to attend class for several days in a row. I acted as the substitute teacher during this time, and was responsible for all the classes and general activities throughout these days. I believe that taking over the full role and duties of any position is one of the key steps in acting as a professional.
Chapter 7: My WPI Education

Biochemistry is an ever growing field with new information being presented every day. My education at WPI in no doubt prepared me for teaching biology at a High school Level. During my time at WPI, I have taken a majority of the classes that are offered in the field of Biology, and the necessary chemistry courses for a Biochemistry major. This provided me with a strong background for teaching the Biology classes, along with aiding in the instruction of the other higher level classes. I have taken high level Cell Biology courses, Anatomy, Genetics, Virology and many other fields including plant biology. The basic and advanced classes easily cover the frameworks presented for a high school student. A singular portion of the framework usually corresponds to a singular class at WPI. The in depth knowledge that each of these classes provided me was key for being able to break down the framework into even more specific components that are a necessary foundation of knowledge. Since I had a deeper understanding of each piece of the framework, I knew from where I needed to start. This was particularly necessary for their studies of genetics. The framework for this particular subject is comprehensive, but the layout can leave something to be desired. My understanding along with the books organization allowed me to provide lectures that were clear and covered all necessary topics. I was also able to use information and examples from Professors to fascinate the students with mutations that weren’t normally shown. The new information that Professors have brought into the classroom was also beneficial and necessary for the education and entertainment of the students.
WPI Professors alter the information they provide every year. This is because the information that is available changes constantly, and this is one of the strong advantages that WPI provides. The classes don’t have stagnant information, or information that is even moderately out of date.

As I taught the Biology classes, I was working with a fairly modern book and a supervisor who is still constantly studying the field. However, I was able to point out where new science has developed in recent years. Biology Professors at WPI often mention new work that is being done on a field and do not hesitate to point out where something that was once believed true is false. I was able to bring some of that to the table while teaching. There were often times the book would describe something in a way that is now known to be a falsehood, or thought of in a different way. This was only supplemented by my own forays into modern journals. WPI has provided me with the ability to research current studies, new models, and evidence that is coming out each and every day. This is one of the most valuable skills and allowed for me to take a standard biology class and introduce a spark of enthusiasm for modern science and legitimate use in which this information is being applied. The ease and speed at which I was able to research certain topics was also invaluable when a student had a particularly difficult question for either myself, or the other teachers I was working with. I could quickly find accurate information and dispense it to the students without taking up class time.

Overall, while I may not have had extensive training in education from classes at WPI, I was incredibly knowledgeable in my subject and this lead to an experience like no other while educating the masses.
Chapter 8: My Classes

The student teaching experience is obviously not complete without the students. I had many great groups of students, and every day was a little different. Tahanto High uses a rotating 6 day schedule. This meant that I would see each class at a different time of day during the week, and each week the day and time would vary. This has its advantages and disadvantages. It meant I never had to see the same group of students at 7:45 in the morning, while at their worst, However, It did mean I would see every class during their peaks and their lows. Some days I would see a class of sleep deprived students arrive and attempt to learn. Many days I would see a class in the middle of the day and they would be on perfect behavior and could sit through the driest of lectures without rapt attention. I believe that a rotating schedule allowed for all of the students to gain more out of the class because they weren’t confined to a singular time period and mood associated with that time. This rotating schedule meant that I did have to adjust my teaching style each and every day I saw a new class.

I was in a constant state of evaluating the mood in the class. This required skills in reading body language and eventually becoming learned in knowing what the time of day would hold. Early mornings were never the most productive for learning. Morning announcements took up an extra five minutes of class time. The students had yet to fully organize homework and so attendance and homework check-ins took slightly longer. More students were likely to be missing their homework or have it uncompleted and more enthusiasm had to be expended to gain the attention of the students. I would often ask general questions about previously learned information to wake up the group. Morning groups were more likely to benefit from easy and heavily lead start up activities. Once they seemed to be in a state to learn, I would begin to lecture or proceed to the activity that had been planned.
Mid-afternoon was the peak time for lecturing. Every question I asked was greeted by a room full of hands. I never struggled to pry an answer out of the group. This was period in which I would often be able to soar through a lecture and use the additional time to informally test the group on the knowledge they had learned throughout the week. This was informative as it allowed for me to adjust the lectures to each group and understand where I needed to focus. Test scores were regularly higher when they were taken at this time of day.

Late afternoon and the end of the day varied greatly in their productiveness. Lunch and the end of the day often re-energized the students. It was no longer a time for enthusiastically gaining attention, but rather reigning in a mob of the overly energetic. I had to regularly remind students to not talk out of turn and wait for permission to answer questions. They could focus on the subject at hand but required firm calmness so as not to get out of hand. This would often be a time for group work, or small projects.

It did not take long to learn patterns of behavior that would appear throughout the day. Adjusting to the behavior and each class did take careful planning and observation. This was further complicated by the range of learning styles, and that each group of students were all quite different. As stated previously, I taught biology periods 1, 4, and 5.

The different periods varied in size, capabilities, and overall motivation with each particular group having its having very clear pros and cons.

