

# A Teaching Practicum in Biology

An Interactive Qualifying Project Report

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Submitted By: Thomas Biernacki

Advisor: Professor John Goulet

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[tbiernacki@wpi.edu](mailto:tbiernacki@wpi.edu)

## Abstract

In the spring semester of 2014, I was a student teacher at Doherty Memorial High School located in Worcester, Massachusetts. This report discusses my foray into teaching at a public school with a very diverse student population. The classes I taught were two honors level freshman biology courses and one honors level physics course. As one of the most enriching experiences in my life, I was able to transfer my knowledge of these subjects to my students through creating bonds with them and getting them excited to learn.

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## Chapter 1: Background

Today's standards of teaching are something that cannot be fully appreciated unless one knows about the state of education over twenty years ago. Being a person that grew up when standardized testing was standard practice, it's remarkable to look back at the Massachusetts Education Reform Act of 1993 and realize how revolutionary it was at the time. The Education Reform Act of 1993 changed how education was handled in Massachusetts in an effort to hold students and teachers to a higher standard and improve the quality of education. Possibly the most notable and impactful change was the Massachusetts Comprehensive Assessment System (MCAS). This was to be a test taken by all students in the state in grades 4, 8, and 10. The MCAS was to test the implementation and carrying out of the new curriculum frameworks that emphasized many subjects, rather than the previous focus on only history and physical education. These new curriculums and the passing of the MCAS now controlled a student's ability to graduate from high school. <sup>(1,7)</sup>

Beyond the changes in the curriculum, the reform act also created a foundation budget that increased the budget of schools in the state during the seven year plan of the act. The increase in budget of course was necessary as the act also mandated 990 hours of secondary school be focused on core academics. The act also saw to the opening of publicly funded charter schools, the testing of teachers on their subject material, and also allowed the state to hold districts responsible for their performance, allowing the state to interject as they saw fit. This new system gave a baseline for the knowledge of both teacher and student and allowed for both to be assessed to see where improvement was needed. <sup>(1,7)</sup>

Massachusetts is often seen as one of the leading states in public education, and that is for good reason. The National Assessment of Educational Progress (NAEP) tests students in grades 4, 8, and 12, and Massachusetts regularly scores well over the national average. In fact, Massachusetts is the only state to have over 50% of its students reach the level of proficient or above. In fact, in 2013 Massachusetts saw 55% of its students at proficient or above while the national average was only 34%. Trends in International Mathematics and Science Study (TIMSS) is an international assessment for mathematics and science that allows for comparison among students in many nations. TIMSS only further bolsters the claim of Massachusetts being a top state in education, as the fourth and eighth grade rankings put Massachusetts in the top six for both science and math when compared directed to the other states and nations that participated.<sup>(8,10,11)</sup>

The curriculum frameworks basically outline what needs to be covered in each subject by each year. These results driven frameworks really push the teacher to make sure the students know everything that is outlined, as they serve as preparation for the MCAS exam. The curriculum frameworks are there to ensure students are held to a high standard while learning, as the content found in them are challenging to fit within an academic school year, especially as the students ages. After reading over the curriculum frameworks for high school biology, I can tell that it certainly is not easy to cover all of those topics in a year. While there are only six major topics (chemistry of life, cell biology, genetics, anatomy and physiology, evolution and biodiversity, and ecology), some seem like they would be much more time consuming and challenging to teach than others. For example, the students I am observing and will soon be teaching are only in their first year of high school, so their chemistry background is very limited yet they are expected to learn about

chemistry in organisms, something that could be heavily aided with chemistry knowledge. The overall expectations of the curriculum frameworks are ambitious and seem like they would result in knowledgeable citizens, but to fully cover everything requires talented teachers.<sup>(2)</sup>

As far as important education reform goes, one of the more recent ones is the Common Core State Standards Initiative. This initiative was set forth by the National Governor's Association (NGA) and the Council of Chief State School Officers (CCSSO) in an attempt to prepare students from kindergarten to grade 12 to enter a 2 to 4 year college or the work force after their high school careers. Specifically, the Common Core only sets goals for learning efforts in the field of English Language Arts and mathematics. These fields were chosen because of they are both major components in many other subjects. It is important to note that the Common Core is entirely optional for a state to adopt and was created by teachers, school administrators, and experts in teaching and was not developed by the federal government in any way. The Common Core presents a framework for each year of schooling, and so the implementation in Massachusetts does not seem to have radically changed how math and English are taught due to the improvements made in the Education Reform Act of 1993. In my research as to how the Common Core at Doherty is being implemented I came up with several requirements teachers need to do. First, the teachers having training they must complete in order to know the ins and outs of the Common Core. They also follow the standards pretty strictly when teaching. The department heads at Doherty are also responsible for making sure everything is happening as it is supposed to, and they check by having the teachers submit lesson plans and their filled out grade books to them to be checked periodically. The Common Core would have

been in part developed based on the Massachusetts' education system due to the state's continually high rating compared to other states, and that is why the implementation would not have been as groundbreaking at Doherty.<sup>(6)</sup>

The socioeconomic profile can be described as all minorities being a lower percentage of the student population than that of the rest of the district, but they are almost all a greater percentage than the student population of the entire state. The African American student population at Doherty is 14.0% compared to 14.2% of that of the district and 8.6% of that of the state. The Asian student population at Doherty makes up 9.7% of the state compared to 8.1% and 5.9% of the district and state, respectively. The Hispanic population is 29.5% of the student population compared to 38.1% and 16.4% of the district and state, respectively. The white population makes up 43.7% of the student population at Doherty, compared to the 35.8% and 66.0% of the district and state, respectively. The Native Hawaiian and Pacific Islander population is 0%, which is very comparable to the district and state. Lastly, the multi-race, non-Hispanic population at Doherty is 2.5% of the student population compared to the district's 3.5% and the state's 2.7%. The ratio of males to female is almost perfectly 1:1. For a language profile, Doherty has 44.5% of its students with English not as a first language and 25.8% of the students are English Language Learners. As far as economics are concerned 59.3% of the students come from a low income home with 52.1% having free lunch and 7.2% having reduced lunch. Reading these numbers are somewhat surprising as far as economics go, because I would say that the majority of kids it would be tough easily distinguish whether or not they receive aid for meals, while the breakdown by race is not very surprising considering I have been

observing multiple classes here and have seen the diversity that the high school has to offer. <sup>(9)</sup>

Doherty Memorial High School's MCAS results for English Language Arts were moderately good while math was a little worse and science even lower than math. Specifically, 86% of the students for proficient or higher for English, 71% of students were proficient or higher for math, and only 62% of students were proficient or higher for science. While not all these scores seems that great, the ten schools that the department of education consider comparable in terms of grades span, enrollment, and special populations were not by any means significantly better. In fact, Doherty is on the lower end in terms of English compared to these schools while they are average for math and above average for science. Whether this is due to the amount of content covered on each subject of the MCAS or not, it seems that scores for English are consistently good while the scores for science are consistently mediocre.<sup>(9)</sup>

With public schools in an urban setting there will be those students whose language spoken at home is not English. These students may need special instruction when it comes to learning English and are deemed to be an English language learner (ELL). Previously, the English ability of a student in Massachusetts was assessed with the Massachusetts English Proficiency Assessment (MEPA), however the new method as of the 2012-2013 school year is the Assessing Comprehension and Communication in English State-to-State (ACCESS) for ELLs test. This test assesses the social and instructional English ability of the student and does so by testing reading, writing, listening, and speaking ability. How well the student does in testing dictates the course of instruction for that student. <sup>(3,4)</sup>



For those ELL students that need the most help in adapting and learning in English, which is based on a level assignment from the ELL test they took, there is the Sheltered English Immersion/Instruction (SEI). SEI provides the student with the most helpful environment in adapting to the English language. The instructors for SEI students are specially trained to help them understand English so they can make enough progress to integrate into a normal English classroom. <sup>(5)</sup>

My student teaching experience at Doherty Memorial High School was comprised of two honors level biology class and one honors level physics class. The biology classes were mostly comprised of freshmen with a one sophomore student. The physics class was given to Mr. King after staff employment changed during the winter break. The students in the physics class were all seniors except for one sophomore and one junior.

## Chapter 2: Standard A- Plans Curriculum and Instruction

Student teaching is no easy task, especially when also taking very time consuming classes at Worcester Polytechnic Institute. This meant that planning lessons had to be very well thought out and always at the forefront of my goals for the week. After observing how my mentor, Mr. King, was able to present the material required by Massachusetts curriculum framework in exciting and engaging ways, that is how I modeled my style of teaching. The science and engineering standards set by the state have high expectations, so there was never a wasted day when presenting the material to the students. By combining the textbooks available to the students and the curriculum framework standards, I feel like I was able to prepare my students well for MCAS standardized assessments required for graduation, as well as imparting them with knowledge that would serve them well in life no matter what path they decide for themselves in the future.

When planning my lessons I always had a theme from the Worcester Public School benchmarks for science as well as the Massachusetts Department of Education standards for science and engineering that the students could take away from class that day. The standards set by the state are grouped by units that I followed sequentially in a manner that I believed would allow my students' knowledge to advance on a daily basis, but also reinforce previous knowledge learned. While I started out almost purely on a lecture based lessons, I took feedback from the students and Mr. King to adapt to a much more interactive classroom that was the most conducive to learning and participation.

Assessments are core to academia and were used by myself to see how well the students were understanding the material. Formative assessments were used on a daily

basis. After presenting material, I would often have an example that I would give the students a few minutes to work on before having them share their answers. For example, when working with Punnett squares, of which there are many cases, I would draw the square with the alleles filled out and then call on students to fill in the innards of the Punnett square. If they did not succeed I would walk them through the process of doing the problem properly, and ensure that all students understood the material. Formative assessments also came in the form of homework that presented the students with material from their textbook to prepare them for material we would cover then in class. The homework was usually to read a section in the textbook and answer questions on it, and it was used to engage the class through more than just in class assessments. When it came to summative assessments, I gave all the classes weekly quizzes that would test their knowledge on what was learned since the previous quiz. As a college student, I have had many assessments and I always feel like I took more knowledge away from frequent assessments rather than large cumulative ones, so I applied this method in my classroom. Often these assessments were comprised of standardized test questions, the type of which were practiced in class, one or two questions from the homework, and some critical thinking questions that had students apply their knowledge instead of just reciting it. While I had high expectations for the students due to the courses being honors level, I tried to also be reasonable with them and made sure they were prepared for their assessments so long as they put in effort. On a few occasions, I gave the students take home assessments that I used to save in-class time and also give them more time to explore the material through any resources that they wanted to utilize.

The reading material I presented the students was in their textbook and was used to give them background knowledge before we covered the material in class. Also, when it was applicable, I recommended videos that could easily be found online that were able to illustrate the material better for students that do better with a physical representation of ideas rather than a verbal and conceptual representation. A number of times I had students participate in groups so they could work together to solve a problem and help each other when it came to understanding concepts. One example of this was when I wanted to illustrate the central dogma of biology, so I made cards of a DNA sequence, its complementary RNA sequence, and then the resulting amino acids produced. I then randomly distributed the cards to the students and had them find the group of three that they belonged to. When genetics can be a very conceptual based topic, I felt that this would help illustrate to the students the concepts of the central dogma and feel that the end result was a better understanding of transcription and translation for the students. Other ways that material was reinforced was by having the students work on writing problems from past MCAS so they could collaborate and prepare for the standardized assessment. I used this to prepare them for the test and to see how well they absorbed the material that was presented to them.

When it came to presenting concepts and vocabulary I would write the main concepts and vocabulary on the board with a short definition of each. I would always further explain the concepts, but wrote what I wanted them to take away from the explanation. For vocabulary I often tried to breakdown the nomenclature of terms to help them distinguish what otherwise would just be another vocabulary word to them. For example, when describing diets of organisms, the terms carnivore, herbivore, and

omnivore are used. I showed them that each one had a root that could be used to define the word, (ie carne=meat, herb=plant, and omni=all). I tried to also reinforce concepts by connecting new ideas with knowledge the students already had, like breaking down the ecology hierarchical structure of ecosystem, community, population, and species by using the city of Worcester as an example.

