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# Factors That Greatly Influence Student Learning in Science Laboratories Remelioration and Inclusive Strategies to Create a Positive, Lasting Impact

Jessica Evershed

*The College at Brockport*, [jever1@u.brockport.edu](mailto:jever1@u.brockport.edu)

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Factors That Greatly Influence Student Learning in Science  
Laboratories: Remediation and Inclusive Strategies to  
Create a Positive, Lasting Impact

Jessica Evershed  
Fall 2013  
Advisor: Dr. Peter Veronesi

FACTORS THAT GREATLY INFLUENCE STUDENT LEARNING IN SCIENCE LABORATORIES:  
REMELIORATION AND INCLUSIVE STRATEGIES TO CREATE A POSITIVE, LASTING IMPACT

By  
**Jessica Evershed**  
-Fall 2013

APPROVED BY

\_\_\_\_\_  
Advisor

\_\_\_\_\_  
Director, Graduate Programs

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

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## ***Chapter 1: Introduction***

Since the release of No Child Left Behind in 2001, educators have had additional pressure to increase the academic achievement of all students in spite of external factors present in the students' lives. Research studies in education have demonstrated that many variables interact to impact how well students perform in school. These variables include students' perceptions of school, students' experiences with the curriculum, method for delivery of instruction, socioeconomic status of students and schools, and parental support, among many others. Increasing student achievement in schools is a complex task to accomplish due to the interaction of many factors such as those previously described and a number of other implicit factors students may experience including socioeconomic status and parental support.

School districts throughout the United States demand various curriculum thresholds for its students. New York State requires students to earn credit for Living Environment in order to receive a Regents diploma. This course has a required minimum laboratory requirement of 1200 minutes for students to qualify for the Regents exam at the conclusion of the course. This requirement, in addition to nature of science being tactile and experiential, supports the need for labs to be effectively integrated into the Living Environment curriculum. How to accomplish this task of effectively integrating labs must be decided based on current research in science education that discusses the many variables which impact student learning.

As a science educator, it is essential to understand these variables in order to successfully modify instruction and laboratory experiences to maximize student learning of scientific concepts and curriculum. Many research studies have occurred which identify these variables to include the method in which labs are delivered, amount of time students spend completing various aspects of the lab, and students' ability to understand relationships between scientific theory and practice. Being aware of such factors will allow educators the opportunity to appropriately modify and improve labs prior to student participation.

## *Chapter 2: Review of Literature*

### *The Effects of Web-based Learning*

Researchers in education have conducted numerous studies to learn the impact of Web-based learning in science classrooms. Wang (2006) and his colleagues studied the use of a computer program, BioCAL, during a unit on digestion in a secondary science classroom. The BioCAL program gave teachers the option to select from six Web-based formative assessment strategies students could use when they completed the assignment. These six strategies included the following: repeat the test, provide with no answer, query scores, ask questions, monitor answering history, and all pass and then reward.

The overall purpose of these strategies was to increase students' academic achievement by providing students with various strategies to learn content (Wang, et. al, 2006). "Repeat the test" allowed students to attempt the same test item on the computer until it was answered correctly. "Provide with no answer" allowed students to view the question on the computer, search for the answer using any available resource, and then return to the question and answer it on the computer. "Ask questions" gave students the opportunity to email a question about the topic or assignment to his or her teacher. "Query scores" allowed students to access their score or their classmate's score on a particular assignment. "Monitor answering history" maintained a record of student responses as they completed an assignment. "All pass and then reward" celebrated the student's successful completion of the assignment by showing an engaging animation.

As previously described, the BioCAL program included six different formative assessment strategies for students to use as they completed their assignments on the computer. For this study, Wang (2006) placed students into one of three groups each using a different number of these formative strategies. Students either used none of the six strategies, three of the six strategies, or all six formative assessment strategies. Those who used three of the strategies had access to their scores on the assignments and the scores of their classmates, were capable of tracking the answers they submitted to each question during the task, and then rewarded with an entertaining animation at the successful completion of the assignment.

Results of Wang's (2006) study indicated that students who had access to all six formative assessment strategies during the Web-based assignment scored significantly higher on the post-assessment than the students who had access to only three or none of these strategies. In addition, there was no significant difference in student achievement between students from the latter two groups (Wang, et. al, 2006). This suggested that Web-based learning in conjunction with the use of all six formative assessment strategies increased student learning and academic achievement. Wang (2006) described the likelihood that these positive results were obtained because students had the opportunity to preview the question and return to it after finding the answer through an appropriate resource and using the formative assessment strategies provided to them. In essence, the group of students who used all six strategies was not limited to answering the question immediately.

Results from this study conducted by Wang (2006) and his colleagues indicated a positive correlation between students' use of six formative assessment strategies in BioCAL and increased academic achievement in the science classroom. However, it is important to take into consideration the various learning styles students exhibit and identify which learning styles would most benefit from a Web-based program such as BioCAL. Wang (2006) identified students with four different learning styles based on Kolb's Learning Style Inventory. Students' learning styles were classified as accommodator, diverger, converger, or assimilator based on how they perceived and processed information (Kolb, 1984). Students classified with accommodator learning styles benefited from concrete experiences and active experimentation in a classroom. Those considered to have a diverger learning style learned best from concrete experiences and reflective observations. Students labeled with a converger learning style were most successful academically through the use of active experimentation and abstract conceptualizations. Students with an assimilator learning style learned best from reflective observation and abstract conceptualizations (Kolb, 1984).

Wang's analysis of the Learning Style Inventory indicated that students with assimilator and diverger learning styles demonstrated higher academic achievement than their peers of other learning styles when completing the BioCAL program (Wang, et. al, 2006). Unfortunately, a majority of the students participating in this study were classified with accommodator learning style and only a few were classified with diverger

learning styles. The administration of this Web-based learning program did not target the students who would most benefit from it.

Yu, She, and Lee (2010) conducted a similar study of Web-based learning in a science classroom. Students were placed into one of two groups; one group used a Web-based learning program and the other did not. Students in each of the two groups were then classified as either low-achieving or high-achieving based on their score from the biology midterm examination. The academic achievement of the students and their ability to problem solve were measured by a pre-test and post-test and compared for students using the Web-based program and those who did not (Yu et al., 2010). The results were further analyzed to identify the impact of Web-based learning on the academic achievement of low-achieving students and high-achieving students. Initial analysis of the results indicated no significant difference between low-achieving and high-achieving students in their ability to problem solve or perform well academically when using a Web-based program. However, further analysis demonstrated an increase in student's retention of science content when they completed the Web-based learning program, especially among low-achieving students. In addition, high-achieving students who used the Web-based learning program demonstrated higher academic achievement for each assessment than the low-achieving students who used the same program. Based on these results, Yu et al. (2010) suggested that use of a Web-based learning environment could have a positive effect on students' ability to problem solve if used over an extended period of time. This method of instruction must be used consistently in order for it to support classroom content and lessons.

An additional benefit for students who used a Web-based learning program was its ability to engage students in science and clarify misconceptions students may have held of various science concepts (Cepni, Tas, & Kose, 2006). Cepni et al. (2006) conducted a research study to determine how Computer-assisted Instruction Material (CAIM), a Web-based learning program, impacted students' attitudes towards science, their cognitive development, and the frequency of their misconceptions regarding photosynthesis.

Students' cognitive development and misconceptions were measured and identified from students' completion of a photosynthesis achievement test and photosynthesis concept test (Cepni, et al., 2006). Cepni et al. (2006) determined that students who used the CAIM program demonstrated skills in the cognitive domain of



Bloom's taxonomy such as comprehension and application while students who did not complete the CAIM program only demonstrated the knowledge component of Bloom's taxonomy.

The use of CAIM also resulted in a decrease in the frequency of misconceptions regarding photosynthesis. For example, Cepni et al. (2006) stated that 100 percent of students at the beginning of his research study held a misconception regarding the source of energy for plants. At the conclusion of the study, 19 percent of students who completed the CAIM program expressed this misconception while 71 percent of students not completing the CAIM program maintained their misconceptions (Cepni et al., 2006). This data provided evidence that student use of a Web-based learning program had the ability to decrease student misconceptions in science. Therefore, educators can infer that the use of programs similar to CAIM can be created and employed in science classrooms to decrease or eliminate student misconceptions of science concepts.