Period one was the largest of the biology groups with more than 20 students. They were generally well behaved and enthusiastic. However, the size and range of student’s comprehension and style did pose some problems when it came to balancing the teaching styles. Informally assessing the class in full was particularly difficult. Most students would choose to
answer questions and gained great pleasure in being correct. Very few would hesitate, and those students were often the most quiet. Correcting worksheets or going over homework’s became mundane over time as there were rarely incorrect answers as the basic worksheets came from works associated with the Pearson Biology book that was used in class. Systematically picking on every student often tended to bring down the mood of the class rather than enhance it. As time went on, this class chose to begin answering in unison as a class. Students who understood the material joined in most enthusiastically. The homework was checked at beginning of class, so it was already apparent who had at least done it. By assessing those students that stayed fairly quiet, I understood who I may have to work with further. Due to the rotating schedule, this class often had periods that were extended due to lunch times. Lectures would be extended by 15 minutes, so they were often allowed to do work alone or in small groups. I would often have extra worksheets, MCAS problems, or general group assignments. During this time, I would cycle through the class and primarily target any group of students that I noticed may be struggling. These groups essentially formed the major cliques. One of the first groups I would visit would usually consist of Sammy, Holden, Christian, and John. Sammy was one of the top female students in the class. Christian and Holden tended to struggle and liked to be a bit more distracting. She was key in keeping them in line and was often already in the process of calming them down before I even acted. The group worked efficiently as I could explain the material to the guys in the group and would know that they’d have further help understanding from Sammy. She was upbeat, and fairly tough. The male members of the group were class clowns that tried acting tough. John was an incredibly active learner during lectures, and would ask questions and was very intuitive. In the corner was a group of fairly quiet girls. Jessica, and Erin were always in the back left corner. Jessica did her work, but seemed apathetic to the situation as a whole. I
would try and make sure she had an understanding of the material, but she maintained average grades. I would regularly work with Erin and answer her questions. She struggled to understand some of the complex material but would keep pressing until she got it. I would often find ways to simplify it down and diagrams were very effective. Sandra and Cassie tended to have the knowledge down, but were still fairly quiet students. In the right corner of the room was a group of guys. Ryan, Nick, Jo, Mo, Teddy, and Aiden were a unique group of guys. Jo was very quiet in class, but always had the answer when asked. Nick would ask for explanations if he saw I was near, but would always finish up an explanation with an, “I got this.” Teddy seemed to follow my lectures very well and improved in his grades while I was present. He would ask relevant questions, and then attempt to throw in a completely off the wall question. Memorably enough, he asked a high level question about the composition of the elbow joint. After my explanation, he further went on to ask how one would break an elbow, and if I had ever broken someone’s arm. It was at these moments I’d sigh and move on. Aiden was very much the same. He was friendly, but would sometimes get distracted. He also had a penchant for falling out of his desk. Mo would struggle to understand material at first. I would work with him after class for further explain any material. He did take pride in his grades and always would high-five me when he got an A. He put in the effort, and he was always happy when it worked. At the front of the class were three very talkative girls. Emma, Stephanie, and Jordan. They were always the first students into class, and would spend the first few minutes of class rapidly telling me about their days. Jordan was incredibly memorable. During a lecture on joints, someone brought up the concept of double joints and hyper extended their leg. She then proceeded to say, “That’s nothing,” and then rotated her prosthetic leg 360 degrees around. I never saw that girl without a smile. Alison and Hannah were in the top left corner and generally would come in bubbly and ready to learn. They
were also very good students and gave perfect examples of a Score 4 on MCAS open-responses. This class was definitely an interesting mix, but I can say they were always eager, and ready to go.

Period 4 was the smallest biology group, and required a strong guiding hand. There were only 14 students in the class, but they were often the most difficult to control. The primary problems were chatting during class, raising of voices, and speaking out during lectures. The chatting was easily solved by breaking up groups if necessary. They tended to chat or laugh mid class. Overall, the class would raise their voices and talk over each other during group discussions. The small size allowed for more freedom to have group discussions, or general chats about biology. However, this occasionally lead to some students talking over one another and voices to slowly rise. I would often have to stop the discussion entirely and refocus the class.

This class also had a wide range in maturity levels among the students. The biology classes consisted of freshmen and sophomores. This class seemed to have the greatest range between the most mature sophomores and youngest freshmen. The sophomores wanted lectures to go quickly and had greater experience in taking short hand notes. They would passively listen while absorbing information, and annotating notes as necessary. The younger students needed complete silence while writing and lecture slides needed to be incredibly concise because they would take down every single word. The solution was to introduce lecture outlines with room for notes. A lecture outline introduced the primary information with room for notes. However, this class was fairly successful in understanding the information, and it may be due to the greater focus that could be spared for each individual student. I had several memorable members of this class. Mikey, Alyssa, and Talbot were at the center of the class and were the ones to generally chat and laugh mid lecture. They were broken up, but still managed to chat from time to time due
to the small class size. However, they were a useful litmus test for if a lecture was confusing. They would share a confused face and ask several clarification questions. I usually knew the class would understand the lecture overall when Mikey would say, “I’ve got this.” Kassandra, and Maggie May were positioned near the front, and were both sophomores. They tended to come in, make conversation, and do their work well. Amelia was another sophomore. She was upbeat, but would often come in flabbergasted. Her grades were mid-range, and she was another student with a clearly defined confused face. When confusion appeared, I would usually reiterate what I was saying in a simpler fashion till it disappeared. When we had time before class, I would answer questions she had about the material. Emmett was difficult for me to work with. He rarely said more than two words, and wasn’t grasping the information well. His twin brother in period 1 was much the same. I would monitor their work to make sure they did it, and they did average overall. However, it was hard to get them to open up about where they were being challenged. I would eventually elicit some questions over time, but they seemed only mildly interested. Caitlyn Myers sat right up front. She detested lectures that required more than the lightest of note taking. She was generally pleasant but often would groan and moan about their being more information in a lecture while we still had thirty minutes left of class. It made it difficult, but she often answered during group discussions and was always excited about in class activities. She understood the material, but didn’t want to read the book nor take down notes. In the top right corner of the class was Chloe. She also wasn’t ever too pleased by taking notes, but helped by agreeing that they were necessary to have. She was cheerful, but was not a morning person. Morning classes were difficult for this class as a whole. Behind Chloe sat Holly, she was one of only two students that had attendance issues. She did not skip class, but she would not always regularly be in school. This peaked when she missed most of a week of school, and no
One including my supervisor was quite sure why. The students just seemed confused by her absence. Making up work was very difficult and required extra help from me. However, I did feel appreciated for it. She was one of the students that was fairly upset when I wasn’t going to be teaching the class any longer. The extra effort to help a student learn did make me feel like I accomplished something.