One of the lessons that I have really picked up in college is that there is no shame in asking for help. While I did my best to reinforce this idea with students, I also often kept this in mind. If I came across a particularly tough topic I would consult Mr. King and see how he taught it in the past and take to heart any advice he had for me. To see if my assessments were too tough or not clear enough, I often asked my roommates or any friends I was around at the time of writing them for feedback. I also gained many perspectives on how to go about different topics by observing different teachers at Doherty. At the end of the day I just wanted to do the best that I could and wanted to do so that my students would all be able to fulfill their potential as well.

When it came to teaching I also wanted the students to feel that they were responsible for what they took away from the class. If they felt they were successful by doing well on assessments, I always wanted to have positive reinforcement when they did well. However some students just would not do as well as others on summative assessments, but I did my best to show them that an increased effort always resulted in better grades. One example of this was by having a review day for a quiz and by rewarding the students that participated the most with a few extra bonus points for the quiz. This interaction with them saw some students that are not always fully engaged suddenly have

an urge to participate. By positively reinforcing participation from students early on, I did not always need to give a reward for there to be active participation, making the initial endeavor successful.

When it came to planning and instruction, I consulted with Mr. King any time I had a question regarding a student with an Individualized Education Program. When I started teaching, the accommodations were already in place and I did nothing to alter that. I always strived to plan lessons where all students would succeed.

Lastly, one unique planning aspect at Doherty came to the rotating long period. The long period would change day to day and add 20 minutes to a period every six days. Considering I had two classes that were supposed to be the same, I had to plan carefully so that the same amount of knowledge would be presented to all the students by the time of the weekly assessment. While not an overly difficult thing to do, it forced me to plan even more carefully.

## Chapter 3: Standard B- Delivers Effective Instruction

Having effective instruction for the entire time of a class is key to making the most of each class period. As an engineering student, I always see a need to make things more efficient, and when it came to managing class time, I did my best to make sure the students were always engaged and learning.

When it came to beginning every lesson, I tried to outline what exactly we were going to cover that day and the importance of each topic. My teaching revolved around writing important notes on the board and then using the overhead projector to use supplementary illustrations that enhanced learning. Before I introduced new material, I made sure that students were familiar with background that I thought was key to understanding the topics of the day.

When it came to actually carrying out the lessons, I always tried to use a variety of techniques for engagement. One of my favorite and the students' strategies was small group work, as they were able to interact with their friends, but I was able to reinforce group work and able to pair students who would work well together and be able to share their knowledge and explain ideas to each other, instead of me just explaining a concept to a single student in front of the whole class. During this group time I was very open to helping any group that asked questions and was able to have the knowledge spread around the class by having them explain things to each other. When direct instruction was not in play, I often tried to have the students develop their critical thinking by asking certain questions that they would then draw their own conclusions on and have them make connections of key concepts through their own revelations. The moment of a student

finally having an “Ah-Ha!” moment after having been struggling with a concept by them working it out is one of the greatest pleasures in teaching. To make sure that everyone was always on the same page, I would take feedback from the students and remediate any problems they were having by reteaching particularly tough concepts, especially if a number of students were having problems.

When it came to extending and completing the lesson, I focused on methods that I thought would directly lead to a better understanding of the material. I assigned homework almost every night of the week and checked it when I took attendance. I would communicate regularly with students to tell them how they were doing in the class and warn the ones that had work missing. If a student performed poorly on an assessment I would often give them an alternative assignment that would allow them to make up the assessment to a passing grade. The assessments I used usually varied so that competence could be reached even if they were not particularly good at one type of question.

When it came to evaluating student learning, I did my best to make sure all students had an understanding of the material before we moved to a new topic of interest. I would often have a review lesson of the material using MCAS questions to make sure they would be ready when it came time to applying the knowledge they were just tested on. When it came to the administrative duties of recording attendance and grades, I followed all the guidelines and did so without loss of instructional time.



## Chapter 4: Standard C- Manages Classroom Climate and Operation

Managing a classroom in Worcester made me nervous when I even started thinking about teaching. I came from a high school in a small town and saw students be disrespectful to teachers just because they felt like behaving that way. Combine that with shadowing different teachers at Doherty before I started to teach and one or two horror stories from WPI students that did this same practicum, and I was just waiting for all my fears to be realized. However, upon the viewing of Mr. King's classes I saw students that were attentive and respectful, which was one of the greatest reliefs I have ever experienced. Suddenly, I felt confident that I could handle teaching and knew that with such confidence and a strong demeanor that I would be able to be an effective student teacher.

When I started teaching after about two weeks of observation, I knew I had to present the students with a number of things. The first was an excitement to teach. If I was not excited about the material, I knew that there was no chance they would be either. I also knew that I had to show them respect in order to establish a mutual respect among teacher and student and between student and student. By doing these two things I felt that I would be able to manage the classroom and create an environment where only respectful interactions occurred, both of which I feel I succeeded at.

The physical environment of the classroom was already in place when I started to teach. It was Mr. King's room and having rows of tables facing the board was the ideal set up as far as I could tell. There was no changing of the physical environment, but I did take feedback from the students to make the learning environment ideal. For example, some days there would be a glare on part of the board from the sun, so I would quickly check to

make sure that the students could see the board before writing notes down. I always did my best to make sure that the physical environment did not hamper instruction, and while that did mean moving a few seats so that side chatter would stop, I felt that I was successful as solutions I implemented often solved any minor problems.

As I previously mentioned, mutual respect was promoted at all times in the class. As someone that is not too far out from being a student in high school, I still have some understanding of the drama that is currently plaguing some high school students. There was only one major conflict that occurred, which was in the honors level physics class, where two female students were feuding on social media. I put a prompt stop to any verbal discussion between the two and one of the students decided to cool down by going to the bathroom, which I believed was the best way to stop the feud and continue with the lesson with no more loss of instruction. Other times students would find themselves on the receiving end of one too many jokes, so I would divert any attention to them back to the lesson, as I understand that even little jokes can get out of hand and be detrimental to a student's work and mental health. Respect was always urged and by showing the students respect by treating them like students that are on track to enter college, I feel I was able to get them to perform at a higher standard academically.

Appropriate behavior of course was also always mandatory. Whether it be tossing a pen back and forth before class or a student poking the back of another student sitting in front of them, I always did my best to put an end to any action that was not focused on learning. Also along these lines, safety was of course a top priority. While no dangerous activities were even performed, no types of threats were tolerated, though all were in jest

from the students. My focus was on always having a strong environment where the students could enter and spend the entire period learning, and that is what I strived every day for. By maximizing the time on task for every lesson and varying the way information was portrayed, I feel like the classroom climate was always a positive one for learning.

## Chapter 5: Standard D- Promotes Equity

For me, equity in the classroom goes hand in hand with respect. Every student in all of my classes was seen as an equal, not just because it is mandated, but because it is the right thing to do and because I expected the best from all of them. To promote equity, I made sure to always have a positive and encouraging environment to share. I would often pose open ended questions that were supposed to guide the lesson based on the class's answers, and I believe that method worked very well. While not all answers received were the answers I was anticipating, I often was able to take pieces of answers and connect it to the lesson. By doing this I reinforced the idea that the students knew more than they thought they did and that by trying they could succeed even if they knew they were taking a risk at being wrong. By creating this environment of positive reinforcement, I was able to get participation from all students and made each feel that they contributed to the classroom discussion, ensuring future participation as well. Of course, some students are just naturally introverted, but by spreading the attention as much as possible I was able to get even some of the more bashful students to become engaged.

One of the activities that was incredibly successful was just trying to get different examples of organisms that fall within different categories in ecology. I used this as a review for the quiz the next day and enticed students to participate by offering a marginal amount of bonus points on the quiz based on participation. By doing this I was able to create an excited environment where nearly all students participated in the activity. During the activity I did tend to allow the usually disengaged students to answer more, but by doing so, I felt I was creating the positive environment that promoted the achievement of

those students who may not usually get praised for getting one of the highest grades on assessments. By combining an inviting environment with a respectful one, students were not afraid to volunteer their ideas to contribute to the class.

When it came to dealing with students of all different backgrounds and promoting American civic culture, I always followed the school committee policies and procedures. By emphasizing notes that had key words at the focus of them, I was able to convey the most important topics to students no matter the English competency. One example in particular was a student named Thao whose first language was not English. However, he did like to be vocal and so by encouraging him to participate I feel he was still able to get the same experience out of the class as all the other students did. When grading assessments, I took the students' English proficiency into account and did my best to read into the meaning of their writing rather than only accepting a cookie-cutter answer. As long as I knew they understood the material and put effort into formulating an answer that was acceptable, their grade reflected their knowledge and effort. Promoting equity among all students was key to forming a good learning environment and encouraging all students to succeed no matter what their background was.

## Chapter 6: Standard E- Meets Professional Responsibilities

Professionalism is key to getting respect from the students and the faculty. Having the appearance and confidence of competency makes it possible to control the classroom. Also, in an environment where I was the youngest, making a good impression on the faculty allowed me to reach out to them easier. While it is good to build a relationship with students to connect with them, it is very important to always be professional. The goal of teaching is to transfer knowledge, and I understood the legal and moral responsibilities behind this.

To get the students to learn, it was always important to entirely know the material I was teaching them. It did not stop there though, as I always had to be enthusiastic when presenting the material, but if I was not excited for class, there was no way they would be. I've taken classes in the past where you could tell the teacher was not interested in the subject matter, and it was tough to be engaged in such classes. As such, I did my best every day to present the material in an energetic and interesting way.

When it came to exhibiting professionalism in the classroom, I made sure to do so every day with my actions and appearance. Every day I wore a shirt and tie wardrobe combination, as this separates the students from the teachers and shows a seriousness in my actions. I also followed all school policies and procedures and was sure to enforce all rules. My professional responsibilities were also seen by when I did my best to help students when they asked for it and when they needed it. For example, if a student need extra help, I spent time with them before school or gave them extra materials. There was one instance where a student's parents wanted to meet with Mr. King and me as they were

concerned over their son's grades. They were not accusatory towards me when it came to grading, but just wanted to make sure their son would be able to pass. I was able to tell them where he struggled, which was he was able to understand the material, but he just needed to apply himself more with homework and studying. His parents were very grateful for my opportunity for extra credit for him, and it was an experience where we all benefited. One more of my responsibilities was seen when I started to teach evolution. Evolution can be a controversial theory depending on the audience, but I made sure to stress to the students that evolution was a theory with evidence and it was up to them whether to believe it or not.

During my practicum, teaching always came first. I took feedback from the students and did my best to improve each day. Teaching two of the same class sometimes meant the second class got the better flowing lesson, but I don't think that made the first class poor. I followed the curriculum frameworks as best I could, trying to get the students to learn as much as possible, but used the frameworks as the minimum baseline. I tried to use outside sources to expand lessons, like recommending YouTube videos for an animated explanation of concepts and made sure to do so professionally. I would have liked to use more video resources in the classroom, but resources did not allow that to happen. Exemplifying professionalism every day was a primary goal for me and was what the field of teaching and the students deserved.

## Chapter 7: My WPI Education

Biology is a very diverse field, and having a university education was key to being able to teach it. The Massachusetts curriculum frameworks cover the following areas: The Chemistry of Life, Cell Biology, Genetics, Anatomy and Physiology, Evolution and Biodiversity, and Ecology.<sup>(12)</sup> As I only taught from January to May, I did not cover all of these topics. The topics I did cover were genetics, evolution, biodiversity, and ecology. While I did not cover the other topics, I am confident I could have if I had started teaching at the beginning of the year. I should note that I skipped over anatomy and physiology because, while I do have background in it, Mr. King teaches a separate Anatomy and Physiology class for juniors and seniors, so it just made more sense for him to teach it after I was done with my practicum. The honors physics class was given to Mr. King after the first semester break, so I started to teach it and covered topics in thermodynamics, oscillations and waves, and fluid mechanics. At there is no MCAS for physics, I was able to cater my curriculum to what the students were interested in learning and what I felt most confident in teaching.