Students' attitudes towards science when using CAIM were measured with a questionnaire issued to students in which they rated their agreement of several statements regarding various components of science education. Students who completed the CAIM Web-based learning program reported more positive perceptions of science than students who did not complete the CAIM program (Cepni et al., 2006). This result was consistent with many other research studies which indicate the correlation between students' attitudes towards school and their academic achievement. The disengagement of students in their education is correlated with their lack of academic achievement. If students enjoyed their classes and had a positive perception of school, educational research suggests that students' academic achievement would increase.

### ***Modeling***

Many factors in addition to student perceptions of school impact student achievement in science. The Next Generation Science Standards (NGSS) and the Science, Technology, Engineering, & Mathematics (STEM) education coalition both describe various strategies to be implemented and focused on in science classrooms to increase student achievement. The Next Generation Science Standards (2012) identify systems and system models as a crosscutting concept in science and the development and use of models as an integral

component of the science curriculum in grades K-12. Successful integration of these components would increase student understanding of abstract concepts and help students recognize the relationship between math, science, engineering, and technology fields.

Modeling exists in many capacities such as physical models, concept mapping models, and structure-behavior-function models. Haugwiz and Sandmann (2010) studied the impact of model kits on student interest and learning of the cardiovascular system. Students completed a pre-test and post-test in addition to a questionnaire indicating their interest levels in the activity. The results of this study indicated an above-average interest among students who used the model kits and an increase in collaboration while assembling the models (Haugwiz & Sandmann, 2010). Haugwiz and Sandmann (2010) also observed an increase in student learning as indicated by an increase in students' post-assessment scores. This increase in academic achievement upon using models further supported the positive impact of using models as a tool for conceptualizing an otherwise abstract concept. Because students demonstrated a gain in knowledge of an abstract concept, it can be inferred that other types of modeling would yield similar outcomes in a science classroom.

The benefits of concept maps as a model have frequently been studied in science education. Komis, Ergazaki, and Zogza (2007) determined the impact of a Web-based concept mapping program, ModelsCreator, on students' ability to work in a collaborative nature and understand the depth of the scientific concept of photosynthesis. At the conclusion of the study, students demonstrated an increase in their ability to derive a mathematical understanding of the photosynthetic system.

Komis et al. (2007) accredited the students' ability to derive this mathematical understanding as a result of engaging in a more challenging learning environment in terms of self-assessment and monitoring. Students were significantly more involved in the testing and interpretation components of the modeling process when they used the ModelsCreator program due to the students' ability to utilize both quantitative and qualitative reasoning. Traditional paper and pencil concept mapping only provided students with the opportunity to use quantitative reasoning (Komis et al., 2007).

It is important to note that only two students participated in the study conducted by Komis et al. Of these two students, one student exercised more control over the creation of the concept map; therefore, each student

did not participate equally with the ModelsCreator program. Because of this limitation, more research concerning the impact of ModelsCreator would need to be completed to accurately determine its true effect on student collaboration. It can, however, be suggested that ModelsCreator helped students develop a more thorough understanding of the process of photosynthesis due to students ability to utilize qualitative reasoning.

Vattam et al. (2011) conducted a study which integrated both Web-based learning and concept mapping. A Web-based program, Aquarium Construction Toolkit (ACT), was incorporated into the classrooms of three middle school science teachers with the purpose of increasing student understanding of the structures, behaviors, and functions of various components of an aquarium (Vattam et al, 2011). Each of these three teachers implemented the ACT program into their classroom as he or she deemed appropriate. Two teachers chose to introduce the Aquarium Construction Toolkit to students before the actual aquarium itself so they could gain familiarity with the various structures, behaviors, and functions of an aquarium system through the use of simulations. Of these two classes, students in one class were instructed to construct a model of a single component of the aquarium system upon completion of the ACT program. Students in the other of these two classes created an initial model of the aquarium system and revised it after completing the simulations provided by the ACT program. The third teacher chose to introduce the aquarium to students before the ACT program. This program was then used to support students' understanding of structures, behaviors, and functions of the various components of the aquarium system as they created a model of all systems in the aquarium. Students completed simulations from the ACT program as they created their concept maps to help them better understand a particular concept or relationship found within an aquarium system.

Vattam et al. (2011) observed an overall increase in student understanding of the several components of the aquarium system regardless of the method in which teachers utilized the ACT program. Analysis of the results for each of the three participating teachers yielded similar outcomes suggesting that successful integration of ACT was versatile. Pre-assessment data indicated that students demonstrated a firm understanding of the structural components of the aquarium. Post-assessment data indicated students gained a deeper understanding of the structures of the aquarium system but more importantly, students demonstrated a significant increase in their understanding of the behaviors found within the aquarium system (Vattam et al.,

2011). Vattam et al. (2011) concluded that the ACT program was successful in many different capacities due to an overall increase in student understanding of the structures, behaviors, and functions of the aquarium system. In addition to supporting the importance of modeling, these results also supported the benefit of using a Web-based learning environment in a science curriculum.

### ***Lab Efficiency***

The use of modeling provides students an opportunity to conceptualize an otherwise abstract concept in science. The use of labs in a science classroom has the same purpose because they help students understand the relationship between scientific theory and practice. In addition to being beneficial to student learning, they are also a requirement for science courses in New York State. Students in New York State must successfully complete and document 1200 minutes of lab work in order to qualify for the Regents exam. It is therefore necessary to create and use labs that maximize student learning of science concepts.

Many researchers in science education have focused on methods to improve the efficacy of labs in science instruction. Skoumios and Passalis (2010) conducted research to learn the degree to which students understood the relationship between scientific theory and practice through the use of lab guides. Students were encouraged to use the lab guides and only ask the teacher questions if it was absolutely necessary. The amount of time students spent completing the following tasks was analyzed: activities not related to the lab, manipulating apparatus, interactions with a third person, working with the lab guide, using paper and pencil, taking measurements, and performing calculations (Skoumios & Passalis, 2010). “Activities not related to the lab” included students holding personal conversations and not participating in the lab activity. “Manipulating apparatus” consisted of students assembling the necessary apparatus in order to complete the lab. “Interactions with a third person” referred to students asking a teacher or other students for help during the lab. “Working with the lab guide” described students’ use of the lab manual to follow the procedure for the lab. “Using paper and pencil” measured the amount of time students spent recording data. “Taking measurements” referred to how often students took measurements throughout the duration of the lab. “Performing calculations” consisted of the amount of time students spent performing mathematical operations (Skoumios & Passalis, 2010).

Skoumios and Passalis (2010) found that most lab time was used to assemble the lab equipment and complete paper and pencil tasks while the least amount of time during the lab was used to perform calculations from the lab or conduct analyses of quantitative data. Based on these results, Skoumios and Passalis (2010) suggested that using lab guides as the main method of laboratory instruction did not help students to understand the relationship between scientific theory and practice. Therefore, labs should be created and administered more effectively to increase the learning that occurs and minimize the amount of time students spend completing less important tasks.

In addition to the amount of time students spent completing the aforementioned seven tasks, researchers also analyzed the frequency with which students expressed technical knowledge and chemistry knowledge while completing their lab. Skoumios and Passalis (2010) defined technical knowledge as any conversation students had regarding the apparatus and chemistry knowledge as any conversation consisting of the science concepts being studied. They observed an increase in technical knowledge when students completed tasks related to the apparatus and an increase in chemistry knowledge when students recorded data and completed other paper and pencil tasks (Skoumios & Passalis, 2010).

The inability of students to relate scientific theory to practice was addressed in the study from Skoumios and Passalis (2010) and is a common concern for many science educators. Various programs have been implemented in schools to address this concern. For example, the Science in Motion program was created in response to federal data demonstrating students' weaknesses in laboratory practices (Thomas, 2012). The Science in Motion program increased the accessibility of laboratory resources to high school students by allowing students the opportunity to utilize hands-on laboratory facilities at a local college. Thomas (2012) observed an increase in assessment scores of students who completed the Science in Motion program which suggested that the use of an authentic science laboratory increased student learning.