Period 5 was a mid-sized class of 17, and showed a great range in enthusiasm and learning styles. It included three of the top students in the grade. The other students were excellent students, but some required a different teaching method. My first experience in teaching was tutoring Sam, Patrick, and Jinchao during class. I would take them aside and allow them to move forward at a slightly accelerated pace. It was clear they were already working ahead. I would hand them a worksheet with new information, and the three would already know what I was required to teach. This is where my WPI education came into play. The first topic was DNA, and they held some interesting notions of genetics. I was able to lead them away from Hollywood concepts of thought, and explain more modern research. However, I was primarily taking them aside because they were causing some disturbances during class. The slower pace of normal lectures caused their attention to drift. If they weren’t chatting, or blatantly ignoring a lesson, they would answer questions out of turn, and take the learning experience away from other students. Patrick was the true problem child in this situation. The problem was solved as soon as he had extra work, or was interested. However, when I took over the class as a whole, I would often have to speak with him to the side because of his behavior. He seemed to curb the worst of the impulses over time. I frequently came close to losing my patience, but I remember that I hadn’t been dissimilar my freshmen year of high school. Jinchao was a perfect student, but I continuously had to explain to him that his miniscule handwriting would end up causing him
problems on the MCAS. It eventually became legible. He would ask me before and after class about complex calculus, and I usually told him that he was better off asking about biology. The rest of the class behaved much like period 1. They were eager to answer questions. I would call on some students directly to answer questions. This class had several students that would know the information but would be extremely hesitant to answer. There was a group of guys in the back that were very intelligent, but occasionally had self-doubt. They would prefer to let Patrick answer all of the questions. I would often ask a question, and look in their general direction until they chose to answer. Niall, and Kirk were the main two individuals that seemed incredibly hesitant to answer. However, once they were prompted, they would answer each question with greater confidence. This class also responded well to group work. I needed the time that group work provided to aid some of the students one on one. Sarah was one of the students that did not understand lectures. She would often get upset by the fact that she wasn’t understanding the information, and I often needed to go slowly through each step of a process and explain things in different way than was presented to the rest of the class. However, I knew she put in tremendous amounts of effort. On some assignments, credit could be regained through an extra assignment. She would put in more time and effort than any other students. Mathew was one of the students that preferred to work alone. He worked well with groups but would often prefer to just do it by himself and caused very little trouble. We had similar tastes in music so he would often talk to me after classes about his interests. Generally, all interactions I had with the students were pleasant even on their worst days.

Several other great opportunities presented themselves while I was teaching. I observed or worked with other classes on different occasions. A.P Bio was comprised of 5 female students and only one male student. This created an interesting tension in the class. It was apparent from
the first day that the male student felt apathetic towards the class and there was some tension. The rest of the class was incredibly tight knit and spent many lunches in the classroom. My supervisor led them in close group discussions, individual research, and studying for the A.P test. I conducted several experiments with them including a basic Hardy Weinberg lab, the A.P. photosynthesis lab, and pill bug lab. These were usually completed as a singular group and allowed for each person to share their observations. The lab periods were generally light hearted, and allowed for me to take a direct lead in organizing a higher level group of students. I also primarily observed, but did teach standard level biology classes. These were lower level students and there were several Teaching Aids that worked with the students with ISPs. My experiences did not formally introduce me to working with these students, but I did gain some experience in working hands on with the students, and was able to observe differences in class structure. The information was given with slightly less detail than the honor level class and in different iterations. Metaphors and analogies were used generously to impart meaning. I had the opportunity to lecture the lower level class on viruses. I used a modified form of a presentation and created, and outline for note taking. The lower level classes were much less likely to take notes and had more difficulties paying attention. The outline provided structure for notes as well as allowing for greater ease of attention. By going slowly, the class seemed to understand the complex topics of viruses without difficulty. This was particularly rewarding as one student that generally struggled thanked me after class. There is no better experience than seeing a student feel like he is walking out of a classroom having truly learnt something.
Chapter 9: Conclusion

Teaching at Tahanto Regional Highschool was one of the single greatest student teaching experiences I can imagine having. The school itself was beautiful, and the campus was surrounded by trees, farms, and the commute each day was like walking into another world. The building was marvelous and I was greeted by waves and smiles from students and faculty both. I believe that I personally benefited from this environment as it was incredibly different from my own experiences.

The classroom environment further boosted my enthusiasm to teach. Students wanted to do well and wanted to learn. As long as I didn’t waste their time, they wouldn’t waste mine. There were bumps, and pitfalls, but I received respect and honestly created many memories with all the students I was able to teach. I got to smile at their achievements, and help them through their own struggles. I don’t think there is a more rewarding experience than seeing a student struggle through a problem and then watching them understand it while I stood by their side. When they felt confident as students, I began to feel confident as a teacher.

But I gained more from the teaching than just educational experience. I was able to see my own high school struggles through a 3rd person perspective and definitely learned more about myself then those students would ever be able to learn from me. It was an experience that will stay with me for a lifetime.

I had the fortune of teaching many groups of incredibly gifted students, and it was an incredibly rewarding experience to see them grow and sad to wave them goodbye.
Appendix A: In class Work

Muggle or Magic: A Human Pedigree Activity

Assume that magical ability (M) is a recessive to non-magical ability (m). A person without any magical abilities is also known as a muggle.

If Mr. and Mrs. Weasley are a wizard and a witch, what are their genotypes?

Mr. Weasley mm Mrs. Weasley mm

2. What must be the genotype of all of their children (Bill, Charlie, Percy, Fred, George, Ron, and Ginny)? mm

3. Draw a pedigree for the Weasley family below. Use shading to indicate genotype. Also, write the names and genotypes below each of the circles or squares.
Now let's look at Hermione Granger's family. Hermione is a witch but her parents are both muggles. What are the genotypes for the three members of the Granger family?

Mom _______  Dad _______  Hermione _______

5. Draw a pedigree for the Granger family. Color according to Genotype.

Also, write the names and genotypes below each of the circles or squares.

Now let's look at Hermione Granger's family. Hermione is a witch but her parents are both muggles. What are the genotypes for the three members of the Granger family?

Mom Mm  Dad Mm  Hermione mm

5. Draw a pedigree for the Granger family below. Color according to Genotype. Also, write the names and genotypes below each of the circles or squares.

Harry is a wizard.

His father, James, was a wizard and his mother, Lily, was a witch.
Both of Harry's dad's parents had magical abilities.

However, Harry's mother's parents did not nor does her sister, Harry's Aunt, Petunia.

Petunia is married to Vernon Dursley and they have a son, Dudley.

None of the Dursleys have magical powers.

Also, write the names and genotypes below each of the circles or squares.

For those who only one allele is known, write the known allele and a question mark.

Complete the pedigree
Fructose, sucrose, and starch are all examples of
A. carbohydrates.
B. lipids.
C. nucleic acids.
D. proteins.