Majoring in Biomedical Engineering allowed me to have a diverse background that covered the majority of topics in the frameworks and allowed me to explain how topics were applicable to the field of biomedical engineering. My previous education in high school was honors biology, advanced placement biology, and honors physics, so I understood what I could expect out of my students in honors biology and honors physics. My education at Worcester Polytechnic Institute also ensured I knew about each of the standards very in depth. I have taken courses in cellular biology, genetics, biochemistry,



anatomy and physiology, physics, and engineering sciences. I was able to use knowledge from all of these courses to improve my instruction.

One of the most important things I have taken away from my courses at WPI is how to present in front of a group. While usually as part of a group, I was able to transition well to teaching, as it is essentially just presenting by yourself for extended periods of time. From all of the presentations I've needed to do, I found the method that worked best for me was to simply know as much about a subject as I could know and to talk about it. By following this method, I feel I was able to provide explanations that were organic rather than scripted. One of the worst things that can happen while presenting is if you wrote a script for yourself and you forget a line, then the rest of the presentation is just completely thrown off. By using my method of just talking about the information, I was able to present knowledge in a meaningful way instead of following a script. Also, being required to dress formally for presentations also made the transition to always dressing up for teaching a breeze.

The best part of majoring in biomedical engineering and teaching biology and physics is that I was able to give examples of how the material the students are learning were able to be applied in a biomedical setting. Like when explaining natural selection and the fight or flight response I was able to go much more into detail about the parasympathetic and sympathetic nervous systems because I had to record and interpret data in a signal processing laboratory class where we built our own ECG machine. When it came to explaining waves I explained how green fluorescence protein creates a detectable light and how X-rays are able to work. The curriculum at WPI makes sure that I am often

reading new journal articles and learning about new advances in biomedical engineering, and by reading these things I was able to share major breakthroughs with my students when I deemed it appropriate. By having such a diverse background, if any students were bold enough to ask the age old question of “So what does anybody use this stuff for?” I was often able to give an interesting answer.

## Chapter 8: My Classes

Spending such a long time with a class results in a bond that a teacher can only hope ends up being positive. I am happy to report that all of my classes were able to be an enjoyable environment with some definite characters, and I mean that in the most positive way possible. I was able to observe the two honors biology classes for about two weeks before I started to teach them and so I was able to know what to expect from them. Then came the honors physics class, which I only observed for a few days before starting to instruct, due to Mr. King receiving the class at the beginning of the second semester. Each class was certainly unique, but all of them were an overall enjoyable experience.

The classes I taught were Periods 2, 4, and 5. So I was always able to watch Periods 1 and 3 and then leave for classes at WPI after Period 5 was done. The teaching day obviously then started for me with Period 2 every day. Almost every day, without fail, I at least was a bit nervous before starting, but once I got into the swing of things, teaching would go smoothly.

Period 2 would always start, without fail, by Sam K. coming in first. He would always ask how my day was and we would converse for a little until more students came in. Then everyone else would come in, chatting with someone until the class began. Sam sat in the front of the class with his friend Tyler. Sam was usually pretty studious and wouldn't be afraid to ask a question, but then Tyler was a bit more reserved and usually was as studious, but would have a joke once in a while that was clever and usually came out of nowhere. At the same table sat Maria and Maura. It took a bit of effort to get them off their phones at the beginning of class, but once they were engaged in the lesson they were

usually vocal and positive. Maura could be a little air-headed at times and ask questions that Maria would poke fun at, but it was always in a friendly manner. Then also in the front row on the table to my right there was Nikki, Nicolette, Klea, and Jeremias. Nikki and Nicolette were self-proclaimed best friends and they played softball together. Nikki did extraordinarily well but didn't flaunt it while Nicolette was able to compliment her with some air-headed moments like Maura did to Maria. Next to Nicolette sat Klea who was not an ELL student but her culture growing up didn't make her privy to some examples that I used that all the other students knew. She was eager to please and sometimes spoke too soon and would make mistakes when answering questions, but wasn't afraid to ask for an explanation if she got something wrong. Next to her was Jeremias who was reserved in the row of girls, but then would sometimes find himself turned around chatting with his friends behind him. He being reserved also was seen sometimes when he did not understand a concept and wouldn't speak up. I tried my best to read his facial expression when I was asking if the class understood everything and would try to explain something again if the expression on his face was not positive. His appreciation was later shown when he brought in a cake on my last day for everyone to share that said "Good Bye Mr. Biernacki," a picture of which can be found in the appendix.

The next row was Natasha, Malachi, Geisaiha, and Brian. Natasha sat behind Jeremias and was usually positive in class. She wasn't afraid to speak up and usually put a lot of effort into her homework. She would be able to answer many questions in class, but her quizzes did not always reflect her knowledge of the material. This later made her apathetic at times, but they may have also been due to her being busy with spring sports. Next to Natasha was Malachi. Malachi was always a positive presence in the class, but his

effort towards the class was not proportional to his positivity. As mentioned previously, I had to meet with his parents to get him on track, but he was grateful for that. Next to him, for most of my tenure, was Geisaiha. Geisaiha could be a bit of a talker and was often apathetic. This resulted in him being moved to the other side of the room, which he and Malachi were grateful for, as they both just wanted to learn. On the end of that table was Brian, who was very studious, usually quiet, and notably polite. He usually did very well and was one of the go to people for answering questions in class. On the same side of the room, behind Natasha sat Brandon. Brandon was not exactly the best at biology, but once he understood a concept he was able to explain it very well. He would also try to be a smooth talker at times and tried to get answers out of me during a quiz, which of course didn't work and smooth talking didn't get him out of homework, no matter how much he would have liked.

On the other side of the aisle was the table of Patrick, Cassandra, Sam A., and Matthew. Patrick did not really speak up much and put on an apathetic act as he did not do his homework often. However, he did perform decent on quizzes and showed that he absorbed at least some information from the class, though a little effort would have gone a long way with him. Next to him was Cassandra who seemed to try to help Patrick but we was not always willing to receive help. Cassandra was one of the go to students when I posed a question to the class and no one else wanted to answer. She was a positive influence on the class and kept the lesson going multiple times. Next to her was Sam A. who did not have the strongest work ethic. He did not always do his homework and his quiz performance could have been better, but when a question was directed to him, he did become engaged with the lesson, which I tried to work in once I caught on to that. The last

student in that row was Matthew. Matt was very quiet, but a hard worker. His hard work could be seen through his success on his work and whenever he spoke up. The last two students in the Period 2 class were in the row behind this one and sat behind Patrick and Cassandra. These two students were Anthony and Ian. Both of these students were very bright and were able to show that through volunteering answers in class and the work that they produced. Ian volunteered often and was a positive person in the classroom. Anthony was a very focused student, as he balanced academics with swimming which he missed a few days because of a competition. Overall Period 2 was a very positive experience and there were not many repeat offenders when it came to distracting the class.

Between Periods 2 and 4, I would usually stay in the classroom while Mr. King had a study hall. The classroom was the location of a health class where I was able to observe and grade papers during it. It was a nice break in the day, as the next two periods I would be teaching back to back.

Period 4 always started with Thao coming in first. He sat in the third row back from the board but usually came while I was still at my desk. I would usually jest and tell him he must come to the class because he is so excited to learn, and he would usually get overly defensive saying he didn't mean to arrive so early. As the rest of the class came in I would go check the homework of everyone and proceed with the lesson. Often the Period 4 lesson would go a bit smoother from my standpoint because I already ran through it with the Honors Biology class of Period 2. The experience helped though, because Period 4 was larger and tended to be a bit more talkative and a bit less studious than Period 2. The students in Period 4 were all unique and made for an interesting class.

The front row consisted of eight students split in two tables with four on each, just like Period 2. The front table to my left had Diana, Gisela, Chantel, and Kayliani. Diana had a very bubbly personality and was always very excited when she performed well on a test. She would ask questions that seemed a bit absent minded at the time and she later realized were a bit foolish, but she did very well on assignments and usually was overly nervous about her answers when she did not have to be. To the right of Diana was Gisela who could catch an attitude at times. When she was in a good mood she cared about doing well in class, but then sometimes she would just not be very cooperative. Sometimes her mood would change when she was simply asked to stop talking during class, and the resistance was noticeable. Next to her was Chantel who was a very curious student and positive, but not the most studious. She often would share concerns very openly and I tried to help sometimes, but other times had to laugh it off because it was often non-serious high school related issues. She was not afraid to ask questions which was nice to have in the class, but she could sometimes be found just staring out the window. Her lack of attention was not due to apathy though, as she would apply herself in the class, but did not always get the best results grade-wise. Next to Chantel was Kayliani. Kayliani and Chantel were friends and Kayliani could do well when she applied herself. The problem was that she did not always do that and when I would not accept half-finished homework she would continue on with the lesson with either a bad attitude or just apathy. I tried my best to get her to do well, but I was not always successful.

The other side of that row consisted of James, Patrick, Tildah, and Diane. James was usually quiet but when he volunteered answers he was very positive. I wish he had asked more questions because he did not always do so well on his work and didn't always do his

homework, but a bit more effort would have seen him do much better. James at least was honest when it came to not doing homework, which is more than can be said at times for other students who tried to pass off other work as homework. Next to James sat Patrick. Patrick was a little socially awkward, but worked very hard and did very well in class. He was also very pleasant and was very polite. Next to Patrick sat Tildah. Tildah also had a bubbly personality but was also one of the hardest workers in the class. She was very positive, always was willing to volunteer an answer, and very bright. The last student in the row was Diane. Diane was a student that I could easily relate to academically, as she was in the top three of her class GPA wise and studied very hard to get there. She almost always had the highest grade in the class and was not afraid to critique things that I did, but never in a negative way, so she was always a positive force in the class.

The table directly behind them consisted of Zoe, Ali, Dustin, and Dylan. Dylan sat behind Diane and would tease her sometimes, which distracted both of them, but he usually was harmless in doing so. Dylan was bright, usually did well, and was willing to volunteer answers, but he did was not the most mature, as a few times he had to be talked to for passing a pen or shoe around. Next to Dylan was Dustin. Dustin did pretty well in the class and would offer answers sometimes. He wasn't the most vocal, but he was positive in the class. Continuing down the row, there was Ali. Ali started off very quiet and did was not the most engaged, but as I continued teaching he seemed to open up and became one of the more vocal and engaged students in the class. He did moderately well and became a positive force in the class instead of a neutral one. It seemed once he knew that the environment was safe for him to share answers and would get a positive answer, he became more willing to be involved. The last student in the row on that side of the



classroom was Zoe. Zoe was not always the most studious and missed a fair share of homework assignments. However, she would become much more involved when she was very interested in a topic and would read up on it and be prepared for class discussion on it. When I started teaching, I gave the students a bonus for listing their favorite music and for guessing mine, which I thought would be a good start to getting to know them. Zoe was one of the only ones to know the music I listed off and I feel that started her in the right direction to paying attention more, as she went from almost no speaking up when I observed Mr. King to offering answers some times when I instructed.

On the other side of the aisle in the row there was Kyle, Mike, Sandra, and Lily. Kyle was the innermost student and switched seats with Jessica later just for personal preference. Kyle was a bright student who did not always try the hardest. He would do his work most of the time, but sometimes just seemed to forget that he had an assignment due. However, he was one of the most engaged students in the class. When the topic of evolution came up, he was thoroughly involved and asked many questions because that topic area interested him so much. He also was a student that would read up on current events and bring interesting studies into the class discussion. While he was not always positive, he overall left a positive impact on the class. Next to Kyle sat Mike. Mike was one of the brightest students in the class and seemed to be successful without having to put too much effort into his work. He was often engaged and even though I had to tell him to have his seat flat on the floor because he was leaning back and talking to kids behind him, he was still respectful and would always be positive in the class. Next to Mike sat Sandra. Sandra started off quiet but thankfully ended up talking more. I say thankfully because even though she generally did well on all the assignments, she usually was a go to student for

answering questions in class. She was very studious and concerned about her grade and was not afraid to ask questions, which probably helped the rest of the class in the process. Next to Sandra was Lily. Lily seemed to absolutely love reading as before class started and if we finished early, she could be found with a novel in her hands. Despite this, she was not the most studious in the class and was pretty quiet, but still did well. When she did offer answers in class she was still soft spoken, but offered insightful answers, even if I had to ask her to speak up a little.