Students' perceptions of labs also have a significant impact on student achievement. Baseya and Francis (2011) conducted a research study to determine how four different components of students' attitudes towards labs varied as they completed problem-based labs and guided-inquiry labs. Baseya and Francis (2011) measured students' perceived excitement of the lab, how difficult students thought the lab was to complete, how

efficiently students were able to complete the lab in the allocated time, and students' perceptions of the association between the lab and lecture material. Student questionnaires indicated that the difficulty of the lab and its efficiency had the most significant impact on students' attitudes about that particular lab regardless of the method of delivery (problem-based or guided-inquiry). Student responses identified the amount of teacher support that was available while completing the lab and their perceived excitement of the lab to have the least significant impact on their attitude towards that particular lab (Baseya & Francis, 2011).

Because students' attitudes about the lab were more greatly influenced by the aspects of it than whether it was problem-based or guided- inquiry, educators are not limited to selecting certain types of labs for students to complete. Research from Baseya and Francis (2011) suggested that a well-planned lab appropriate for the students' cognitive development would be effective in increasing student achievement. This would allow science teachers to successfully differentiate labs in their classrooms without being concerned of the style of lab delivery.

Results from the study conducted by Baseya and Francis (2011) also suggested that the delivery of lab instruction did not impact students' perceptions of the lab they completed. Corsi (2012) conducted research that further examined the effect of expository labs and inquiry labs on student test scores and their confidence in practicing science. Although the population of students who participated in this study was considered at-risk, the results were transferable to other populations of students as well. Corsi (2012) found that at-risk students scored higher on the post-assessment and rated a higher level of confidence when they completed inquiry labs as opposed to expository labs. These results refute a research study conducted by Baseya and Francis (2011) which determined that the delivery of the lab did not have a significant impact on student learning. It is important to note, however, that Corsi (2012) did not measure the difficulty or efficiency of the labs completed by the students.

### ***Impact of Socioeconomic Status***

The methods in which to increase student achievement when completing labs has thus far only included variables that the teacher has control over. However, there are many factors in students' lives beyond the classroom that impact how they perform in school and how much learning occurs. There is a strong consensus

among educators in science education that the strongest predictor of academic achievement is socioeconomic status.

The identification of students as “at-risk” is often indicative of a student’s socioeconomic status (SES). Perry and McMonney (2010) focused on the relationship between the socioeconomic status of a student’s school and the academic achievement of the individual student. They found that SES of the school had an overall positive impact on student achievement. Students classified as low-SES demonstrated an increase in test scores when they attended schools classified as middle-SES or high-SES. Academic performance, particularly in reading and mathematics, increased as the school’s SES increased although reading scores reached a threshold at some point between middle-SES and high-SES schools. Perry and McMonney (2010) suggested that this threshold resulted because students transitioned from public schools to private schools. Results of this study also indicated that high-SES students experienced a small yet insignificant decrease in academic achievement with the attendance of low-SES students (Perry & McMonney, 2010). Allowing students from low socioeconomic backgrounds to attend schools of a higher socioeconomic status is one action school districts could employ to increase the academic achievement of students.

In addition to the socioeconomic status of the school, that of the individual student is also indicative of student achievement. Crosnoe (2009) focused on the enrollment of low-SES students in advanced courses within schools of varying levels of middle- to high-SES students and students’ psychosocial adjustment while attending these schools. Throughout this study, he considered several factors such as race, parent education, family income, individual SES, school SES, academic transcripts, and student responses to a survey (Crosnoe, 2009).

Several important results were obtained from this study. Low-SES students who attended middle- or high-SES schools scored less well in math and science than low-SES students who attended low-SES schools. The discrepancy in math was more significant for low-SES students in high-SES schools while the discrepancy in science was more evident among Latino and African American students. Low-SES students also did not reach the curriculum threshold that would allow them to apply to college. Student questionnaires indicated that low-SES students held a more negative self-image and felt isolated more often (Crosnoe, 2009). African

American students experienced these negative feelings most strongly in high-SES schools. Crosnoe (2009) determined that a person's race/ethnic identification in a middle-SES school had the most significant impact in predicting science coursework and psychosocial outcomes. It is therefore necessary to create a positive learning environment for all students, in particular minorities and students of low socioeconomic status backgrounds.

Crosnoe (2009) described these results in terms of the "frog pond effect" and the "double disadvantage." The frog pond effect claimed that low-SES students faced greater competition for academic resources and experienced more psychosocial problems when attending a middle- to high-SES school. The double disadvantage suggested that minority students of a low socioeconomic status experienced the frog pond effect to a more severe degree than other low-SES students (Crosnoe, 2009). This psychosocial phenomenon was also expressed in a study from Battle and Pastrana Jr. (2007) although White students reported these feelings to a lesser degree than other races.

Battle and Pastrana Jr. (2007) conducted a study to determine the longitudinal effects of race and socioeconomic status on Hispanic students' academic achievement during their senior year of high school and their achievement two years after graduating high school. These results were then compared to those of White students. Battle and Pastrana Jr. (2007) were interested to know how the combination of race and socioeconomic status affected the obtained results and whether or not students benefited equally from an increase in socioeconomic status. Factors such as the students' gender, location of school (urban or not urban), type of school (public or private), family size, parental control, cultural capital, and economic capital were considered.

The results of this study from Battle and Pastrana Jr. (2007) found there to be no significant difference in academic achievement between Hispanic and White students. Analysis two years post-graduation revealed higher academic achievement and an increase in socioeconomic status among Hispanic students compared to their White classmates. However, the incomes of Hispanic adults did not reflect their increase in socioeconomic status. The salaries of Hispanic adults were not comparable to White adults of similar socioeconomic backgrounds. Another interesting finding observed by Battle and Pastrana Jr. (2007) was the increase in academic achievement of Hispanic females two years post-graduation. Hispanic males demonstrated higher



academic achievement in 12<sup>th</sup> grade but this pattern was reversed two years post-graduation. Determining the reason for this shift in academic achievement can help educators provide resources and training of skills to ensure all students regardless of gender or ethnicity have a more equitable opportunity for success.

Family size also played a significant role in the academic achievement of Hispanic students in the study conducted by Battle and Pastrana Jr. (2007). A positive correlation existed between large family size and academic achievement for students in 12<sup>th</sup> grade although this was reversed for Hispanic students two years after graduation. Social capital and low socioeconomic status also impacted students' academic success to a more severe degree two years after graduation. The most significant claim derived from this study was that socioeconomic status predicted academic outcomes ten times more than the percentage of students receiving free lunch (Battle & Pastrana Jr., 2007). The inequality minorities experienced in spite of "equal" educational opportunities provide insight into the negative perceptions many minority students hold of the education system.

### ***Absenteeism***

Such negative perceptions of school are one reason for the absenteeism and truancy of students. Several research studies throughout the world have focused on the factors which impact student behaviors of absenteeism and truancy. Researchers have identified varying degrees of absenteeism such as no absenteeism, absenteeism, and problematic absenteeism (Lannegrand-Willems et al., 2012). Truancy has been defined as "the act of absenting oneself from school without a legitimate cause and without the permission of one's parents or the school authorities" (Akume, Awopetu, & Nongo, 2013, p. 275). Akume et al. (2013) discussed one consequence of absenting oneself from school to be indicative of future problems such as poor character formation and inability to acquire life skills.

There are many reasons students choose not to attend school. The overarching reason as extrapolated from many research studies is the discontent students have of the educational system. For example, students in France have the opportunity to attend vocational secondary schools which offer programs of study such as joinery, building trades, secretarial work, hotel business, clothing trades, electronic, and mechanical trades in addition to their core classes (Lannegrand-Willems et al., 2012). Lannegrand-Willems et al. analyzed the impact

of five factors within the student's life and their effect of these factors on students' attendance. Data was collected in regards to students' demographics and their academic standing in school, personal variables of school involvement such as participation in extracurricular activities, students' relationships with parents and teachers, students' perceptions of school climate, and students' beliefs in school justice. More specifically, Lannegrand-Willems et al. (2012) studied the students' involvement in school, the amount of teacher support available for students, how lessons were presented, the order and organization in the classroom, and the clarity of rules and expectations for students.