Which group of organic compounds contains fatty acids?
A. carbohydrates
B. lipids
C. nucleic acids
D. proteins

Cellular respiration involves a series of chemical reactions. Which of the following is a primary way that enzymes affect these reactions?
A. They decrease the pH of the products.
B. They increase the rate of the reactions.
C. They take the place of oxygen as a reactant.
D. They change the location of the reactions in the cell.

Cellulose is a complex carbohydrate that makes up the cell walls of plants. Which of the following elements are main components of cellulose?
A. calcium and chlorine
B. carbon and hydrogen
C. potassium and chlorine
D. sodium and hydrogen

Resistance to antibiotics results from variations in the genetic code of Streptococcus pneumoniae. Which type of molecule encodes genetic information in Streptococcus pneumoniae?
A. carbohydrate
B. fatty acid
C. nucleic acid
D. protein

The role of an enzyme in a chemical reaction is to change which of the following?
A. the type of reaction
B. the activation energy of the reaction
C. the pH at which the reaction occurs
D. the temperature at which the reaction occurs
Which type of molecule in the yolk of a chicken egg provides the most energy for a developing chick?
A. lipid
B. nucleic acid
C. salt
D. water

Which of the following is the main reason that humans need to include carbohydrates in their diet?
A. Carbohydrates are broken down in cells for energy.
B. Carbohydrates combine to form many different proteins.
C. Carbohydrates act as catalysts to speed up chemical reactions.
D. Carbohydrates are the building blocks for cell growth and repair.

What is the purpose of Chemical Respiration? What role does energy play?

What is the purpose of Photosynthesis? What role does energy play?
Visit the Cells Alive Meiosis page: http://www.cellsalive.com/meiosis.htm

What is the chromosomal number of the beginning cell? (How many chromosomes are shown? How many Pairs)

What is the Haploid Number?

Which colors represent pairs of Homologous chromosomes?

Explain why some colors transfer between Metaphase I and Prophase I.

What is the chromosomal number after Meiosis? (think N vs. 2N)

Explain what happens during each of the steps of either Meiosis/Mitosis:

Prophase:

Metaphase:

Anaphase:

Telophase:
The Japanese 4 o'clock plants show two different purebred forms of pure red, and pure white. However, the hybrid form appears pink. What are the three different genotypes? Describe by name and letter code. Use the letter R.

Red
Pink
White

If two pink flowers are crossed, what percentage of the offspring will be red, pink, or white?

The disease of sickle cell anaemia can cause death before reproductive age. The harmful genotype is homozygous recessive. Heterozygous individuals enjoy an immune defense against malaria. If you were a doctor, what would you tell a set of heterozygous parents about the risks involved with having a child? What is the probability that their child could die of malaria? What is the probability that their child will suffer from the harmful side effects of sickle cell anaemia.

Chickens are able to appear as black, white, or black and white speckled. What type of inheritance pattern is this? How would the offspring appear if a black and white chicken were bred?

A pea plant can have two different traits. They can be green (dominant) or yellow (recessive). They can also be smooth (dominant) or wrinkled (recessive). If a dihybrid cross is performed, what is the ratio of phenotypes that will appear? Support your answer with a Punnett square.
A parent that is heterozygous for type A blood has children with a person that is heterozygous for type B blood. What are the expected phenotypes? What blood type will each individual be able to accept?

A jaguar has multiple different alleles. They can appear as black, spotted, striped, or blonde. They are dominant in the order presented. Create a written system of alleles for the fur color. What offspring would appear if a heterozygous spotted/blonde individual is mixed with a pure bred striped individual? Support your answer with a Punnett square.

Colorblindness is recessive to normal vision and also sex linked on the X chromosome. Brown eyes are dominant to blue eyes and use the phenotype coding B(brown) and b(blue). What is the sex and phenotype of the offspring of a blue eyed, color blind carrier female; and a brown eyed heterozygous unaffected male? Support your answer with a Punnett square.
Chapter 33: The Nervous system

Function

1.
2.
3.

Structure

Subunit:
CNS:
PNS:

Dendrite:
Axon:
Schwann Cell:
Node:
Axon Terminal:
Nerve Impulse: ______________________ (other name):

At rest:

Inside Cell: Charge: Ion
Outside Cell: Charge: Ion

What ion flows into the cell during an impulse?

What happens to the charges on the inside and outside of cell?

What is the purpose of the Myelin sheath?

What is released at the axon terminals? What are these chemicals stored in?
Appendix B: Open Response Lecture

Cyanobacteria are prokaryotic organisms commonly found in streams and ponds as chains of cells. A portion of a chain of cyanobacteria cells is shown in the diagram below. The major parts of a cyanobacteria cell are labeled.

1. Identify one structural characteristic of a cyanobacteria cell that is similar to a characteristic of a plant cell.
2. Identify two structural characteristics of a cyanobacteria cell that are different from the characteristics of a plant cell.
3. Identify and describe the most likely process of reproduction in cyanobacteria. In your description, be sure to include what happens to the genetic material and the cell.

---

Cyanobacteria are prokaryotic organisms commonly found in streams and ponds as chains of cells. A portion of a chain of cyanobacteria cells is shown in the diagram below. The major parts of a cyanobacteria cell are labeled.

1. Identify one structural characteristic of a cyanobacteria cell that is similar to a characteristic of a plant cell.
2. Identify two structural characteristics of a cyanobacteria cell that are different from the characteristics of a plant cell.

No nucleus, sheath, photosynthetic membrane, no chloroplast

3. Identify and describe the most likely process of reproduction in cyanobacteria. In your description, be sure to include what happens to the genetic material and the cell.

**A sexual reproduction. Produce by fission. bacteria.**

*(not TOTALLY true, but good answer)*
Sarah and her biological sister, Danielle, have some physical characteristics that are the same and some that are different, as shown in the table below.

1. Identify the molecule that stores the hereditary information for these characteristics in the chromosomes of every body cell.
2. Identify the total number of chromosomes that should be in one of Sarah’s body cells and the number of chromosomes that should have been contributed by each biological parent.
3. Explain the roles of meiosis and fertilization in achieving the chromosome numbers you identified in part (b).
4. Explain why Sarah and Danielle have some physical characteristics that are different from each other, even though they have the same biological parents.