The table behind those four was spread out because there was only three students instead of four. There was Kafui, Thao, and Andrew. Kafui was a transfer student as she was a sophomore. She was very studious, very polite, and did well. She was usually quiet, but that was because she already understood the information. Next to her was Thao, as already mentioned. Thao was an interesting student as he was not always the most engaged student, but was pleasant when he did become involved. He seemed he wanted to put on the appearance of not wanting to be involved in the class, but did not refuse becoming involved when the opportunity presented itself. The last student in the row, and separated by a seat from Thao was Andrew. Andrew was one of the most vocal students and was not afraid to throw out an answer, even if he was not positive it was the correct one. This was a good thing though as it would usually keep the lesson going. He was a bit full of himself when he succeeded, calling himself “King Andrew”, but never meant it in a way to put others down, resulting in him being one of the most positive students in the class. He could be distracting at times by getting Mike to turn around and talk to him, but would stop when asked, but that was why there was a space between him and Thao.

Across the aisle, the table only consisted of Esther. Esther put effort into the class as she did all of her homework and would be engaged in the class, but did not seem to always put effort into studying for the quizzes. She was usually positive and would interact and become engaged if I asked her a question directly. The rest of the room was a bit spread out. In the back row to my right side was Tamardre, who preferred to be called Dre. Dre was very quiet and seemed to beat himself too much over getting a question wrong, which I tried to counter with offer positive reinforcement anytime he spoke up or answered questions. He usually did his homework and when he understood a concept he did well on assignments, but he did not always speak up when he needed help, but when he did I would make sure I helped him and tried to pay extra attention to him when I had the students working on something in groups. The last two students in the class were Gina and Jessica, who originally sat in the back row to my left, until Jessica switched spots with Kyle. Gina was a bright student when she put her mind to things, but did not always do that. She started off answering many questions, but that declined overtime, which might be because of the material and it not interesting her as much. She still did well when she applied herself though. Jessica on the other hand went from not answering too many questions to becoming one of the most involved students in class. She was not afraid to ask questions and seemed to become more studious as the class went on. She started to seem to do so when she moved her seat away from Gina, which didn't seem like it was a problem, but the improvement was nice to see. Overall, Period 4 was definitely an experience and was full of characters, but it was always very pleasant.

The last period of my day was the Honors Physics class of Period 5. The class was mostly full of seniors and one junior and one sophomore. The class was pretty laid back

due to the “senior-it is” from getting them so late in the year, and the teacher before Mr. King seemingly not pushing them too hard. The structure was also different from the Honors Biology classes because though were dictated by doing well on the MCAS, while there was no MCAS for this course. I therefore took feedback on what they wanted to learn based on what they were planning on studying in college and what I knew I would do well at teaching. The result was teaching them heat, waves, and fluids. Some of this was pretty concept heavy, but I tried to do my best with the materials at my disposal. Due to the nature of them beings seniors, I structured the class a bit different, where I gave them an assignment every night, but would check all of them on Friday. The lessons also consisted more of a bit of lecture and then examples on how to solve problems, as physics tends to be calculation heavy. Having taken chemistry classes, an oscillations and waves physics class, and a fluid mechanics class, I feel I was able to still teach the mostly disinterested seniors some information that could help them in their future endeavors.

Despite the shorter amount of time I had with them, I feel I was still able to bond with them, in part due to the age difference not being as great. The class was pretty spread out seating wise and the students tended to sit with their friends, which was not a problem because they were not constantly talking. In the front row there was Eliza, Theodhora, and Sandra. Eliza and Theodhora sat next to each other and were very studious, getting the homework done ahead of time and both being able to simplify the problems to the point where they understood everything completely. They were both not afraid to ask questions and would be vocal and engaged most of the time. Sandra sat in the middle of the front row and was very quiet. She would usually keep to herself, but was a focused student and would

ask for help when she needed it. She also gave me a thank you card on the last day I taught, which was a really touching and kind gesture.

The row behind Sandra there was the group of Magdalen, Chris, Kathleen, and Mike. Magdalen preferred to be called “Maggie” and she was a pretty good student overall. She didn’t seem to always pay attention, but she would ask questions when she was confused about a topic. She was definitely a positive student though and contributed to the class being enjoyable. Next to Maggie was Chris. Chris was a bright student who just did not apply himself as much as he could. It was understandable as he just needed to pass the class since all the seniors were already accepted to college, but that made teaching him a bit frustrating. When he did contribute, it was great, but I just wish he would have done so more. Next to Chris was Kathleen. Kathleen was studious but also suffered from “senioritis” a bit, and sitting next to Chris did not really help with that. However, she did often take notes and would ask questions and actually do the homework fully, so she was definitely a good student. She was going to major in Kinesiology, which has a lot in common with the biomechanics classes I have taken, so I tried to link whatever we were learning back to that. The last student at that table was Mike. Mike was going to study civil engineering, so I knew that I would be able to help him at least a bit, since there was many base classes between most of the engineering majors. He did not always act the brightest, but he could still succeed when he applied himself. He was often interested, so he would ask questions and do his best to grasp concepts, which made him a pleasant part of the class.

The opposite side of that row sat Megi and Alex. Megi was a junior who was very studious. She was able to grasp the concepts quickly and with ease and showed a strong

interest in physics. She would ask question when she needed to and was overall positive in the class. Alex sat next to Megi and she was the only sophomore in physics. Alex was originally from Greece, but no ELL adaptations were needed. Alex was an incredibly focused student who did all of her work very early so she would be able to make sure she understood everything. She would sometimes read too much into problems and ask questions that I was not even always prepared for, but she was very bright. She was focused on becoming a doctor, so that determination in high school would definitely serve her well in the future.

The rest of the students were scattered in the back rows of the classroom. There was Samira and Trung who sat together. Trung was a very bright student who succeeded when he applied himself, but sadly that was not all the time. He would put effort into the things that he remembered to do and was just a very positive student whenever he engaged in class discussion. Samira was a pretty good student, but again was a senior that could have been a bit more studious. She was usually positive though and tried when she felt like it. The times she was most engaged though was when she would ask about what we were learning and how it applied outside of physics, and always had an answer, but I was never completely sure whether it was genuine interest or if she was trying to sidetrack the class. It did make the class a bit livelier though and there was not too much I had to cover with them, so I welcomed the discussion. Felix sat alone and was always very quiet. He would not seem to always pay attention in class, but was a hard worker and was able to easily grasp the concepts that I was teaching. Whenever he did talk it was pleasant and actually humorous, but that side of him did not come out too often. The last student was Amersaline. Amersaline was similar to Samira when it came to class discussion, but she

seemed to put in possibly the least amount of effort into the class, so it was tough sometimes to gauge how well she would do if she did apply herself more. She was positive, but sometimes could be completely disengaged in the class. Period 5 was a completely different experience compared to the two freshmen biology classes. The students certainly showed a bit more maturity, which I certainly welcomed in the last class I taught every day. While it was not exactly the most challenging of the classes I taught, it was still an interesting experience when the students were engaged.

## Chapter 9: Conclusion

Teaching in an urban classroom was something that I was not sure I was ready for. When I began, I was nervous and anxious and could barely believe what I was actually doing. However, I was able to adapt quickly and got into a teaching stride much more easily than I thought.

Through my experiences in the classrooms of Doherty Memorial High School and with the guidance of Mr. King and Professor Goulet, I feel that I have achieved competence in the professional standards found in teaching. By showing respect for the students, they would reciprocate the respect and effective instruction was accomplished. By being competent when it came to knowledge needed and by being able to adapt to challenges in the classroom, my experience at Doherty resulted in a successful student teaching practicum. The positive time I had at Doherty and the enjoyment I got from it was a very unique opportunity that I feel I was able to learn just as much as my students did.



## Appendix A: A Sample of Lesson Plans

Lesson Plan 2/7/2014

Hand back quizzes

Review quiz answers

DNA replication- process of copying DNA before mitosis, meiosis, or binary fission

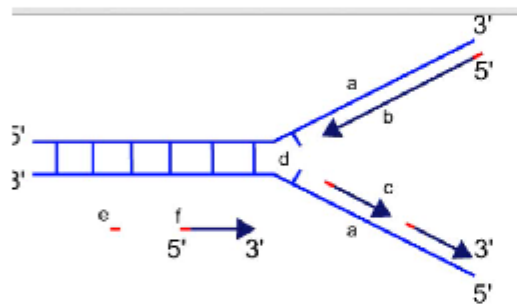
Define enzyme

Steps of replication:

1. Helicase separates strands
  - a. Moves down and breaks hydrogen bonds between nitrogenous bases
  - b. Y-shaped region is the replication fork
2. DNA polymerase adds nucleotides
3. DNA polymerase finishes and leaves

Semi-conservative replication- one strand is from old DNA

DNA polymerase goes two ways



Joined by DNA ligase

3'- downstream

5'- upstream

Prokaryotic- circular DNA

Start in reverse directions and meet up

Eukaryotic- DNA replication happens at many points (origins)

DNA polymerase fixes mistakes

Change in nucleotide sequence- mutation

Cancer

Start protein synthesis, homework: p 210 1-6

In tomato plants, the allele for red fruit color (**R**) is dominant to the allele for yellow fruit color (**r**). The allele for round-shaped fruit (**F**) is dominant to the allele for pear-shaped fruit (**f**). Two tomato plants, heterozygous for fruit color and fruit shape, are crossed. The Punnett square for this dihybrid cross is shown below.

|           | <b>RF</b> | <b>Rf</b> | <b>rF</b> | <b>rf</b> |
|-----------|-----------|-----------|-----------|-----------|
| <b>RF</b> | RRFF      | RRFf      | RrFF      | RrFf      |
| <b>Rf</b> | RRFf      | RRff      | RrFf      | Rrff      |
| <b>rF</b> | RrFF      | RrFf      | rrFF      | rrFf      |
| <b>rf</b> | RrFf      | Rrff      | rrFf      | rrff      |

- For this cross, identify all the possible phenotypes of the offspring.
- Considering only fruit color, determine the ratio of offspring with red fruit to offspring with yellow fruit predicted by the Punnett square.
- Considering only fruit shape, determine the ratio of offspring with round-shaped fruit to offspring with pear-shaped fruit predicted by the Punnett square.
- Explain what is meant by independent assortment and describe one way in which your answers to parts (a), (b), and (c) support the conclusion that the genes for fruit color and fruit shape sort independently.

In guinea pigs, the allele for black hair (**B**) is dominant to the allele for brown hair (**b**). The allele for short hair (**S**) is dominant to the allele for long hair (**s**). The genes for hair color and hair length are located on different chromosomes. Guinea pigs with black, short hair (**BbSs**) are crossed with guinea pigs with brown, long hair (**bbss**). Some offspring have black, short hair or brown, long hair like the parents. Additionally, some offspring have black, long hair or brown, short hair. Which of the following explains the different phenotypes in the offspring?

- The expression of the alleles for hair color is influenced by the alleles for hair length.
- The alleles for hair color and hair length assort independently during gamete formation.
- The alleles for hair color and hair length mutate during the first cell divisions of the offspring.
- The interaction between the alleles for hair color and hair length is incomplete dominance.

Which of the following laws or principles states that the two alleles of a gene pair separate during gamete formation?