The vocational secondary schools in France offered two types of diplomas to students including a vocational training qualification (CAP) or certificate of technical education (BEP). The former degree did not allow students to apply to higher education while the latter provided students with more employment opportunities after graduation. Students selected a program of their choice but did not necessarily complete their desired program due to space limitations (Lannegrand-Willems et al., 2012). Of all the variables analyzed during this study, Lannegrand-Willems et al. (2012) determined that the type of vocational training program and ability to participate in this training had the most significant impact on student absenteeism. Of the two degrees offered by the vocational secondary schools, the vocational training certification was less likely to help students succeed after high school. Several students who were working towards this degree because they were not placed in the other program reported negative perceptions of justice in the school system. They were also more likely to be classified as absentee students or problem absentee students (Lannegrand-Willems et al., 2012). The correlation between student dissatisfaction with their education and nonattendance is a significant issue which needs to be addressed in the education system.

Various implications for education could be justified based on the results of this study. Lannegrand-Willems et al. (2012) provided many suggestions to improve students' perceptions of school. They suggested having an intervention for students who were problem absentees. Students could be counseled in an effort to help them understand the value and importance of their education. Students could also discover their role in their academic achievement and develop a sense of control in their future. Lannegrand-Willems et al. (2012) also claimed that absenteeism could be prevented during periods of transition in education. As previously

mentioned, students began their vocational program after their first year of high school. The students' perceptions of school in addition to the educational system influenced students' attendance rates. School counselors and psychologists could help change students' perceptions of adults so they feel that adults are supportive of them in their educational endeavors. Peer tutoring could also be utilized in classrooms to help students develop a more positive perception of the classroom atmosphere (Lannegrand-Willems et al., 2012).

The French High Council for Education reported three concerns for students attending vocational schools. Students were typically socially disadvantaged, repeated a course in the curriculum, and were often absent from school (Haut Cionseil de l'Education, 2009). Absence from school most often resulted in decreased academic performance. The National Forum on Education Statistics (2005) identified several factors that affected student achievement including student attendance and mobility. Parke and Kanyongo (2012) cited several pieces of research describing indicators of absenteeism. One particular article cited by Parke and Kanyongo (2012) described characteristics shared by mobile students such as belonging to families with low income, having parents with low levels of education, and belonging to minority groups (Alexander et al., 1996). These characteristics are reflective of a student's socioeconomic status and thus serve as a strong predictor of student achievement.

Parke and Kanyongo (2012) conducted research to determine the relationship between mobility and attendance while taking into consideration students' gender, ethnicity, and socioeconomic status. They identified different degrees of mobility such as stable attenders, stable non-attenders, mobile attenders, and mobile non-attenders (Parke & Kanyongo, 2012). The term stable referred to students who remained in the school district; attenders attended school while non-attenders did not. Mobile referred to students who moved frequently to other schools or school districts. Attenders and non-attenders were similarly identified as that previously mentioned (Parke & Kanyongo, 2012).

Data concerning mobility was compared among students in elementary schools, middle schools, and high schools. Students in the first grade had the highest percentage of stable attenders. As grade level increased in elementary school, the percentage of stable attenders decreased. A similar pattern was observed in the middle schools as students progressed from sixth grade to eighth grade; the percentage of stable attenders decreased

and the percentage of mobile attenders increased. This pattern was reflected even more significantly by the time students entered high school. During this time, nonattendance rates increased the most among students although no significant differences were observed between students of different races (Parke & Kanyongo, 2012).

Analysis of scores from the Grade 8 mathematics assessment was used to measure the academic achievement of students with varying levels of mobility. These scores indicated that students classified as stable attenders reached higher academic achievement in math compared to stable non-attenders, mobile attenders, and mobile non-attenders (Parke & Kanyongo, 2012). In terms of mobility, mobile attenders scored higher than mobile non-attenders on the Grade 8 mathematics assessment. Results of the Grade 11 mathematics assessment yielded similar outcomes in each of the participating high schools. Parke and Kanyongo (2012) used the Standard Aptitude Test, School Performance Index, and Average Student Achievement to measure the academic achievement of high school students. Results from these indicators were consistent with the aforementioned assessments and thus supported the claim that attendance and mobility impacted student achievement.

Research in education has demonstrated the negative impact of truancy on student achievement. Akume, Awopetu, and Nongo (2013) conducted a research study to examine factors that impacted truancy including students' socioeconomic status (SES) and the location of their home, whether it was urban or rural. Students were issued a questionnaire to complete in which they provided demographic information and their frequency of truancy (Akume et al., 2013).

Results from the study conducted by Akume et al. (2013) indicated a correlation between socioeconomic status and truant behaviors as supported by an increase in truant behaviors among students from low socioeconomic and high socioeconomic backgrounds (Akume et al., 2013). Truancy was also observed to occur more often among students living in rural regions than urban regions. The value of these results lies in its support that a relationship exists between parent's socioeconomic status, location where a student lives, and truant behavior. Akume et al. (2013) explained how socioeconomic status and a student's home location both encompass other factors that serve as indicators of student attendance. These included lack of proper

supervision of children and their behavior, inability to instill discipline in the child, and lack of a conducive learning environment at home (Akume et al., 2013).

### ***Implications for Education***

Each of the aforementioned research studies held several important implications for science education. Parke and Kanyongo (2012) suggested four priorities for future research based on their understanding of mobility and attendance rates. These included mobility in upper elementary grades, nonattendance in high school, discrepancy in percentage of students receiving free or reduced lunch, and the negative impact of mobility and nonattendance. Action plans need to be utilized to address these four significant concerns.

Because the curriculum became more rigorous as students progressed throughout school, students who moved frequently were more disadvantaged by gaps in education and curriculum. An increasing achievement gap could disengage and frustrate students, thus resulting in nonattendance. Research concerning the correlation between dissatisfaction of the school system and student absenteeism supports the negative impact disengagement and frustration have on student achievement (Lannegrand-Willems et al., 2012).

Parke and Kanyongo (2012) also suggested that household or economic responsibilities became a priority for some absentee students. As an educator, it is important to understand the external factors impacting student achievement in school. Addressing these concerns is a prerequisite for any intervention schools could employ.

Other implications for education as described by various research studies include the need for counseling services. Akume et al. (2013) stated the importance of parents receiving counseling to properly engage their child in school. It was recommended that parents from high socioeconomic status backgrounds learn methods to avoid overprotecting their child so students would not feel it necessary to rebel and engage in truant behavior. Parents of low socioeconomic status were advised to participate in training aimed at helping them be more productive in their children's schooling. This training included families learning how an education will benefit the student's future. Akume et al. (2012) also recommended that truant students be counseled so they understand the importance of being in school as well as the value of their education.

Akume et al. (2012) further suggested that teachers attend seminars to learn effective behavior modification strategies to implement with truant students. Attending school would be a more valuable experience for students if governments provided additional learning materials to urban and rural schools that would increase student interest (Akume et al., 2012). Results obtained from Lannegrand-Willems et al. (2012) offered similar implications for education as discussed by Akume et al. (2012) such as having interventions and counseling services for students with attendance concerns.

## *Summary*

Teachers have a common goal of increasing student achievement in their classrooms. Research in science education has indicated that no one particular method of instruction benefits all students during the same lesson. It is therefore necessary for teachers to incorporate a variety of current research-based strategies into their lessons to increase academic achievement and depth of learning. Many effective teaching strategies as supported by research include the integration of Web-based learning programs, use of concept maps and other structure-behavior-function models, as well as the method in which the lesson is delivered.

Students demonstrated an overall increase in learning as indicated by post-assessment scores when they completed various Web-based learning programs and created models of abstract science concepts. In most cases, students' cognitive development also increased. For example, students who utilized concept mapping Web-based programs were able to identify qualitative relationships between components of a system while only quantitative relationships were recognized among students not utilizing the concept mapping program (Komis et al., 2007).

In addition to measuring the academic achievement of students upon completion of a program, many researchers inquired about the participants' attitudes towards that program. Student questionnaires were frequently issued to students to gain information such as their perceptions of various aspects of their experiences with the education system. Several research studies supported the correlation between a negative perception of education and low academic achievement. Many low-achieving students indicated through their questionnaires that they believed there was no justice or equality within the school system. A negative perception of education further impacted students' attendance and truancy rates. Many students who were considered attendance concerns felt disappointed with their program of study and thus decided to purposely absent themselves from school (Lannegrand-Willems et al., 2012).