<table>
<thead>
<tr>
<th></th>
<th>Sarah</th>
<th>Danielle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Color</td>
<td>blue</td>
<td>brown</td>
</tr>
<tr>
<td>Natural Hair Color</td>
<td>light brown</td>
<td>dark brown</td>
</tr>
<tr>
<td>Ring Finger Length</td>
<td>shorter than index</td>
<td>shorter than index</td>
</tr>
<tr>
<td>Skin Tone</td>
<td>olive</td>
<td>olive</td>
</tr>
</tbody>
</table>
A. DNA is the molecule that stores hereditary information in the chromosomes of every body cell.

8. Sarah should have 46 chromosomes in every body cell, she should have gotten 23 chromosomes from her mother and 23 from her father.

C. Meiosis and fertilization are important in getting the correct number of chromosomes. Gametes (sex cells) are formed through meiosis, this produces cells with only 23 chromosomes. As the egg is fertilized by the sperm, both cells have 23 chromosomes. They fertilize and a cell is produced with 46 chromosomes, 23 from the sperm and 23 from the egg.

D. Sarah and Danielle have some different physical features even though they are from the same parents. Each parent has 2 alleles that they could potentially give to offspring. One of these alleles will be chosen along with one from the other parent. This allows for genetic variation as the same alleles won’t always be picked and different combinations of alleles lead to different traits.
Scoring Guide - Score Point 3

4. The molecule that stores hereditary information such as eye color, hair color, ring finger length, and skin tone within the chromosomes of every body cell is DNA.

3. Sarah should have 46 total chromosomes in each one of her body cells, with 23 inherited from her mother and 23 inherited from her father.

1. Meiosis is the division of a cell to form new daughter cells. In meiosis 1, the product is two cells and in meiosis 2, the product is 4 cells. Each cell has a full set of chromosomes in it before it divides, but after division, each cell now has half the chromosomes it had before, meaning that the cell originally had 46 chromosomes, but after meiosis was completed, it had 23.

2. Sarah and Danielle have some physical features that are different from one another, even though they have the same biological parents and this is because the alleles of each parent could have been inherited differently for each child. For example, the eye color and hair color differences between sisters could be because one daughter inherited the dominant trait, while the other daughter inherited the recessive trait, giving them different physical characteristics.
Scoring Guide - Score Point 2

8. A. The nucleus stores hereditary information for traits characteristics in the chromosome of every body cell.

b. In sperm, body cells there should be a total of 23 chromosomes. Each parent should have given 23 chromosomes.

c. Meiosis forms daughter cells in telophase.

         The sperm has made its way into the egg and is now producing a fetus.

Scoring Guide - Score Point 1

A) The information that is stored in them is they get 23 from their mom and 23 from their father.

B) The total of cells that sarah is suppose to have in her body is 46, all together her parent contributed 33 each.

C) The role of meiosis is when the water gets into the chromosomes and reproduces.

D) Reasons why they don't have the same because they both got the same chromosomes but different characteristics.
Scoring Guide - Score Point 0

a. The molecule that stores the hereditary information for these characteristics in the chromosomes in every body cell is DNA.

b. The total number of chromosomes that should be in one of Sarah's body cells is 23 chromosomes, and the number of chromosomes that should have been contributed by each biological parent is 23.

c. The role of meiosis and fertilization is how the eye color, the natural hair color, the ring finger length, and the shoe size all match up.

d. Sarah and Danielle have some physical characteristics that are different even though they have the same biological parents. It is because one of the sisters could have their mom's eye color and the other sister could have their dad's natural hair color.
Gregor Mendel developed an understanding of heredity through his experiments with pea plants. The diagram below shows a cell with two pairs of homologous chromosomes and a genotype of AaBb.

1. Identify all the possible allele combinations that could be formed if this cell undergoes meiosis.
2. Identify one of Mendel's laws that is illustrated when you write out these allele combinations. Explain this law.
a. All the possible allele combinations could be
Ab, Ab, aB, ab.

b. Mendel's law of independent assortment proves the nature of true homologous chromosomes. This law states that the chromosomes separate individually and then assort themselves randomly with the opposite set of homologous chromosomes during the process of meiosis. This therefore dictates the different allele assortment.

---

a. The combinations are:
   Bb Aa, Ab Ba, AA BB
   aa bb

b. The larger, more dominant gene supersedes the smaller recessive gene.
People may be Rh-positive or Rh-negative for their blood types. Rh-positive individuals have Rh factors, or markers, on the surface of their red blood cells. Rh-negative individuals do not have these markers. Several genes code for Rh factors. The D allele, which codes for one type of Rh marker, is responsible for the majority of Rh-positive phenotypes. Because of this, the D and d alleles are often used to describe Rh blood type inheritance. Determining Rh blood type inheritance is especially important when an Rh-negative woman is pregnant. If the baby is Rh-positive, the woman is treated with a special medicine so she does not produce antibodies that attack the baby’s red blood cells.

Using the given allele symbols, identify the genotype of an Rh-negative woman.

Draw Punnett squares to represent all the different crosses in which an Rh-negative woman could have an Rh-positive baby.

For each Punnett square you drew in part (b), determine the percent chance that the baby will be Rh-positive.
### Appendix C: Assessments