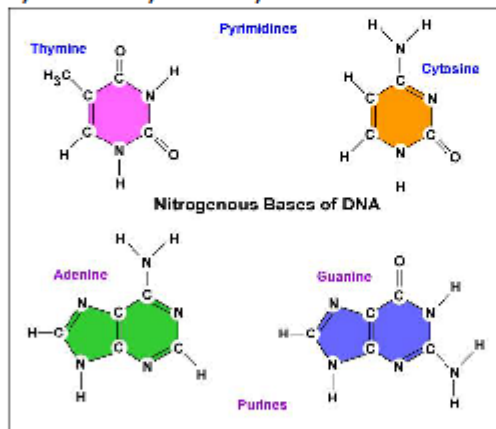
- law of segregation
- principle of linkage
- principle of dominance

### James Watson and Francis Crick

- Use Rosalind Franklin's xray diffraction pictures to propose double helix model
  - o Like a spiral staircase, would explain replication
  - o Draw model

### DNA structure

- Made of nucleotides
  - o Consists of five-carbon sugar, phosphate group, and nitrogenous base
  - o Five-carbon sugar: deoxyribose
  - o Phosphate group: PO<sub>4</sub>
  - o Nitrogenous base: contains carbon and hydrogen, is a base (accepts hydrogen atoms/protons)
  - o Alternate between phosphate group and deoxyribose (bases bonded to deoxyribose)
- Nitrogenous bases
  - o Held together by hydrogen bonds (2 or 3 bonds made)
  - o Each pair is one two-ring and one one-ring base
  - o ATGC: adenine, thymine, guanine, cytosine
  - o Purines: adenine and guanine
  - o Pyrimidines: thymine and cytosine



- o Erwin Chargaff—how?
  - Cytosine and guanine have same percentages- must be paired
- o Base Pairing Rules: AT-GC
  - Are complementary base pairs
  - Base sequence: order of base pairs
- Tomorrow: replication
- No homework, study

Lesson Plan 2/11/2014

Central dogma:

DNA----(transcription)---->RNA----(translation)---->proteins

Protein synthesis- forming proteins for DNA info and carried out by RNA

RNA differences:

1. Ribose not deoxyribose
2. Contains uracil instead of thymine (A-U, G-C)
3. Single stranded
4. Much shorter, contains one gene

mRNA- messenger RNA- straight chain (brings from nucleus to ribosomes in cytosol)

rRNA- ribosomal RNA- in ribosome (site of protein synthesis)

tRNA- transfer RNA- three nucleotides emphasized (transfers amino acids to ribosome to make protein)

Steps of Transcription: (happens in eukaryotic nucleus or prokaryotic cytoplasm)

1. RNA polymerase binds to promoter (strand of base pairs)
2. RNA polymerase adds free RNA nucleotides that are complementary to the DNA
  - a. Only a certain site is copied, so DNA rewinds
3. RNA polymerase reaches termination signals are releases

Genetic code:

Codon: 3 base pairs

Which of the following observations **best** supports the conclusion that dolphins and sharks do not have a recent common ancestor?

- A. Dolphins form social groups, but sharks are solitary.
- B. Dolphins hunt during the day, but sharks are nocturnal.
- C. The number of dolphin species is far less than the number of shark species.
- D. The jawbone structure in dolphins is very different from the jawbone structure in sharks.

Turtles are classified in the order Testudines. Some turtles are aquatic and others are terrestrial. Aquatic turtles have webbed feet and short claws, but terrestrial turtles do not. Which of the following statements **best** explains why aquatic turtles and terrestrial turtles are classified in the same order but have such different feet?

- A. Aquatic turtles evolved from fish, and terrestrial turtles evolved from reptiles.
- B. Aquatic turtles and terrestrial turtles have similar body plans, but they grow at different rates.
- C. Aquatic turtles interbred with different species, and terrestrial turtles bred only within their own species.
- D. Aquatic turtles and terrestrial turtles evolved from a common ancestor, but they have adapted to different environments.

44 The table below shows small portions of the amino acid sequences of a particular protein in four animal species.

| Animal Species | Portion of Amino Acid Sequence |
|----------------|--------------------------------|
| 1              | Met-His-Leu-Ala-Pro            |
| 2              | Met-His-Leu-Glu-Glu            |
| 3              | Met-Tyr-Leu-Ala-Pro            |
| 4              | Met-Ala-Leu-Arg-Trp            |

- a. Based on the data in the table, which two species are most closely related? Explain your answer.
- b. Describe and explain **three** other forms of scientific evidence that could be used to study the relatedness of these four animal species.

32 The table below shows the classifications of three different sea lions.

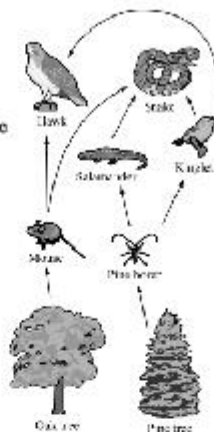
|                | California Sea Lion  | Galápagos Sea Lion | New Zealand Sea Lion |
|----------------|----------------------|--------------------|----------------------|
| <b>Kingdom</b> | Animalia             | Animalia           | Animalia             |
| <b>Phylum</b>  | Chordata             | Chordata           | Chordata             |
| <b>Class</b>   | Mammalia             | Mammalia           | Mammalia             |
| <b>Order</b>   | Carnivora            | Carnivora          | Carnivora            |
| <b>Family</b>  | Otariidae            | Otariidae          | Otariidae            |
| <b>Genus</b>   | <i>Zalophus</i>      | <i>Zalophus</i>    | <i>Phocarcos</i>     |
| <b>Species</b> | <i>californianus</i> | <i>wollebaeki</i>  | <i>hookeri</i>       |

- a. Identify which two of the sea lions are most closely related.
- b. Justify your answer to part (a).
- c. Describe and explain **two** types of evidence scientists would have used to determine the proper classifications of these three sea lions.

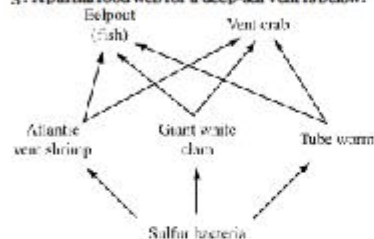
1. A major reservoir for oxygen is the atmosphere. Which of the following processes adds oxygen to the atmosphere?
- cellular respiration
  - combustion
  - decomposition
  - photosynthesis

A food web is shown below.

2. Which of the following organisms compete for the mouse as a food source?
- hawk and snake
  - snake and kinglet
  - oak tree and pine tree
  - pine borer and salamander

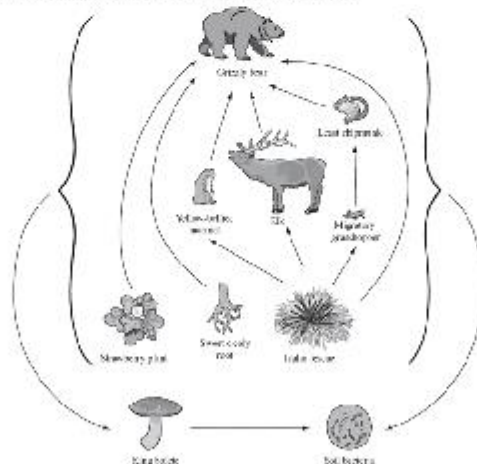


3. A partial food web for a deep-sea vent is below.



- Which organism or organisms are the producers in this food web? Explain your answer using evidence from the food web.
- Compare how much of the energy initially entering the vent ecosystem is available to the Atlantic vent shrimp and to the eelpout based on their trophic levels. Explain why there is a difference in the amount of energy available to each species.

4. A partial food web for organisms in Yellowstone National Park is shown below.



Assume the elk population in Yellowstone National Park increases. Discuss how this increase in elk will **most likely** affect each of the following populations:

- Idaho fescue
- migratory grasshopper
- grizzly bear

Be sure to include specific reasons to support each of your responses.

Ticks carry bacteria that cause Lyme disease. Ticks do not get Lyme disease, but they can transfer the bacteria to humans, who can get the disease. Which of the following statements **best** describes the relationships among the bacteria, the ticks, and the humans?

- The relationship between the bacteria and the ticks is competition, and the relationship between the ticks and the humans is predation.
- The relationship between the bacteria and the ticks is competition, and the relationship between the ticks and the humans is parasitism.
- The relationship between the bacteria and the ticks is commensalism, and the relationship between the ticks and the humans is parasitism.
- The relationship between the bacteria and the ticks is commensalism, and the relationship between the ticks and the humans is predation.

Tapeworms are sometimes found in the small intestines of sheep. A tapeworm attaches to the intestinal wall using suckers and then absorbs nutrients from the sheep's intestine. Which of the following terms describes the relationship between the tapeworm and the sheep?

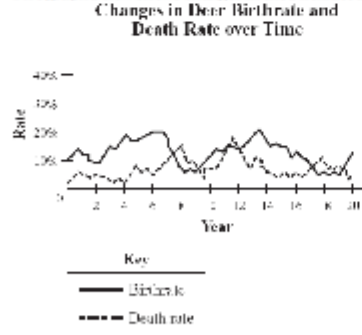
- competition
- herbivory
- parasitism
- predation

Lake Superior is on the northern border of the continental United States. The graph below shows changes in the size of the moose population on an island in Lake Superior from 1960 to 2005. The island is in a remote location several miles off the northwest shore of the lake.



- Explain why immigration and emigration are **not** likely to have an effect on the size of the island's moose population.
- Describe what happened to the size of the island's moose population from 1995 to 1997, and describe how the birth rate and the death rate must have compared during this time.
- Identify **two** different natural factors that could have contributed to the change in moose population size you described in part (b).
- Explain why **each** of the factors you identified in part (c) contributed to the change in moose population size.

The graph below shows changes in the birthrate and death rate for a large population of deer over a 20-year study period.



- Describe and explain **two** factors that can affect the birthrate in the deer population.
- Describe and explain **two** factors that can affect the death rate in the deer population.
- Identify **one** time period on the graph during which the deer population was increasing. Explain your answer.

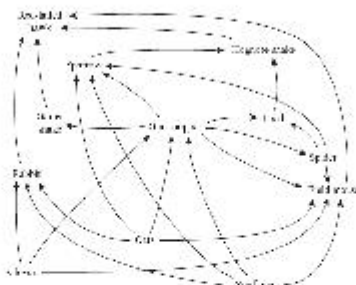
If the producers in a food web were removed, which of the following changes would **most likely** occur?

- A. The entire food web would collapse over time.
- B. The food web would depend on the decomposers for energy.
- C. The consumers would begin making energy for the food web.
- D. The populations of the remaining organisms in the food web would increase.

Which of the following **best** describes the producers in a terrestrial food web?

- A. They are at the highest trophic level.
- B. They are not affected by decomposers.
- C. They convert solar energy to chemical energy.
- D. They obtain all their nutrients and energy from consumers.

The diagram below shows a food web for an ecosystem.

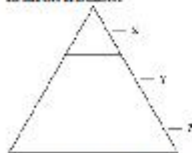


- a. Identify the producers and the consumers in this food web.
- b. In this ecosystem, is more energy available to the field mouse population from eating spiders or from eating oats? Explain your answer.

The table below lists the ecological roles of several organisms in a desert ecosystem.

| Organism | Ecological Role    |
|----------|--------------------|
| cactus   | producer           |
| cricket  | primary consumer   |
| lizard   | secondary consumer |
| rat      | primary consumer   |
| snake    | secondary consumer |
| yucca    | producer           |

An energy pyramid shows how energy flows between different groups of organisms in an ecosystem. An incomplete energy pyramid is shown below.



- a. Copy the energy pyramid into your Student Answer Booklet. Fill in the pyramid with the desert organism(s) that belong in **each** level. Be sure to include all six desert organisms from the table in your pyramid.
- b. Describe the roles of primary consumers and secondary consumers in all ecosystems.
- c. Is there more energy available for organisms in the top level of the pyramid (X) or the bottom level of the pyramid (Z)? Explain your answer.



1. Fruit flies have hair-like bristles on the back side of their bodies. The bristles can be long or short. Flies with short bristles have two recessive alleles (ss) for the trait. A fruit fly that is heterozygous for the bristle trait is crossed with a fruit fly that has short bristles. The cross produces 220 offspring. How many of the offspring are expected to have short bristles?

- A. 0
- B. 55
- C. 110
- D. 220

2. Which of the following is an example of a mutation?

- A. A red blood cell loses its nucleus.
- B. A zygote receives two X chromosomes.
- C. A strand of mRNA is produced from DNA.
- D. A nucleotide is missing in a replicated DNA strand.

3. In red-green color blindness, individuals cannot perceive the colors red and green in the same way as individuals with full color vision. Full color vision is coded by a dominant allele (B) on the X chromosome. Red-green color blindness is caused by a recessive allele (b) on the X chromosome.