School districts enforce a curriculum threshold for students to meet in order to earn a high school diploma. Science teachers in New York State have the additional responsibility of ensuring students complete a

required 1200 minutes of laboratory work throughout the duration of their science course in order to take the Regents exam. Many research studies have occurred throughout various parts of the world that focus on the efficacy of labs in science classrooms and identifying strategies and programs for teachers to use that will increase student achievement upon completion of labs. Interestingly, the method of lab delivery did not appear to have a significant impact on students' interest in that lab; it was more important that the lab was created and administered efficiently (Baseya & Francis, 2011). Some research in science education regarding the use of lab guides indicated that students did not gain a higher cognitive understanding of the science concept because they spent too much time completing less important aspects of the lab (Baseya & Francis, 2011). The use of the lab guides must be further analyzed to learn how to make them more effective for student learning.

Research in science education has the intention of identifying methods and strategies for teachers to use that will increase student engagement and thus result in students developing a richer knowledge base and higher cognitive level of understanding. However, these strategies and programs cannot be effective if a number of overarching variables are not addressed. As supported by a number of research studies, the most important variable educators must address is the socioeconomic status of the student. Socioeconomic status encompasses a number of characteristics such as income level, parent's level of education, location of student's home, and frequency of mobility. Many research studies identify the inequality socioeconomically disadvantaged people encounter even when equal socioeconomic status has been achieved. Therefore, there is a societal issue which must be addressed and acted upon prior to any academic intervention.

Academic achievement is a complex task to achieve due to the interaction of many different variables faced by students. Teachers and other stakeholders in the education system must actively seek out current research in education to learn what these variables are and how to accommodate them in the classroom.



Narrative: Significance of Project

Science teachers use different types of labs such as expository labs and a range of inquiry labs. The goal of any lab is to help students make connections between science concepts learned in class and real life applications. Various research studies have identified factors which impact student learning from science labs. These include the method in which labs are delivered, amount of time students spend completing various aspects of the lab, and students' ability to understand relationships between scientific theory and practice. For example, the difficulty of the lab and how efficiently it was administered has the greatest impact on students' attitudes about that lab (Baseya & Francis, 2011). Students' attitude towards any aspect of the school environment influences their academic achievement (Cepni, Tas, & Kose, 2006). It is therefore necessary for educators to identify weaknesses in the labs used in their classrooms. Once recognized, the labs can be modified to maximize student learning. Modifying labs currently being used by teachers will yield higher academic achievement among students, increase the level of understanding of scientific concepts, and improve scores on the Regents exam. Revising these labs to reflect current research in science education will also make these labs more adaptable to a range of educational settings and student learning needs. The following chapter will consist of fifteen labs in their original versions with annotations of the rationale for revisions. Each of these labs will be followed by the revised lab itself.

# Factors That Greatly Influence Student Learning in Science Laboratories: Remelioration and Inclusive Strategies to Create a Positive, Lasting Impact

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# AIDS Transmission Lab

## Background

AIDS (Acquired Immune Deficiency Syndrome) is caused by the Human Immunodeficiency Virus, also known as HIV or AIDS virus. The AIDS virus cannot infect people as easily as many other viruses. People get AIDS typically from one of the following interactions:

- Sharing hypodermic needles, such as when injecting illegal drugs
- Having sexual contact with an infected partner
- Being born to an HIV-infected mother
- Getting HIV-infected blood into an open wound

It can take up to ten years or more for the AIDS virus to make people sick. In the meantime, people with the virus may look and feel healthy, often for years. This makes it nearly impossible to determine someone's AIDS status just by looking at them. There is currently no cure for HIV or AIDS. Once infected, you will carry the virus for the rest of your life and have the potential to infect others through the previously mentioned interactions.

Replaced by

## Pre-lab

**Directions:** The directions are numbered and explicit to ensure students complete all parts of the task.

1. Read the following excerpt from the article "What is AIDS? What is HIV?" found in the Medical News Today journal.
2. Answer the questions that follow each section.
3. Highlight or underline where in the text you found that answer.

The article excerpt supports the implementation of the Common Core State Standards (Shift #5 Writing from Sources) in the Living Environment curriculum.

The format of this excerpt is chunked to help students focus their attention to a particular section of text. It also accommodates students who require chunking in their IEPs. Questions are minimal but meaningful and focus students' attention on the pertinent information in the preceding text.

**AIDS** (Acquired immune deficiency syndrome or acquired immunodeficiency syndrome) is a disease caused by a virus called **HIV** (Human Immunodeficiency Virus). The illness alters the immune system, making people much more vulnerable to infections and diseases. This susceptibility worsens as the disease progresses.

How does AIDS affect the immune system?

HIV is found in the body fluids of an infected person (semen and vaginal fluids, blood and breast milk). The virus is passed from one person to another through blood-to-blood and sexual contact. In addition, infected pregnant women can pass HIV to their babies during pregnancy, delivering the baby during childbirth, and through breast feeding.

List 4 places HIV is found in.

- 
- 
- 
- 

The use of bullets provides students a visual reminder of how many responses they need to provide.

HIV can be transmitted in many ways, such as vaginal, oral sex, anal sex, blood transfusion, and contaminated hypodermic needles.

List 5 ways HIV can be transmitted.

- 
- 
- 
- 
- 

Lab

Scenario: (sounds more fun and engaging than “directions”

Directions: We are going to do an activity that shows how AIDS is spread between people based on certain behaviors. Each student will be assigned a specific role to play. You will be given “bodily fluids” that will be exchanged with others based on the role you are given. The roles and their descriptions are listed below:

- Abstinent** – does not exchange bodily fluids with anyone
- Monogamous** – exchanges bodily fluids with one member of the (several times)
- Promiscuous** – exchanges bodily fluids with members of the opposite sex (several times)

Students will be assigned a fictional character to portray during this activity. AIDS is a sensitive topic for some students. Assigning a fictional character will make it less personal and reduce the likelihood of a student experiencing negative perceptions of the lab.

**Prostitute** – gets paid for exchanging bodily fluid with members of the opposite sex (this can happen several times)

**Bisexual** – exchanges bodily fluids with both men and women (this can happen several times)

**Homosexual** – exchanges bodily fluid with members of the same sex (this can happen several times)

**IV drug user** – exchanges bodily fluid with men or women (this can happen several times)

Students will not preview the terms. They will be given an index card with the term and a description. At the conclusion of the activity, students will discuss how “AIDS” spread to each other. This discussion will include the transmission of a sexually transmitted disease throughout a population based on certain behaviors. This activity will serve as a model for a problem in today’s society and relate back to the pre-lab article excerpt.

I will not tell students the purpose of this lab. At the conclusion of the lab, I will ask them to reflect on what the purpose of the lab was. This modification will force students to think and reflect!

Purpose

The purpose of this lab is to demonstrate how certain behaviors affect the spread of AIDS.

Hypothesis (*What behavioral roles do you think will spread AIDS to the most people? Why?*)

What character behaviors from the simulation did you notice led to the spread of AIDS?

given a card for a character with a certain behavioral role.

1. Each student will be assigned a behavioral role. You must keep this behavioral role a secret!
2. Each student will be given a test tube containing “bodily fluids” (don’t worry - it’s just water!) The “bodily fluids” in your test tube represent fluids with a known ability to transmit HIV (such as blood, semen, vaginal secretions, and breast milk.) This reinforces the pre-lab article. One test tube will also have “AIDS” (it’s really just a chemical.)
3. Students will be given 5 minutes to act out their roles.
4. To exchange fluids, students must ask the other person permission to do so. You need to follow the behavioral role you were assigned! Remember to keep your role a secret. ☺
5. Once permission is granted to exchange fluids, one student will pour a small amount of “bodily fluid” into the other person’s test tube. The person receiving the “bodily fluid” will swirl their test tube then pour some of their “bodily fluid” into the other person’s test tube.
6. Each time you exchange with someone, write that person’s name down on your index card.  
I will announce that students just modeled behaviors that represent those in society.
7. After 5 minutes has passed, each student will visit the “doctor” to be tested for AIDS. Mrs. Evershed is the doctor.
8. If there is a color change in your test tube, you have AIDS. ☹

I do not want students to feel offended.