<table>
<thead>
<tr>
<th>1. Fossil</th>
<th>a. A trait that leads to greater reproductive success and is selected for by nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Paleontologist</td>
<td>b. A scientist that studies fossils</td>
</tr>
<tr>
<td>3. Relative dating</td>
<td>c. Using radioactivity to date rocks</td>
</tr>
<tr>
<td>4. Radiometric dating</td>
<td>d. A rapid evolution that leads to an increase in life and the ancestors of most modern organisms</td>
</tr>
<tr>
<td>5. Cambrian Explosion</td>
<td>e. Determining the age of something by comparing rock layers</td>
</tr>
<tr>
<td>6. Artificial selection</td>
<td>f. States that if a population is in equilibrium, then the allelic frequencies are constant</td>
</tr>
<tr>
<td>7. Natural selection</td>
<td>g. Selective breeding, humans selecting for traits</td>
</tr>
<tr>
<td>8. Biogeography</td>
<td>h. A new species evolves WITHOUT a physical barrier</td>
</tr>
<tr>
<td>9. Camouflage</td>
<td>i. The distribution of plants and animals around the world</td>
</tr>
<tr>
<td>10. Adaptation</td>
<td>j. Adaptation allowing for an organism to blend in with the environment</td>
</tr>
<tr>
<td>11. Hardy-Weinberg principle</td>
<td>k. A CHANGE in allelic frequency due to random chance</td>
</tr>
<tr>
<td>12. Genetic drift</td>
<td>l. The evolution of a species due to a physical barrier</td>
</tr>
<tr>
<td>13. Allopatric speciation</td>
<td>m. Darwin developed a theory on this stating that evolution could take place based upon nature selecting for traits due to the fitness of an organism</td>
</tr>
<tr>
<td>14. Sympatric speciation</td>
<td>n. Preserved evidence of life</td>
</tr>
<tr>
<td>15. Endosymbiotic theory</td>
<td>o. Explains the development of membrane organelles in Eukaryotes</td>
</tr>
<tr>
<td>16. Gradualism</td>
<td>p. Divergent evolution, a species gives rise through evolution to many more species</td>
</tr>
<tr>
<td>17. Punctuated equilibrium</td>
<td>q. The selection of a mate based upon specific traits</td>
</tr>
<tr>
<td>18. Sexual selection</td>
<td>r. Evolution that happens in small steps over a longer period of time</td>
</tr>
<tr>
<td>19. Bottleneck effect</td>
<td>s. Population becomes small due to a chance even resulting in change of genetic frequency</td>
</tr>
<tr>
<td>20. Adaptive radiation</td>
<td>t. Evolution that happens in quick bursts of large change</td>
</tr>
</tbody>
</table>
True/False

1. On the geological time scale, an era is longer than a period.
2. Miller and Urey constructed a chamber containing the hypothetical atmosphere of early Earth, input energy in the form of a spark, and the chamber produced simple prokaryotic cells.
3. The purpose of the covered flask in Francesco Redi’s 1668 experiment was to trap flies inside the flask with the meat.
4. A vestigial structure in one organism can be defined as a reduced form of a functional structure in another organism.
5. Fossils, although interesting, do not actually provide evidence of evolution.

Multiple Choice

1) While looking for fossils on an eroded hillside, you discover fossil coral and fish in one layer. In a layer just above you find the fossil imprint of a fern frond and some fossil moss. Assuming the rock has not been disturbed which of the following is the most probable conclusion?
   A) The area had been a sea until recent times
   B) In ancient times a sea had been replaced by land
   C) A forest had once grown there but had become submerged by water
   D) A saltwater sea had changed to a freshwater lake long ago

2) What was the earliest form of multicellular life on Earth?
   A) Fish
   B) Invertebrates
   C) Flowering Land plants
   D) Reptiles

3) What criterion would you predict will be used to divide the Cenozoic from the next era in the future?
   A) The eruption of a volcano
   B) A mass extinction
   C) Extinction of the white rhino
   D) A local warming trend

4) Which is an accurate statement of the differences between spontaneous generation and biogenesis?
   A) Spontaneous generation is the idea that life only comes from non-living material, while biogenesis states that life only comes from a living organism.
   B) Spontaneous generation is the idea that life can come from non-living material, while biogenesis states that life only comes from a living organism.
   C) Spontaneous generation and biogenesis are two names for the same idea concerning origin of life.
   D) The concept of spontaneous generation states that a species generates offspring when favorable, while biogenesis states life was created in a single event.
5) Which option places the likely events in the origin of life in the correct order?
   a) abiotic synthesis of amino acids and other organic materials/synthesis of proteins/development of a genetic code/evolution of cells/endosymbiosis
   b) abiotic synthesis of amino acids and other organic materials/development of a genetic code/synthesis of proteins/endosymbiosis/evolution of cells
   C) synthesis of proteins/endosymbiosis/development of a genetic code/abiotic synthesis of amino acids and other organic materials/development of cells/endosymbiosis
   D) abiotic synthesis of amino acids and other organic materials/synthesis of proteins/development of a genetic code/evolution of cells/development of a genetic code/endosymbiosis

6) Which of these is evidence for the endosymbiont theory?
   a) Mitochondria and chloroplasts cannot live on their own outside a cell
   b) Mitochondria and Chloroplasts are surrounded by a membrane
   C) Mitochondria and Chloroplasts contain their own circular DNA
   D) Mitochondria and chloroplasts both transform energy from one form to another

7) What was the significance of the Cambrian explosion to the evolution of life on Earth?
   a) It was a mass extinction during which nearly 90% of marine species were lost
   b) It was caused by tectonic plate instability, resulting in an eruption
   C) It was a rapid diversification of the ancestors of most major animal groups.
   D) It was the event in which life began, but no fossils survive

8) Consider a fossil find containing dinosaur nests, broken eggshells, and embryos. The shells and bones appear to have some original material and some mineralization. How would you classify it regarding fossil type?
   A) trace
   B) original material
   C) permineralized
   D) trace, replacement, and original material

9) Within a decade of introduction of a new insecticide, nearly all of the descendants of the target insects are resistant to the usual sized dose. What is the most likely explanation for this change in susceptibility to the insecticide?
   A) Eating the insecticide caused the insects to become more resistant
   B) Eating the insecticide caused the insects to become less resistant
   C) The pesticide destroyed organisms that cause disease in the insect, allowing them to live longer
   D) the insects developed physiological adaptations to insecticide

10) Which answer best shows an animal's adaptation to the tropical rain forest?
    A) Camouflage in a tree frog
    B) The long neck of a giraffe
    C) an elephant's long trunk
    D) Migration of birds in winter
11) When investigating the shell color of a species of snail found only in a remote area seldom visited by humans, scientists discovered the distribution of individuals that is shown in the graph below. Based on the information shown, what form of selection is the snail population undergoing?

   ![Graph showing shell color distribution]

   A) Stabilizing  
   B) Disruptive  
   C) Artificial  
   D) Directional selection

12) What type of adaptation is shown below?

   ![Graph showing adaptation]

   A) Mimicry  
   B) Camouflage  
   C) Artificial selection  
   D) Homologous structure

13) Which term best describes the structures shown below?