- a. Identify the phenotype of a female with the genotype  $X^B X^b$ .
- b. Identify the phenotype of a male with the genotype  $X^B Y$ .
- c. Draw a Punnett square for the cross  $X^B X^b \times X^B Y$ , and identify the following:
  - the percentage of offspring expected to be male and colorblind
  - the percentage of offspring expected to be female and colorblind
- d. Explain why red-green color blindness occurs more frequently in males than in females.

4. In tomato plants, the allele for red fruit color (R) is dominant to the allele for yellow fruit color (r). The allele for round-shaped fruit (F) is dominant to the allele for pear-shaped fruit (f). Two tomato plants, heterozygous for fruit color and fruit shape, are crossed. The Punnett square for this dihybrid cross is shown below.

|    | RF   | Rf   | rF   | rf   |
|----|------|------|------|------|
| RF | RRFF | RRFf | RrFF | RrFf |
| Rf | RRFf | RRff | RrFf | Rrff |
| rF | RrFF | RrFf | rrFF | rrFf |
| rf | RrFf | Rrff | rrFf | rrff |

- a. For this cross, identify all the possible phenotypes of the offspring.
- b. Considering only fruit color, determine the ratio of offspring with red fruit to offspring with yellow fruit predicted by the Punnett square.
- c. Considering only fruit shape, determine the ratio of offspring with round-shaped fruit to offspring with pear-shaped fruit predicted by the Punnett square.
- d. Explain what is meant by independent assortment and describe one way in which your answers to parts (a), (b), and (c) support the conclusion that the genes for fruit color and fruit shape sort independently.

## Appendix B: Biology Assessments

Name: \_\_\_\_\_

Date: \_\_\_\_\_

1. The information below describes the most specific levels of classification that the mushroom sea squirt, *Saccosca gaimardi*, shares with four other organisms.

- The mushroom sea squirt is in the same class as the common sea grape.
- The mushroom sea squirt is in the same family as the blue spot ascidian.
- The mushroom sea squirt is in the same order as the white speck tunicate.
- The mushroom sea squirt is in the same phylum as the starry skate.

2. To which of the four organisms is the mushroom sea squirt most closely related?

- A. common sea grape
- B. blue spot ascidian
- C. white speck tunicate
- D. starry skate

3. Which of the following is the **best** scientific evidence that mammals evolved from reptiles?

- A. similarities in the diets of extinct reptiles and modern mammals
- B. similarities in the average lifespans of modern reptiles and modern mammals
- C. fossils of ancient reptiles and mammals that appear together in the same layers of rock
- D. Fossils that show gradual changes in skull shape from reptile-like organisms to mammal-like organisms

4. An extinct shark named *Scapanorhynchus* existed over 100 million years ago. It had a long snout, sharp teeth, and a long tail fin. Which of the following statements explains how scientists **most likely** learned this information about *Scapanorhynchus*?

- A. They studied fossilized remains of *Scapanorhynchus*.
- B. They analyzed the DNA sequence of *Scapanorhynchus*.
- C. They looked at the skeletons of modern sharks that live where *Scapanorhynchus* lived.
- D. They studied the anatomy of other aquatic animals that lived when *Scapanorhynchus* lived.

5. Four students researched the classifications of the following eight whales:

- killer whale, *Orcinus orca*
- gray whale, *Eschrichtius robustus*
- humpback whale, *Megaptera novaeangliae*
- pygmy right whale, *Caperea marginata*
- fin whale, *Balaenoptera physalus*
- minke whale, *Balaenoptera acutorostrata*
- North Atlantic right whale, *Eubalaena glacialis*
- bowhead whale, *Balaena mysticetus*

The students were asked which two whales are most closely related and why. The table below summarizes the students' answers.

| Student | Whales Most Closely Related                  | Reason                            |
|---------|--|-----------------------------------|
| 1       | killer whale and gray whale                  | They are both mammals.            |
| 2       | humpback whale and pygmy right whale         | They are both whales.             |
| 3       | fin whale and minke whale                    | They are both in the same genus.  |
| 4       | North Atlantic right whale and bowhead whale | They are both in the same family. |

Based on the classifications, which student gave the correct answer to the question?

- A. student 1
- B. student 2
- C. student 3
- D. student 4

6. Circle all of the following kingdoms that have eukaryotic cells:

Plantae      Animalia      Eubacteria      Fungi      Archaeobacteria      Protista

7. Blue jays and kingbirds are both classified in the order Passeriformes. In the current taxonomic system, this means that the two types of birds must also belong to the same

- A. family.
- B. genus.
- C. phylum.
- D. species.

8. Circle all of the following kingdoms that have a defined nucleus:

Plantae      Animalia      Eubacteria      Fungi      Archaeobacteria      Protista

9. What is the two-part naming system created by Carolus Linnaeus that consists of the genus name and species identifier?

10. What is problematic about defining the kingdom Protista?

Bonus 1: What is the phrase we use to remember the order of hierarchies?

Bonus 2: What theory states that eukaryotic cells arose from ancient bacteria living together?

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Mendel Quiz: Monohybrid and Dihybrid Crosses

For the Questions 1-5, assume the following: Tall (T) is completely dominant for pea height over the recessive short (t):

1. What is the expected phenotype of the offspring with parents that consist of one that is homozygous dominant and the other heterozygous?
2. Draw a Punnett square for a cross between a parent who is homozygous recessive and one that is heterozygous.
3. For #2, what are the chances that you obtain a short pea plant?
4. For #2, what is the genotypic ratio of the offspring? Be sure to specify the genotypes in the ratio.
5. If you are given a tall pea plant of unknown genotype, perform a test cross, and obtain offspring that are 50% tall and 50% short, what is the genotype of the unknown tall pea plant?
6. If you cross a red rose and a white rose and only get pink roses as offspring, what is this an example of?

For the Questions 7-10, you are given the following: in Chihuahuas long fur (L) is dominant to short fur (l) and brown fur (B) is dominant to black fur (b). You then given two Chihuahuas to cross that are both heterozygous for both traits (LlBb x LlBb).

7. Draw a dihybrid cross of this situation.
8. What are all the possible phenotypes of the offspring? (Remember, dihybrid phenotypes are two traits!)
9. What is the expected ratio of brown fur Chihuahuas to black fur Chihuahuas in the offspring?
10. What is the phenotypic ratio of both traits in this cross? (Hint: it's going to be 4 numbers long)

Name: \_\_\_\_\_

Date: \_\_\_\_\_

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

Replication, Transcription, and Translation Quiz

1. List three differences between DNA and RNA. (15 points)
2. Name the enzyme that unwinds DNA. What bonds does it break to unwind DNA? (10 points)
3. What is the difference between DNA polymerase and DNA ligase? (10 points)
4. List the parts of a nucleotide. (15 points)
5. Distinguish between tRNA and mRNA. Where is rRNA located? (10 points)
6. What type of bond holds together amino acids? (5 points)
7. Define cancer. What happens to DNA to cause cancer? (10 points)
8. The following is a list of DNA nitrogen bases. Write the resulting complementary mRNA strand that is created during transcription. (12 points)

AAATGCTACGGGGTAACT

9. The following is a list of nitrogen bases in mRNA. Write the resulting amino acids in order that are created during translation. (13 points)

GUUAUGACUAAAUAUAU

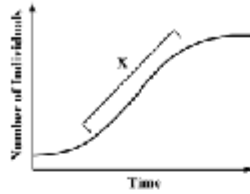
|            |   | Second base  |  |  |   |            |   |                  |
|------------|---|--|--|--|---|------------|---|------------------|
|            |   | U  | C  | A  | G   |            |   |                  |
| First base | U | UUU } Phenylalanine <b>F</b><br>UUC }<br>UUA } Leucine <b>L</b><br>UUG }             | UCU } Serine <b>S</b><br>UCC }<br>UCA }<br>UCG }     | UAU } Tyrosine <b>Y</b><br>UAG }<br>UAA } Stop codon<br>UAG } Stop codon       | UGU } Cysteine <b>C</b><br>UGC }<br>UGA } Stop codon<br>UGG } Tryptophan <b>W</b> | Third base | U | U<br>C<br>A<br>G |
|            | C | CUU } Leucine <b>L</b><br>CUC }<br>CUA }<br>CUG }                                    | CCU } Proline <b>P</b><br>CCG }<br>CCA }<br>CCG }    | CAU } Histidine <b>H</b><br>CAG }<br>CAA } Glutamine <b>Q</b><br>CAG }         | CGU } Arginine <b>R</b><br>CGC }<br>CGA }<br>CGG }                                |            |   |                  |
|            | A | AUU } Isoleucine <b>I</b><br>AUC }<br>AUA }<br>AUG } Methionine start codon <b>M</b> | ACU } Isoleucine <b>I</b><br>ACC }<br>ACA }<br>ACG } | AUU } Asparagine <b>N</b><br>AAC }<br>AAA } Lysine <b>K</b><br>AAG }           | AGU } Serine <b>S</b><br>AGC }<br>AGA } Arginine <b>R</b><br>AGG }                |            |   |                  |
|            | G | GUU } Valine <b>V</b><br>GUC }<br>GUA }<br>GUG }                                     | GCU } Alanine <b>A</b><br>GCC }<br>GCA }<br>GCG }    | GAU } Aspartic acid <b>D</b><br>GAC }<br>GAA } Glutamic acid <b>E</b><br>GAG } | GGU } Glycine <b>G</b><br>GGC }<br>GGA }<br>GGG }                                 |            |   |                  |

Name: \_\_\_\_\_ Date: \_\_\_\_\_

- \_\_\_\_\_ 2. The two strands of a DNA molecule are held together by  
a. ionic bonds.      b. covalent bonds.      c. peptide bonds.      d. hydrogen bonds.
- \_\_\_\_\_ 3. According to the base-pairing rules, guanine binds with  
a. cytosine.      b. adenine.      c. thymine.      d. guanine.
- \_\_\_\_\_ 4. Which of the following is NOT a correct structure of a nucleotide?  
a. adenine—deoxyribose—phosphate      c. cytosine—deoxyribose—phosphate  
b. adenine—ribose—phosphate      d. guanine—deoxyribose—phosphate
- \_\_\_\_\_ 2. Replication of the two DNA strands takes place  
a. in two different directions.  
b. in the same direction of the replication fork.  
c. in a direction opposite to that of the replication fork.  
d. at right angles to the direction of the replication fork.
- \_\_\_\_\_ 3. In replication in prokaryotes,  
a. there are two origins.  
b. two replication forks move in opposite directions.  
c. replication proceeds in one direction.  
d. there are no replication forks.
- \_\_\_\_\_ 1. A protein is a polymer consisting of a specific sequence of  
a. amino acids.      c. RNA nucleotides.  
b. fatty acids.      d. DNA nucleotides.
- \_\_\_\_\_ 2. The genetic code specifies the correlation between  
a. a DNA-nucleotide sequence and an RNA-nucleotide sequence.  
b. an mRNA-nucleotide sequence and a tRNA-nucleotide sequence.  
c. an mRNA-nucleotide sequence and an rRNA-nucleotide sequence.  
d. an RNA-nucleotide sequence and an amino-acid sequence.
- \_\_\_\_\_ 3. During translation, one end of a tRNA molecule pairs with a complementary  
a. nucleotide sequence in DNA.      c. tRNA molecule.  
b. mRNA codon.      d. protein molecule.
- \_\_\_\_\_ 4. In eukaryotic cells, RNA is copied from DNA in the  
a. ribosomes.      c. nuclear membrane.  
b. nucleus.      d. cytosol.
- \_\_\_\_\_ 5. Two amino acids are linked by a peptide bond when  
a. two ribosomes attach simultaneously to the same mRNA transcript.  
b. two tRNAs pair with neighboring codons on an mRNA transcript.  
c. two codons on an mRNA transcript bind to each other.  
d. a ribosome attaches to two codons on an mRNA transcript.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

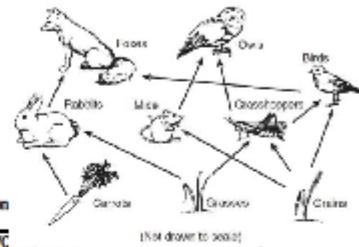
1. The graph below shows the change in the size of a mammal population.  
Population Size over Time



Which of the following statements could explain the change in population size in region X?