Your character has

**Data** Students will create a data table to record their exchanges of bodily fluid and whether or not that person tested positive for AIDS.


Analysis Questions

1. What was the purpose of this lab?

character

This helps the student make connections between practice and theory.

2. Who was the original ~~person~~ with AIDS? Hint: You may have to compare your data table with others! (This supports Common Core Shift #4 Text-based Answers)

character

3. What behavioral role did this person have?

Rewording these statements decreases the likelihood that students feel there is a "right" and a "wrong" answer. I can gauge how they perceive the risk level of various behaviors.

would you consider to be

4. What behavioral roles are ~~considered~~ low risk for spreading AIDS?

5. Explain your answer to number 4.

When I ask "Why?" at the end a question, students do not answer it. If I make it a separate question, it increases the chances that they explain their rationale.

would you consider

6. What behavioral roles are ~~considered~~ high risk for spreading AIDS? Use evidence from the pre-lab reading **and** the lab. This question supports Common Core Shift #5 Writing from Sources: Writing emphasizes use of evidence from sources to inform or make an argument.

6. ~~How can you prevent the spread of AIDS?~~ This is addressed in the Conclusion.

Conclusion

**CLAIM:** ~~How is AIDS transmitted?~~ This question is not specific. What behaviors increased the risk of a person contracting AIDS?

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**EVIDENCE:** Describe ~~the behavioral roles that spread AIDS.~~ This is a knowledge level question. I want students to demonstrate application skills. Why did these behaviors put people at a higher risk?

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**INTERPRETATION:** How does this AIDS Transmission Lab apply to the real world?

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This lab can also be completed by students who were absent. Rather than participate in the actual modeling of AIDS transmission, students can complete the simulation. The remainder of the lab can then be completed for lab minutes.

Students will view a computer simulation of AIDS transmission that I created using the AgentSheets computer program. Characters are identified by different behaviors such as IV drug user, promiscuous, and abstinent. However, I will not tell students about the behaviors. They will be asked to record the number of characters who contracted AIDS and hypothesize the relationship between certain behaviors and the risk of contracting AIDS. Web-based learning increases student interest, decreases misconceptions, and helps students retain concepts (Wang, et. al, 2010).

Revised Lab #1  
AIDS Transmission Lab

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

### AIDS Transmission Lab

#### Pre-lab

Directions:

1. Read the following excerpt from the article "What is AIDS? What is HIV?" found in the Medical News Today journal.
2. Answer the questions that follow each section.
3. Highlight or underline where in the text you found that answer.

**AIDS** (Acquired immune deficiency syndrome or acquired immunodeficiency syndrome) is a disease caused by a virus called **HIV** (Human Immunodeficiency Virus). The illness alters the immune system, making people much more vulnerable to infections and diseases. This susceptibility worsens as the disease progresses.

How does AIDS affect the immune system?

HIV is found in the body fluids of an infected person (semen and vaginal fluids, blood and breast milk). The virus is passed from one person to another through blood-to-blood and sexual contact. In addition, infected pregnant women can pass HIV to their babies during pregnancy, delivering the baby during childbirth, and through breast feeding.

List 4 places HIV is found in.

- 
- 
- 
- 

HIV can be transmitted in many ways, such as vaginal, oral sex, anal sex, blood transfusion, and contaminated hypodermic needles.

List 5 ways HIV can be transmitted.

- 
- 
- 
- 
-



## Lab

Scenario: Everyone in the class will participate in a simulation of AIDS transmission. You will each be assigned a character to play and then exchange “bodily fluids” based on your character’s role.

### **Procedure**

1. Each student will be given a card for a character with a certain behavioral role found in today’s society. You must keep this behavioral role a secret!
2. Students will be given a test tube containing “bodily fluids” (don’t worry - it’s just water!) The “bodily fluids” in your test tube represent fluids with a known ability to transmit HIV (such as blood, semen, vaginal secretions, and breast milk). One test tube will also have “AIDS” (it’s really just a chemical.)
3. You will be given 5 minutes to act out your role with your classmates.
4. To exchange fluids, you must ask the other person’s permission to do so. You need to follow the behavioral role your character was assigned! Remember to keep this role a secret. 😊
5. Once permission is granted to exchange fluids, you will pour a small amount of “bodily fluid” into the other person’s test tube. The person receiving the “bodily fluid” will swirl his/her test tube then pour some of his/her “bodily fluid” into your test tube.
6. Each time you exchange bodily fluid with someone, write that person’s name down on your index card.
7. After 5 minutes have passed, all students will visit the “doctor” to be tested for AIDS. Mrs. Evershed is the doctor. 😊
8. If there is a color change in your test tube, your character has AIDS.

### **Data**

Create a data table to record who your character exchanged bodily fluids with and whether that person tested positive or negative for AIDS. Use the space below.

### **Analysis Questions**

1. What do you think the purpose of this lab was?
2. Who was the original character with AIDS? (Hint: You may have to compare your data with others!)
3. What behavioral role did the character have who began with the AIDS?
4. Explain your answer to question 3.
5. What behavioral roles in this simulation would you consider low risk for spreading AIDS?
6. Explain your answer to question 5.
7. What behavioral roles would you consider to be high risk for spreading AIDS? Use evidence from the pre-lab reading **and** the lab.

### **Conclusion**

**CLAIM:** What behaviors increased the risk of a character contracting AIDS?

**SUPPORT:** Why did these behaviors put characters at a higher risk of contracting AIDS?

**ANALYSIS:** How does this AIDS Transmission Lab apply to the real world?

# LAB 14 Modeling Gene Transfer with a Plasmid

by Jenny Vuhuro Brady, Graduate College, University of Arizona

**Inquiry:** How can plasmids be used to transfer new pieces of DNA into an organism?

**Introduction:** The first step in genetic engineering is to incorporate a desired gene into a plasmid. The plasmid and gene must be prepared so that they can be joined together to form a new recombinant plasmid. One way to do this is to cut both the gene and the plasmid with restriction enzymes that leave overhanging or so-called *sticky ends*. If the sticky ends of the plasmid and the gene are complementary, they will form hydrogen bonds. The sticky ends can then be joined permanently by ligase enzymes to make a new plasmid containing recombinant DNA. In this activity you will make a model recombinant plasmid by piecing together a paper gene and paper plasmid that have been cut with restriction enzymes.

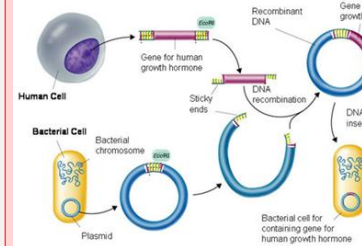
- Objectives:**
- EXPLAIN the function of a restriction enzyme.
  - MODEL the process of making a recombinant DNA plasmid from a desired gene and the plasmid.

**Comment [m1]:**

The author's information may cause students to feel this lab will be too hard for them. Students' perceptions of the lab influence their willingness to learn. The perceived difficulty of the lab negatively affects has the greatest impact on students' attitudes about the lab (Baseya & Francis, 2011).

Students will have little prior knowledge of the use of plasmids in genetic engineering. This question will be addressed at the end of the lab to ensure a higher quality response.

This introduction includes a lot of information. A diagram will be included to supplement the information.



The introduction will be followed by a brief video clip demonstrating the process of recombining DNA and a plasmid.

The objectives will be rewritten in more user friendly terms and placed at the beginning of the lab to help students better understand the title of the lab and what they will accomplish at the conclusion of the lab. There are many new concepts and vocabulary terms in this lab so it is important to minimize the amount of frustration students will feel.

Students will be provided with a picture representing the vocabulary term and a space to write the definition for each term. (This activity supports Shift #6 of the Common Core: Academic Vocabulary.)

The current procedure is confusing. Rather, students will be given color coded pieces of paper with the DNA sequences already typed. Giving students the labeled paper will reduce errors later in the activity and will also result in more accurate completion of the lab. Creating a model of an abstract concept will help students understand the concept more accurately (Nun & Stolarsky, 2009).

This section is for the teacher's use and not the students' use therefore it will be excluded.