   ![Graph showing structures]

   a) Homologous  
   b) Heterologous  
   c) Analogous  
   d) Vestigial
14) Which type of natural selection favors individuals with moderate traits?
   a) Stabilizing
   b) Disruptive
   c) Directional
   d) Moderational

15) Which of the following is a correct statement about the relationship between natural selection and evolution?
   a) Natural selection results from evolution
   b) Natural selection is one mechanism of evolution
   c) Natural selection includes evolution as part of it
   d) Natural selection and evolution are the same thing

16) How do fossils demonstrate evidence of evolution?
   a) They show that ancient species share similarities with species now on earth
   b) They are primary source of evidence of natural selection
   c) They show evidence of species that are now extinct
   d) Fossils reveal that many species have remain unchanged

17) Which of the following is an accurate comparison of derived traits and ancestral traits?
   a) Derived traits result from artificial selection; ancestral from natural selection
   b) Derived traits appear in species; ancestral traits appear in genera.
   c) Derived traits are primitive; ancestral traits are complementary
   d) Derived traits are recent features; ancestral traits are more primitive features

18) Which of the following is the explanation of why bird wings and reptile forelegs are evidence of evolution?
   a) Similar functions point to a common ancestor
   b) Analogous structures indicate a common ancestor
   c) Vestigial structures point to a common ancestor
   d) Homologous structures indicate a common ancestor

19) Superficially similar features molded by natural selection in very different species are classified as what kind of structures?
   a) vestigial
   b) homologous
   c) analogous
   d) comparative

20) What is the term describing the process that occurs when a species evolves into a new species without a physical barrier separating populations?
   a) adaptive radiation
   b) coevolution
   c) sympatric speciation
   d) allopatric speciation
21) If a species is suddenly introduced into a new habitat, what might occur?
   a) habitat speciation
   b) coevolution
   C) adaptive radiation
   D) selective speciation

22) What is the process by which two isolated unrelated species may come to share remarkably similar traits?
   a) convergent evolution
   b) homologous evolution
   C) co-evolution
   D) allopatric speciation

23) 72 individuals out of a population of 200 are homozygous dominant. Using the equations
   $P^2+2PQ+Q^2=1$, and $P+Q=1$. Find the percent of the population that is heterozygous.
   a) .64
   b) .48
   C) .36
   D) .16
1) Write the formula for Photosynthesis. What type of organism performs photosynthesis? What is the role of energy in the equation? (8)

2) Write the formula for Cellular respiration. What organisms perform cellular respiration? What is the role of energy in the equation? (8)

Multiple Choice (4 pts each)

3) How many Chromosomes are in human skin cell?
   a) 46
   b) 24
   c) 48
   d) 23

4) How many chromosomes are in a human egg cell?
   a) 46
   b) 23
   c) 24
   d) 48

5) What is the name of a segment of DNA that controls production of protein and serves as a source for different traits?
   a) Gene
   b) Homologous Chromosome
   c) Chromatid
   d) Exon
5) What is the final chromosomal count of any haploid cell?
   a. 2n
   b. 4n
   c. n
   d. 23

7) What is the direct source of energy in cellular respiration?
   a) Sun
   b) Sugar
   c) ATP
   d) Oxygen

8) ____ is a product of photosynthesis
   a) ATP
   b) Energy
   c) Oxygen
   d) Carbon Dioxide

9) True or False (2 pts each)
   ____ Homologous Chromosomes are Identical
   ____ A fertilized Egg cell contains 4n the number of chromosomes
   ____ Plants perform cellular respiration
   ____ Enzymes increase the rate at which cellular respiration occurs
   ____ ATP is a necessary reactant for Photosynthesis
Appendix D: Labs

DNA Isolation from Onion

Objective: to Extract and Isolate DNA from an Onion

Onions are made of plant cells. These cells contain DNA like most other cells. They also contain a cell wall and cell membranes along with other different parts of the cell. We will be blending up onions to break the cell walls, and using soap and water to dissolve the membrane and DNA. We will then add an alcohol to isolate the DNA.

Materials
Blender*
Onions
1 knife
cutting board*
Measuring cup*
water
Liquid Soap
paper towel
Strainer
bowl
clear cups
plastic forks
isopropyl alcohol (99%, aka rubbing alcohol)

Procedure
Peel and cut up onions, and blend.
Add ¼ cup water per every 2 onions.
Bland to a puree
add ¼ cup liquid soap per every 2 onions,
Gently Stir
Allow mixture to sit for 5 minutes.
Filter through paper lined strainer
After filtration place the mixture into clear plastic bowls.
Add a 1:1 amount of isopropyl alcohol to what was filtered out
Observations:
What was observed after the addition of isopropyl alcohol?
What is macromolecule that we are observing?
What part of the cell is this located in?
What other macromolecules were involved today?

If a solid was observed after the addition of isopropyl alcohol, what is the role of the alcohol?
Why was the blender necessary to deal with the cell wall?
What is soap and why was it necessary to remove the cell membrane?

Explain the purpose of each labeled portion.
The Hardy-Weinberg Equilibrium

Lab Activity AP Biology 2010

Introduction: Hardy and Weinberg came up with a mathematical equation that predicted the allele distribution in a population based on the following principles:

- The population is large (statistically speaking)
- The population is breeding freely — no restrictions of any kind
- The gene pool in the population had no mutations
- There is no gene flow due to immigration or emigration
- There is no selection: gene combinations are all the same and do not lead to an advantage over another combination

If these conditions were in place, HW Equilibrium predicts that allele frequencies in the population should be maintained. The allele frequencies are based on a basic Punnett Cross between two heterozygous individuals: 1 AA : 2 Aa : 1aa. or in the language of HW 1 pp (p squared) : 2 pq : 1 qq (q squared). Since there are only two alleles: p and q = 100% of the population (p + q = 1) and p squared + 2 pq + q squared = 1

Let’s try to see if this holds true: Scenario 1

1. Get a bucket with two colors of beads. Decide which color is p and which is q. You should have 100 beads total, 50 q’s and 50 p’s.
2. Blindly and with your partner take turns to pick out a bead each out of the bucket and pair them up. Record your combination then throw the beads back. Do this for 40 breedings.
3. Analysis: Your population was in equilibrium at the beginning. Analyze your data by adding up all the p’s and all the q’s. How close are you to equilibrium?
4. Analysis: Add up all your q squareds and 2pq and p squareds — how close are you in equilibrium?

Selection: Scenario 2

1. Selection means that one combination of alleles has an advantage over another. Start with the same bucket, but this time every time you get the combination qq – the baby dies. If this happens, do not record the result, just throw the beads back and draw again. Do this for 40 breedings.
2. Analysis: Your population was in equilibrium at the beginning. Analyze your data by adding up all the p’s and all the q’s. How close are you to equilibrium?
3. Analysis: Add up all your q squareds and 2pq and p squareds — how close are you in equilibrium?