- A. Birth rate is greater than death rate.
- B. Emigration rate is greater than birth rate.
- C. Death rate is greater than immigration rate.
- D. Emigration rate is greater than immigration rate.

2. List five different interactions found in the food web to the right. (only predation and competition)

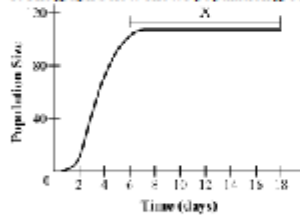


| Interaction | Predator /Competitor | Prey /C. |
|-------------|----------------------|----------|
|             |                      |          |
|             |                      |          |
|             |                      |          |
|             |                      |          |

3. An animal population increases from 800 individuals to 900 individuals. Which of the following could explain this change in population size?

- A. The number of species competing with the animal for food increased.
- B. The emigration rate of the animals from the population decreased.
- C. The number of breeding pairs in the animal's population decreased.
- D. The population size of the animal's predator increased.

3. The graph below shows population growth for paramecia kept under laboratory conditions for 18 days.



4. Which of the following statements explains what is not happening in the region of the curve labeled "X"?

- A. The population's growth rate is zero.
- B. The paramecia are in water that is too warm.
- C. The paramecia have reached the carrying capacity of their environment.
- D. The population's birthrate equals the death rate.

5. The ecological relationship between a tapeworm and a human is the same type of relationship as that between

- A. a tick and a deer.
- B. a frog and an insect.
- C. a mouse and a chipmunk.
- D. a bee and a flowering plant.

6. When locust populations grow too large for an area, the individual locusts are crowded and food becomes scarce. In response to these conditions, some of the locusts leave the area and enter a new habitat. Which of the following terms **best** applies to the action of the locusts entering the new habitat?

- A. Commensalism
- B. emigration
- C. immigration
- D. mutualism

Name: \_\_\_\_\_ Date: \_\_\_\_\_

- Which of the following provides the **most convincing** evidence that two different animal species evolved from a common ancestor?
  - They live in similar environments.
  - They have similar adult body shapes.
  - They have similar methods of locomotion.
  - They show similar features in embryonic development.
- A scientist is examining a fossilized insect that may be an ancestor of modern dragonflies. Which of the following should the scientist compare to **best** determine how closely related the fossilized insect is to modern dragonflies?
  - their diets
  - their habitats
  - their predators
  - their anatomies
- Fossils typically provide evidence for evolution because
  - they are millions of years old.
  - they exist in all types of rocks.
  - they supply good samples of RNA.
  - they show patterns of biological change.
- Fossils of snakes with hind limbs but no forelimbs have been discovered. Which of the following conclusions is **best** supported by this fossil evidence?
  - Snakes are likely to evolve limbs in the future.
  - Snakes are well adapted to live on land without limbs.
  - Snakes have evolved from an ancestral reptile with limbs.
  - Snakes are poor competitors compared to reptiles with limbs.
- Scientific evidence shows that modern dogs, wolves, and foxes all have a common ancestor. Further evidence shows that dogs are more closely related to wolves than to foxes. Which of the following observations provides the **best** evidence that dogs are more closely related to wolves than to foxes?
  - The diets of dogs and wolves are more similar than the diets of dogs and foxes.
  - The lifespans of dogs and wolves are more similar than the lifespans of dogs and foxes.
  - The genetic sequences of dogs and wolves are more similar than the genetic sequences of dogs and foxes.
  - The body sizes of dogs and wolves are more similar than the body sizes of dogs and foxes.

Use the following word bank for 6-10.

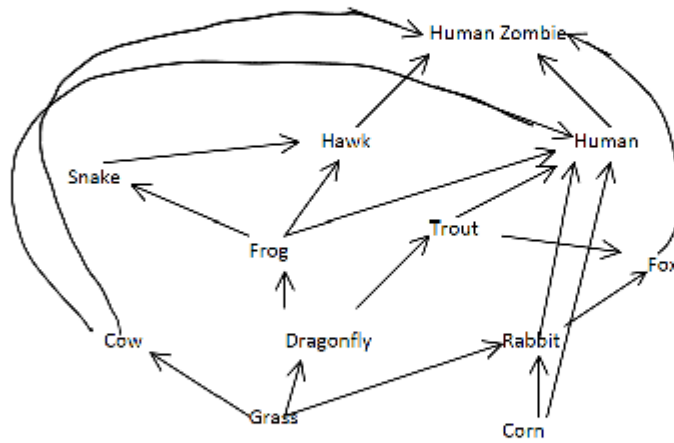
|                       |                      |                      |                      |                   |
|-----------------------|----------------------|----------------------|----------------------|-------------------|
| Divergent Evolution   | Convergent Evolution | Coevolution          | Artificial Selection | Natural Selection |
| Homologous Structures | Analogous Structures | Vestigial Structures |                      |                   |

- For over 15,000 years, humans have controlled the breeding of dogs, deciding which traits are to be passed on. What do you call the process of humans controlling which traits are passed on?
  - The arctic hare, snowy owl, and arctic fox are all white and are found in snow-filled environments. What do you call the process that resulted in them all being white?
  - Grizzly bears and polar bears have similar body structure and appearance. However, they live in different environments, do not mate with each other, and are different species. What do you call the process that led to this?
  - The fins of both dolphins and sharks help them navigate in water, but dolphins' fins are made of bone while sharks' fins are made of cartilage. What kind of structure are these?
  - Wisdom teeth and the appendix were once used by a human ancestor to aid in the breakdown and digestion of cellulose. However, they now have no apparent function in humans. What kind of structure are these?
- Bonus 1: Natural selection is often called a certain phrase. What is this phrase? (Hint: "SOTF")
- Bonus 2: What is the name of the book Darwin published to make his idea on natural selection and evolution public?

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. What is the difference between a community and an ecosystem?
2. How many trophic levels are there? Name all of them. How much energy is passed from one trophic level to the next?
3. What is a niche? What is the difference between a generalist and specialist?
4. Distinguish between omnivore, herbivore, and carnivore. Which one has more energy available to it due to its diet?
5. Summarize the carbon cycle.
6. Nitrogen makes up 78% of the air we breathe. Explain the process that allows animals to consume nitrogen.

Use the following food web for questions 7-10.



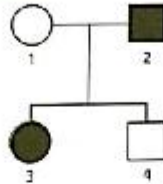
7. List the producers and consumers in this food web.
8. Which organisms in this food web are omnivores?
9. If all of the grass just died and there was no more grass, which populations would still be able to live?
10. Which organism provides the most energy to the human zombie? How do you know this?



Name: \_\_\_\_\_ Date: \_\_\_\_\_

5. Which of the following is a point mutation that does not produce a frameshift?  
 a. substitution      b. insertion      c. deletion      d. inversion

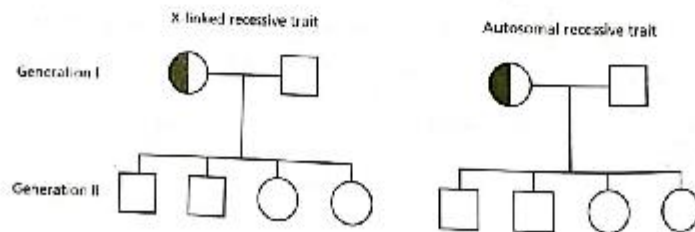
1. Which individual(s) in the pedigree shown below must be a carrier?  
 a. 1 only  
 b. 4 only  
 c. 3 only  
 d. both 1 and 4



2. Since the ABO blood group alleles are codominant, an individual with the genotype  $I^A I^B$  will have blood type  
 a. A      b. B      c. AB      d. O
3. Which of the following human traits is not a polygenic trait?  
 a. skin color      b. eye color      c. height      d. ABO blood type
4. A trait whose expression is affected by the presence of sex hormones is said to be  
 a. sex-influenced.      b. sex-linked.      c. X-linked.      d. Y-linked.

4. **Critical Thinking** A couple has four children, and each child has a different ABO blood type. What are the blood types and genotypes of the children and the parents? \_\_\_\_\_

**STRUCTURES AND FUNCTIONS** In the two pedigrees below, indicate all possible offspring in generation II by correctly filling in the male and female symbols for generation II. Use a completely filled symbol to represent an individual who displays the trait and a half-filled symbol to represent a carrier.



Name: \_\_\_\_\_ Date: \_\_\_\_\_

Use the following word box as answers to Question 1 and 3:

|                  |                     |                 |                       |
|------------------|---------------------|-----------------|-----------------------|
| Polygenic        | Complex Character   | codominance     | incomplete dominance  |
| Multiple alleles |                     | X-linked Traits | Sex-influenced Traits |
| Deletion         | Inversion           | Translocation   | Nondisjunction        |
| Substitution     | Frameshift Mutation | Insertion       | Point Mutation        |

1. Match a word from above to the examples below that best describe the situation. (30 points)

a. \_\_\_\_\_ The alleles for blood type are  $I^A$ ,  $I^B$ , and  $i$ . When a parent with A-type blood and the genotype of  $I^A \times i$  has a child with a parent with B-blood type and the genotype of  $I^B \times i$ , the resulting offspring has blood type AB and a genotype of  $I^A \times I^B$ .

b. \_\_\_\_\_ Identical twin brothers are separated at birth and are raised in different locations: one in Hawaii and the other in Alaska. They find each other 20 years later and notice that the one from Hawaii has a much darker skin tone while the one from Alaska is pale.

c. \_\_\_\_\_ Queen Victoria is a known carrier for hemophilia, but she does not exhibit it. She has several children with her husband, King Albert, who does not have hemophilia. However, one of their sons, Leopold, was found to carry and exhibit hemophilia.

d. \_\_\_\_\_ Two siblings from the same parents have the following phenotypes: child one has brown eyes, light brown hair, and is 5' 10" tall and child two has blue eyes, blonde hair, and is 5'6" tall. This suggests that the traits of hair color, eye color and height are considered what?

e. \_\_\_\_\_ A parent with straight hair has a child with a parent with curly hair. The resulting child has wavy hair, where neither parental trait is fully shown.

2. You know the following: leucine is an amino acid that is coded by the following mRNA codons: UUA, UUG, CUU, CUC, CUA, and CUG; and isoleucine is an amino acid that is coded by the mRNA codons of AUU, AUC, and AUA. Also, AUG is a start codon and the stop codons are UGA, UAA, and UAG.

a. A mutation occurs in the DNA that resulted in the following change in the mRNA:

(before) AUG UUG CUU UGA → AUG UUG CUC UGA (after)

What type of gene mutation is this? Would this mutation be harmful? Why or why not? (15 points)

b. Another mutation occurs in the DNA that resulted in the following change in the mRNA:

(before) AUG UUG AUU UGA → AUG UUU AUU UGA (after)

Would this mutation be harmful? Why or why not? (10 points)

3. Use the types of mutations from the word box at the top of the page to answer the following questions. (25 points)

a. Down syndrome is a disorder caused by the triplication of chromosome 21. The resulting number of chromosomes in someone with Down syndrome is 47. What chromosomal mutation causes this?

b. A DNA sequence undergoes the following mutation:

(before) TAC AGC ATT TTA GCC → TAC AGC ATT TGC C

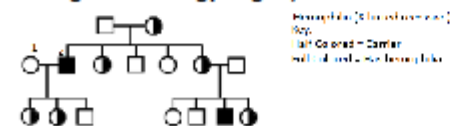
What mutation occurred? What type of mutation results from this? (looking for two answers)

c. A DNA sequence undergoes the following mutation:

(before) TAC AGC ATT TTA GCC → TAC AGC ATT TTT AGC C

What mutation occurred? What specific mutation can this be classified as? (looking for two answers)

4. Using the following pedigree, answer the following. (20 points)



a. Draw a Punnett square for parents 1 and 2 with respect to hemophilia. (Remember it is X-linked and to name and define the letter you use; e.g.  $X^H$  = does not have hemophilia,  $X^h$  = has hemophilia).

b. Explain why the daughters of parents 1 and 2 are both carriers for hemophilia. Which parent is "to blame" for them being carriers?