A student... principles of genetic engineering... *Biotechnology 5, "Genetic Engineering in Organisms."*

**Tech Talk:** Be certain you understand the meaning and use of the following terms before proceeding with the lab.

- gene
- plasmid
- restriction enzyme
- genetic engineering
- complementary DNA sequence
- recognition site

### Materials (per group):

- scissors
- 2 pieces of construction paper (green, blue, yellow and orange)
- transparent tape

### Safety

Be careful when using the scissors.

This will be excluded because it is common sense.

### Procedure

- Cut a piece of ~~yellow~~ <sup>green</sup> construction paper lengthwise into four equal strips. Tape the strips of paper together to form one long strip of paper.
- Beginning on the top left edge, as shown in Figure 14.1, copy the following partial sequence for the pUC19 plasmid onto the strip of yellow paper. Do not leave spaces between the letters. The letters represent nucleotides in DNA. Plasmids usually contain between 5 000 and 10 000 nucleotides. The dots represent the nucleotides that are not shown.

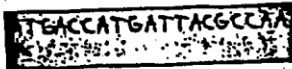


Figure 14.1

### pUC19 plasmid sequence:

... ATGACCATGATTACGCCAAAGCTTGCATGCCTGCAGGTCGACTCTA  
GAGGATCCCCGGGTACCGAGCTCGAATCACTGGCC ...

3. On the same strip of yellow paper, write the sequence for the complementary DNA strand directly under the sequence for the first strand.

example: ATGACCATGATT...  
TACTGGTACTAA...

Trim any extra paper from the end of the yellow strip, leaving a 1-cm overhang. Tape the two ends together to make a complete circle that represents the pUC19 plasmid, as shown in Figure 14.2. NOTE: Make sure that the DNA sequence of the plasmid is visible around the top of the circle facing outward. Label the yellow circle plasmid.



Figure 14.2

The directions will be simplified with key words in bold for emphasis.

5. Using a half-sheet of orange construction paper, cut two strips of paper that are as wide as the yellow strips. Tape the two strips of orange paper together to make one long strip.
6. Copy the sequence for the lux gene on the orange strip of paper. The actual lux gene makes a chemical that causes an organism to glow in the dark. On the same strip of orange paper, write the sequence for the complementary DNA strand directly under the sequence for the first strand.

lux gene sequence:

CACAAGCTTAGCTTAGAGTACCTAGATAAGGCATAGATCTAGCTACGGAA

7. After you write the lux gene sequence, trim any excess paper from the ends so that the gene sequence fills the top edge of the paper. Label the orange strip of paper gene.
8. Identify the recognition sites for the following restriction enzymes on the pUC19 plasmid DNA. The solid lines indicate where the restriction-enzyme has made a cut within the recognition sequence. Draw lines on the yellow strip of paper labeled plasmid to show where the plasmid should be cut by the two restriction enzymes listed below. Label each side of the cut site with the name of the restriction enzyme that was used.

Hind III

5'— A | A G C T T  
3'— T | T C G A A

Bam HI

5'— G | G A T C C  
3'— C | C T A G G

9. Identify the recognition sites for the following restriction enzymes. Draw lines on the orange strip of paper labeled gene to show by the two restriction enzymes listed below. Label each side of the restriction enzyme that was used.

Hind III

5'— A | A G C T T  
3'— T | T C G A A

Bgl II

5'— A | G A T C T  
3'— T | C T A G A

10. Use the scissors to cut the yellow strip of paper that represents the plasmid and the orange strip of paper that represents the gene according to your cut site markings. Be careful to leave the overhang, or sticky ends, intact.
11. Match the complementary sticky ends from the pUC19 plasmid and the lux gene to form a new plasmid. Tape the orange and yellow pieces together to represent the bonds that will form between the complementary strands. The result should be a circle of yellow and orange paper. In a real plasmid, the sticky ends are first held together by hydrogen bonds, and then permanent covalent bonds are formed by the ligase enzyme.
12. Tape the yellow and orange strip of paper and the extra pieces of orange and yellow paper to your laboratory recordsheet. Then, answer the questions and problems.

Students typically perform a lab simulating gel electrophoresis before this lab. Students therefore have experience with recognition sites and restriction enzyme and can access prior knowledge and experience.

Directions for cutting the DNA will include students underlining the recognition site and drawing a line between the 2 bases in which it cuts. This helps scaffold the activity of restriction enzymes.

The term "scissors" will be replaced by "restriction enzyme" to stress the function on restriction enzymes in the cutting of DNA.

Name \_\_\_\_\_ Section \_\_\_\_\_ Date \_\_\_\_\_

## Laboratory Recordsheet 14: Modeling Gene Transfer with a Plasmid

### DATA RECORD:

Fold your model recombinant DNA plasmid so that the inserted *lux* gene is easily visible. Tape your plasmid and extra pieces of DNA to the space below.

Plasmid

Extra DNA Fragments

### ANALYSIS AND CONCLUSIONS

1. Explain what a restriction enzyme does.

---

---

2. Why are two different restriction enzymes used to cut the pUC19 plasmid and the *lux* gene DNA? What would have happened if only the *HinD* III enzyme was used?

---

---

3a. What does the <sup>green</sup>yellow and <sup>blue</sup>orange circle of paper represent?

b. What do the other <sup>green</sup>yellow and <sup>blue</sup>orange pieces of paper that you taped to this recordsheet represent?

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4. Describe the process you used to insert the gene into the plasmid.

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#### Comment [m2]:

The directions are confusing and do not address the role of ligase in joining together fragments of DNA. Students will physically cut the sticky ends of the DNA and the plasmid and join them based on base-pairing rules previously learned. Students will have a teacher check initialed, tape the recombinant DNA to the lab and discard the extra pieces. This will eliminate confusion and potential misconceptions about the formation of recombinant DNA using a plasmid.

#### Comment [m3]:

These questions require a low level of thinking and can be answered from reading the lab and not actually completing it. The questions will be reworded to access a deeper level of understanding.

**Plasmid Lab CEI**

**Write a CEI conclusion for this lab:**

**C= Claim. Make a statement relating to the purpose of the lab.**

**E= Evidence. List 2 things you learned from the lab that are essential for successful gene transfer with a plasmid.**

**I= Interpretation. How has gene transfer with a plasmid impacted the medical field in the last 20 years?**

**Comment [m4]:**

The conclusion will be scaffolded to support learners of all ability. Organizing the three parts of the CEI allow students to focus on each part individually. This lab was original modified by teachers in a different building so it will be revised to reflect language used at Greece Athena High School. The term "CEI" will be replaced with "CSA" in which the evidence becomes support and the interpretation becomes analysis.

The Support portion of the CSA supports Common Core Learning Standards Shift #4: Text-based answers.

The Analysis portion is relevant to students in today's society. A brief research assignment will help students make the connection between the lab and current events in the medical field.

Revised Lab #2

Modeling Gene Transfer with a Plasmid

Name \_\_\_\_\_

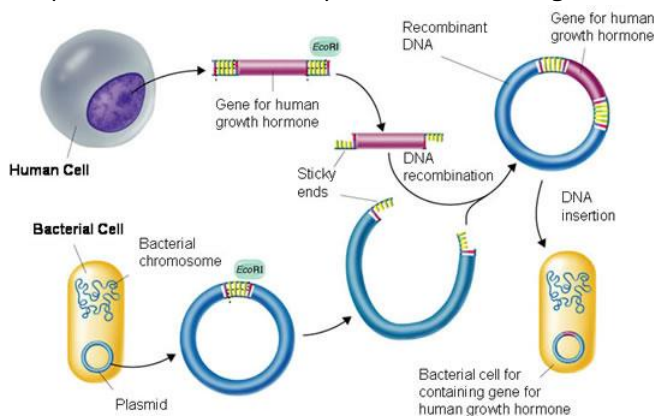
## Modeling Gene Transfer with a Plasmid

### Objectives

1. use restriction enzymes to cut DNA at recognition sites
2. create a model of recombinant DNA between a plasmid and human DNA

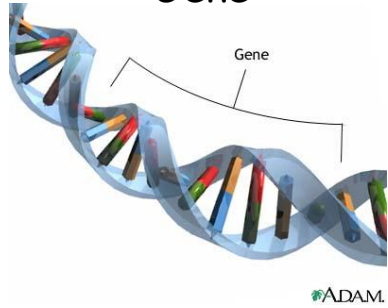
### Introduction

The first step in genetic engineering is to incorporate a desired gene into a plasmid. The plasmid and gene must be prepared so that they can be joined together to form a new recombinant plasmid. One way to do this is to cut both the gene and the plasmid with the restriction enzymes that leave overhanging or so-called sticky ends. If the sticky ends of the plasmid and gene are complementary, they will form hydrogen bonds. The sticky ends can then be joined permanently by ligase enzymes to make a new plasmid containing recombinant DNA.