Heterozygote Advantage: Scenario 3

1. Let’s take it one step further. This lab is based on what is happening right now in Africa due to a combination of sickle cell genes and the infectious disease Malaria. If a person is born with qq, they have sickle cell disease and usually die before reproductive age. If a person has pp – no sickle cell disease and normal blood, they have a good chance of catching Malaria and dying from it at a fairly early age. A person who inherits one sickle cell gene and one normal one will not die of the sickle cell disease [there maybe some inconveniences], but the weird thing is the malaria parasite cannot survive in their poorly oxygenated blood and therefore, these folks do not get Malaria.
2. Let’s see what that means: Do everything like in scenario 2, except when you get a pp, toss a coin to see if they survive Malaria. If the coin lands head up, they die and you have to pick again. Qq’s still die as before.
<table>
<thead>
<tr>
<th>Scenario 1 Normal</th>
<th>Scenario 2 Selection</th>
<th>Scenario 3 Het Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>37</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>39</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Totals</td>
<td>Totals</td>
<td>Totals</td>
</tr>
</tbody>
</table>
Debrief and Questions to answer:

Reading:

Hemoglobin, the molecule that carries oxygen in the red blood cells of human children and adults, is a protein made of two alpha subunits and two beta subunits. The genes that encode the alpha and beta subunits are both known to have several alleles. Many of these alleles derive from point-mutations in the DNA sequence that lead to single amino-acid substitutions in the protein. Most of the mutant alleles are very rare, because they reduce the efficiency of oxygen transport by red blood cells. In sub-Saharan Africa, there is a surprisingly high frequency of an allele that produces an abnormal form of the beta subunit of the hemoglobin molecule. 2. The allele is the result of a single point mutation in the coding region of the beta subunit gene. This mutation results in a substitution of valine for glutamic acid in position six of the beta subunit. This substitution alters the shape of the hemoglobin molecule. Hemoglobin molecules containing altered beta subunits will crystallize under conditions of low oxygen tension. When this happens, the red blood cells which carry the hemoglobin molecules change shape drastically. Instead of their normal platelet shape, the red blood cells become sickle-shaped. We will use the symbol $i$ to represent the allele for the normal form of the beta subunit, and the symbol $q$ to represent the mutant form responsible for cell sickling. The three possible genotypes in a population containing both alleles are $ii$, $iq$, and $qq$. People with the genotype $ii$ make normal hemoglobin and have a normal phenotype. People with genotype $qq$ produce hemoglobin that is highly prone to sickling, and as a result suffer from anemia caused by poor oxygen delivery by the sickle-shaped cells in the blood. Furthermore, periodic and painful crises can lead to serious organ damage. This condition, known as sickle-cell anemia, is often fatal. Many homozygotes die before the age of reproduction. People with the genotype $iq$ produce a mixture of normal and abnormal hemoglobin. For the most part, the production of normal hemoglobin compensates for the production of mutant hemoglobin, and the heterozygotes do not suffer from sickle cell anemia (although they are, of course, carriers of the sickle-cell trait).

Malaria, a disease which can cause debilitating anemia and potentially fatal brain and blood clots in people, is caused by four species of protozoa in the genus Plasmodium. By far the most pernicious of the four is Plasmodium falciparum which is common in sub-Saharan Africa. The plasmodium is transmitted from one person to another by way of a vector, the mosquito. Several tropical mosquito species are capable of transmitting the plasmodium, and as a result, the disease is endemic to many tropical areas. In Africa, where 90% of the world’s malaria cases exist, the mosquito Anopheles gambiae is the main vector for the plasmodium. Mosquitoes transmit the disease by drawing blood from an infected person. With the blood, they also draw up plasmodia. These plasmodia live in the gut of the mosquito, where they reproduce sexually, and move to the mosquito’s salivary gland. When the mosquito then draws blood from an uninfected person, the plasmodium is transferred to that person in the saliva of the mosquito. The plasmodia invade the human blood stream and quickly move to the liver where they multiply by asexual reproduction. The offspring of these invaders move back into the blood and inhabit red blood cells. Further asexual reproduction causes the red blood cells to burst, which causes the severe symptoms of the disease.

In 1949, J. B. S. Haldane suggested that the reason that the deleterious $i$ allele occurs in high frequency in some human populations is because individuals who are heterozygous for the allele (genotype $iq$) do not suffer from the severe anemia due to cell sickling, but also enjoy resistance to malaria. He based this proposition solely on the observation of higher than expected frequencies of allele in regions where malaria is endemic.
Questions:

1. In your own words explain if the sickle cell allele in the United States would show a similar distribution to the one in Africa. Why or why not?

   No. We have a much lower rate of malaria, and so sickle cell heterozygosity would be more detrimental (harmful) to an individual. It would be better to be homozygous dominant and free of the disease.

2. If you drew graphs that show allele distributions for the three different scenarios, which of the graphs below would most resemble Scenario 1? Scenario 2? Scenario 3? Explain your answer!

   ![Graphs](Image)

   2: If leans towards PP
   3: High heterozygosity

3. What are the five conditions in which the HW equilibrium could not be applied? Did your results agree with this?

   Natural Selection is taking place. So 2, 3.

   Large population, no emigration immigration, no mutation, random mating, no natural selection

4. Calculate: In a population of 500 yellowbellied sapuckers, 50 had the recessive trait of short beak. Calculate the allele frequencies and genotype frequencies according to HW:

   q squared: 50/500 = 10%
   q = √(0.10) = 316
   p = 0.84
   p squared: 0.84² = 0.67
   2pq = 2(316)(0.84) = 432

   How many individuals would be heterozygous? 2pq = 0.432

5. Calculate the genotype frequencies if a devastating illness hit the species. The population is now only 200 and 102 of the individuals have the dominant trait. Why does this tell us about what trait is more likely to survive the disease?

   P² = 2pq = 102/200
   q² = (200-102)/200 = 0.49
   q = 0.7
   p = 0.3
   p² = 0.09
   2pq = 0.42

   Recessive traits more likely to survive
Works Cited


4) "Education Reform: Ten Years after the Massachusetts Education Reform Act of 1993."