Quiz Type A

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. Explain, in your own words, what the difference between gradualism and punctuated equilibrium is. Create your own example of a species changing over time in each case (include description of the trait and how long each trait took to develop). (20 points)

2. A species of ivy invades the beetles' current habitat and becomes the dominant form of vegetation. The color of the ivy's leaves is similar to the beetles' average color. Considering selective pressure on the beetles from predatory birds, which type of natural selection would most likely occur in this case and why? (20 points)

3. A certain species of snail shows variation in its shell coloring, from solid yellow shells to brown, banded shells. Birds are the main predator of this snail. A scientist observes populations of this snail in various habitats. She hypothesizes that the yellow-shelled snails are better camouflaged in grasslands than the brown-shelled snails are.

- a. Based on the scientist's hypothesis, describe how the percentage of yellow-shelled snails most likely compares with the percentage of brown-shelled snails in grasslands. (15 points)
- b. Assuming the scientist's hypothesis is correct, explain how natural selection could have acted over time to produce the relative percentages of snails you described in part (a). (15 points)

The scientist observes two new grassland habitats. In one grassland habitat, the percentages of yellow-shelled snails and brown-shelled snails match what the scientist expected based on her hypothesis. In the other grassland habitat, the percentages of yellow-shelled snails and brown-shelled snails are different from what she expected. The scientist plans to study the size of the bird populations in each habitat to try to explain her observations.

- c. Explain the reasoning that supports the scientist's plan to study the bird population sizes. (10 points)

4. Explain, in your own words, what geographic isolation is. What type of speciation does it lead to? Research and find an actual example of this. (20 points)

## Appendix C: Physics Assessments

Name: \_\_\_\_\_ Date: \_\_\_\_\_

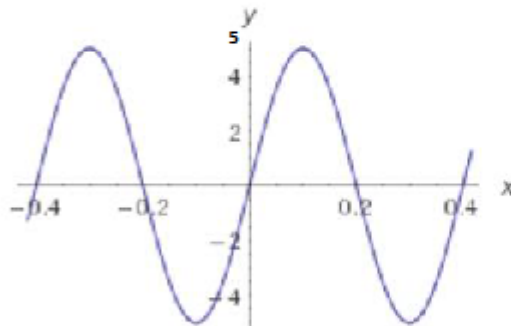
1. A dead whale had dynamite used on it, with people thinking it would move the whale onto a boat rather than exploding and making it rain whale. Pretend that it didn't explode into a million pieces and it was moved onto a boat that is 5.0 meters by 7.0 meters in dimensions. When the whale lands on it, the boat is displaced downward by 0.50 meters. Assuming the boat is in normal water, what is the mass of the whale?
2. Using the mass of the whale you just found, now pretend he was blasted onto the same boat with the same dimensions, but into a sea of mysterious red fluid. This time the boat sinks 0.60 meters. What is the density of the mysterious fluid?
3. Nemo was abandoned by his family in an ocean of water. What is the absolute pressure that Nemo faces if he is 50.0 meters deep into the water?
4. Luke Skywalker just decided to cut his arm off. The wound did not cauterize, so blood is coming out of a main artery at 50.0 m/s. The blood originates from an arteriole that is smaller in diameter and travels at 150.0 m/s where the diameter is 1.00 cm. What is the diameter of the opening of the main artery where the blood is coming out?
5. The opening at the bottom of the toilet bowl is 0.050 square meters. When you flush, the water passes that point at a speed of 15.0 m/s. The water is then transferred to a pipe where the cross sectional area is 0.020 square meters. What is the velocity of the water at the point in the pipe where the velocity is 0.020 square meters?

Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. Taylor the Goat likes to scream loudly after breaking up with her billygoat. If she screams with an intensity of  $5.00 \times 10^{-1} \text{ W/m}^2$ , and you are standing 10.0 meters away, what is the power of her screams? How many decibels is the scream?
2. Kumar is having some stomach trouble in a public restroom and you happen to overhear him in the stall in the corner. As you are washing your hands 5.00 meters away from him, you hear a sound of power 2.15 watts. What is the intensity of this sound? How many decibels is this sound?
3. In a game of chicken, Rob and Bob are driving towards each other while Rob is using his horn at a frequency of 505 Hz. If Bob is hearing the sound and driving at 75 m/s and Rob is producing the sound and driving at 100.0 m/s, what frequency does Bob observe? Assume the velocity of the sound is 340 m/s.
4. You've fallen and you can't get up so an ambulance is coming to get you. The ambulance has its siren on and is traveling towards you at a speed of 154 m/s. If the siren is admitting a frequency of 1520 Hz and the velocity of the sound is 340 m/s, what is the frequency you observe as you lay helpless on the ground?
5. A baby is crying at a frequency of 2002 Hz, so you run away from it at a speed of 15 m/s. What is the frequency of the cry you observe as you are running away? Assume the velocity of the sound is 340 m/s and that the baby cannot move.

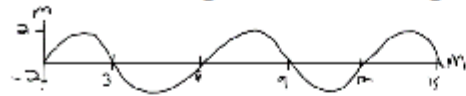
Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. If a force of 482 N applied to a vertical spring stretches the spring 50.0 cm from its original equilibrium position, what is the spring constant?
2. How much force is required to pull a spring 2.50 m from its equilibrium point if the spring constant is 5364 N/m?
3. Amanda Bynes is swinging on a wrecking ball in simple harmonic motion. Assuming gravity is normal and the period of the wrecking ball is 17.6 seconds, what is the length of the chain holding the wrecking ball? (hint: this resembles a pendulum)
4. A piñata is swinging from a 2.04 m string in simple harmonic motion. How long is the period?
5. One person of mass 741 kg goes on that slingshot ride at Six Flags New England. For those that don't know, this resembles a singular simple spring system with a spring constant of 732,000 N/m. The person vibrates in simple harmonic motion. What is the period of this mass-spring system?
6. A mass of 0.50 kg is attached to a vertical spring system and oscillates in simple harmonic motion with a period of 0.326 seconds. What is the spring constant of the system?
7. Give the following graph: What is the amplitude? What is the period? What is the frequency?

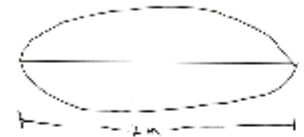


Name: \_\_\_\_\_ Date: \_\_\_\_\_

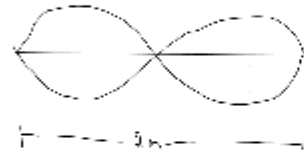
1. Label the following wave with: Crest, Trough, Wavelength, and Amplitude.



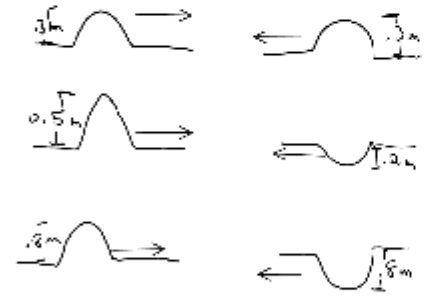
2. Label the following standing wave with: Nodes and Antinode. What is the wavelength?



3. If the above standing wave was formed at 22 Hz, at what frequency would the following standing wave be formed at if the same medium is used? Also, label the nodes and antinodes. What is the wavelength in this case?



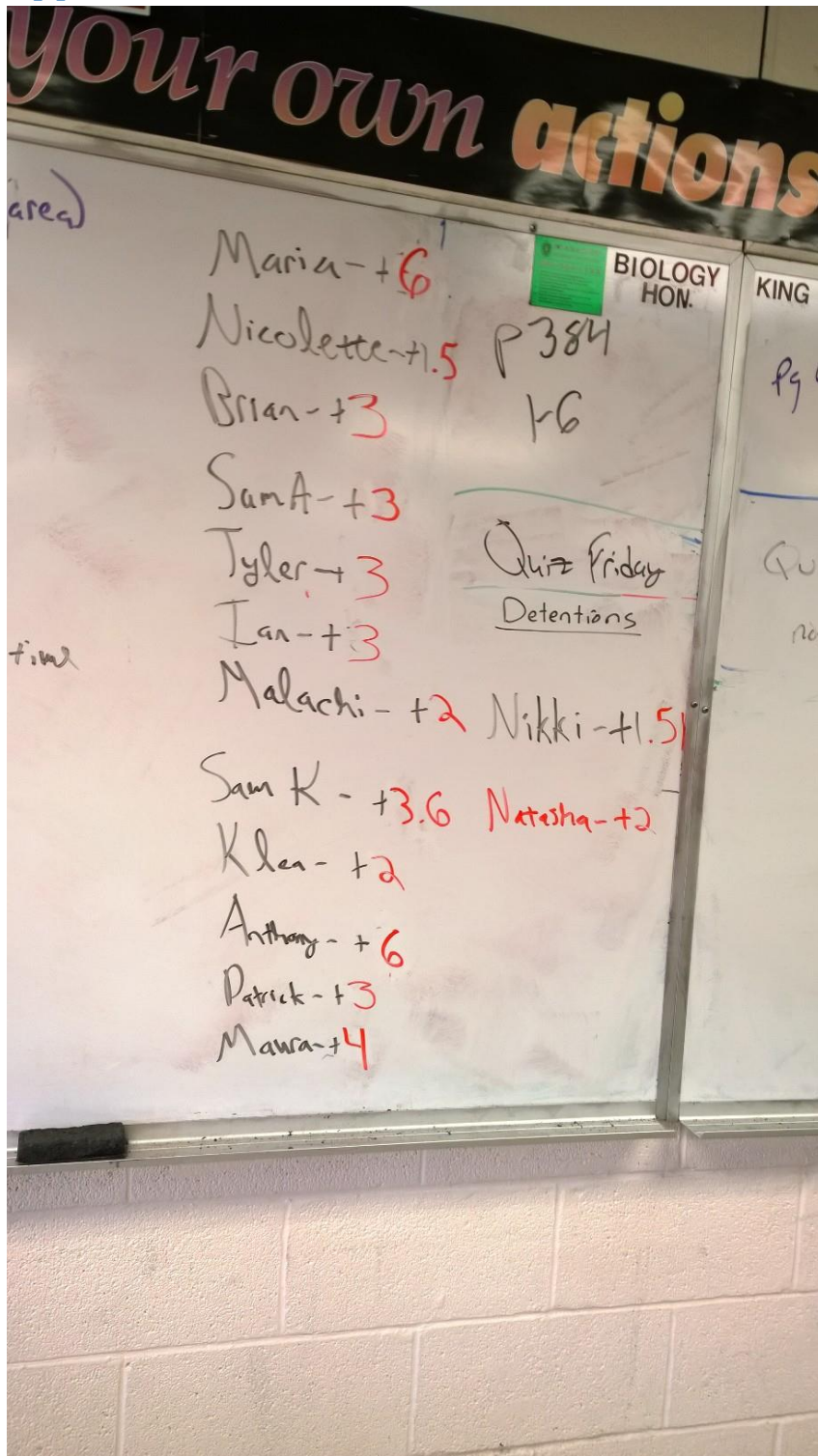
4. Find the amplitude of the resultant wave for the following cases:



5. Tan mom goes tanning but doesn't realize that ultraviolet radiation gives you cancer. If the ultraviolet waves travel at a speed of  $3.00 \times 10^8$  m/s and the wavelength is 122 nanometers, what is the frequency in this instance?

6. A wave has a wavelength of 1505 nanometers and frequency of  $5 \times 10^7$  Hz. What is the velocity of the wave?

Appendix D: Miscellaneous





s/area)

MARSDEN  
388-304-1133

BIOL  
HC

P384  
K6

9000 births/year.

5000 deaths/year

Quiz Friday

Detentions

Esther - +2

Thao - +3

Dre +1

Sandra - +1.0

Andrew - +2

Dylon - +1

Diana - +2.5

Jessie - +2

Gisela - +0.5

Lily - +3

Dustin - +1

Mike - +3

Patrick - +1.5

Tildah +1



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