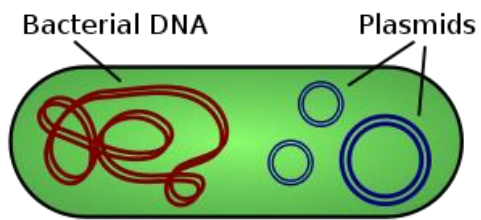
Now let's watch the video clip to see how this really happens!

## Gene



Definition:

## Plasmid



Definition:

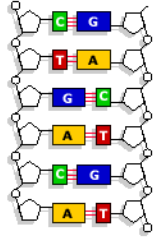
## Restriction Enzymes



Definition:

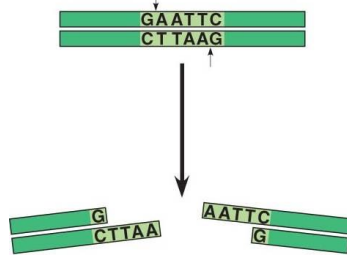


## Complementary DNA sequence



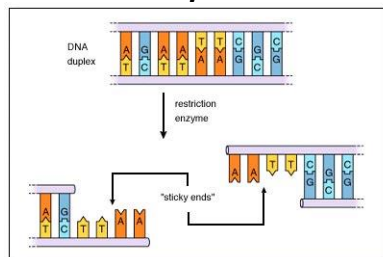
Definition:

## Recognition Site



Definition:

## Sticky Ends



Definition:

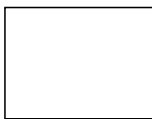
## Procedure

1. Cut the 4 yellow plasmid DNA sequences along the dotted lines. Arrange them from top to bottom according to the number on the strip. When you have finished this, get a teacher check.



2. Tape the 4 yellow plasmid DNA sequences into a circle. (Make sure the bases are facing out!)

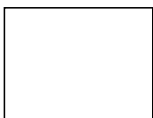
3. Cut out the 6 blue DNA sequences. Arrange them from top to bottom according to the number on the strip. When you have finished this, get a teacher check.



4. Tape the 6 blue DNA sequences into a **LINE**.

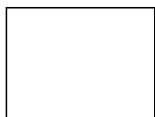
5. Cut out the 9 pink restriction enzymes.

6. Using a pencil, mark the recognition sequence of each restriction enzyme on the yellow plasmid DNA (make sure you do this the same way it's shown on the pink sheet). Label which number enzyme cuts in that spot. **IT IS OKAY IF YOU DO NOT USE ONE OR IF YOU USE ONE MORE THAN ONCE!!!** Get a teacher check.



7. Throw away the restriction enzymes you did not use, are found in the shaded area, or are used more than once.

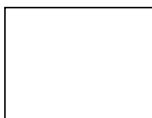
8. Find the recognition sequences of the remaining restriction enzymes on the blue DNA strand. Label which number enzyme cuts in that spot. Get a teacher check.



9. Look at the blue DNA strand. Which restriction enzyme cuts closest to the beginning and end of the shaded gene?

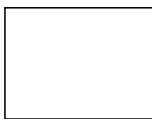
Enzyme # \_\_\_\_\_

Get a teacher check.



10. Cut along the recognition sequence with the "restriction enzymes" in the yellow plasmid (1 site) and the blue DNA (2 sites)

11. Observe the sticky ends of the yellow plasmid DNA and blue DNA pieces. Tape together the complementary sticky ends of the yellow plasmid and blue gene. Get a teacher check.



12. Tape your recombinant DNA on the back of this activity.

Analysis Questions

1. What is the function of restriction enzymes?

---

2. What did you use in this activity to represent the function of restriction enzymes?

---

3. What is the function of ligase?

---

4. What did you use in this activity to represent the function of ligase?

---

5. What happened to the shape of the plasmid when a restriction enzyme was added?

---

6. What could happen if the plasmid were cut at more than one site?

---

7. Why was it important to cut the DNA strand as close to the gene as possible?

---

8. In this activity, you incorporated an insulin gene into the plasmid. What process will the DNA in the new plasmid go through to produce a protein that makes insulin?

---

## Conclusion

Claim: Define recombinant DNA.

Support: Explain how recombinant DNA was created.

Analysis: Research an example of recombinant DNA technology in the medical field. Discuss it below.

Original Lab #3  
Microscope Lab

Living Environment Section:  
Microscope CSI Lab

Name:  
Date:

**Comment [m5]:**

Students will be given the same introduction and will be required to highlight or underline where in the text they found that answer. This will support Common Core Learning Standards Shift #4: Text-based answers.

The text will be chunked to focus students' attention on particular information. This will accommodate IEPs of students who require chunked text in their classroom modifications.

This lab is typically one of the first labs of the year so it is a good opportunity to introduce students to lab expectations in terms of Common Core, the use of manipulatives and writing a high quality conclusion while reviewing information they have experienced before.

There will be two parts to the pre-lab; one will focus on understanding how microscopes function based on their composition and the second part will focus on individual parts of the microscope students will manipulate.

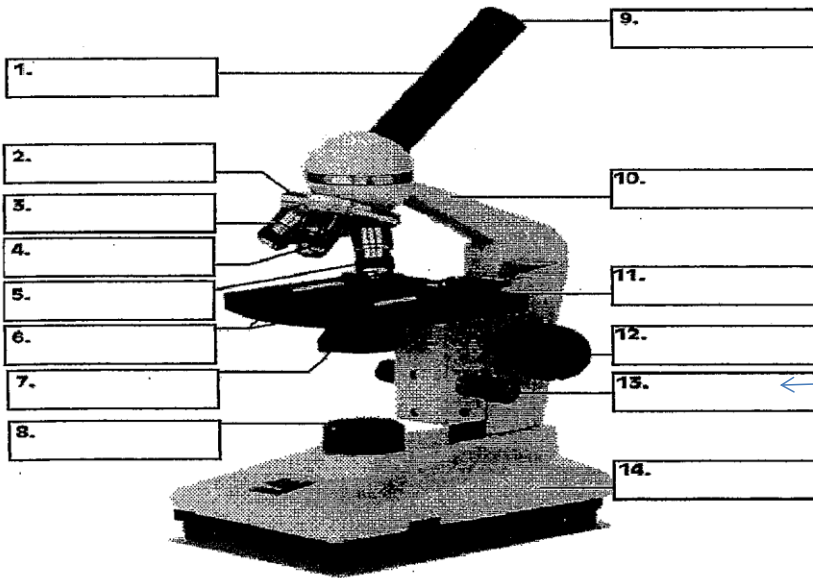


**Introduction**

"Micro" refers to **tiny**, "scope" refers to **view or look at**. Microscopes are tools used to enlarge images of small objects so as they can be studied. The compound light microscope is an instrument containing **two lenses**, which magnifies, and a variety of **knobs to resolve (focus)** the picture. Because it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to as being a

light microscope. In this lab, we will learn about the proper use and handling of the microscope.

**1. Using your book and notes label the parts of the microscope:**



Students will be given a note sheet of definitions describing various parts of the microscope. Students will tentatively label the parts of the microscope with manipulatives. This activity:

Supports Common Core ELA shift #6 Academic Vocabulary.

Supports learners of various abilities because it allows students to modify and adjust their labels as needed.

Accommodates tactile learners.  
Allows students the opportunity to interpret a diagram and text.

The magnification written on the ocular lens (eyepiece) is \_\_\_\_\_

The magnification written on: the scanning objective (this is the first and largest number written on it) \_\_\_\_\_ x

the low power objective is \_\_\_\_\_ x the high power objective is \_\_\_\_\_ x

**2. The total magnification using the lenses can be determined by multiplying the objective lens with the ocular lens. What is the total magnification of an item viewed with the:**

The SCANNING \_\_\_\_\_

The LOW Power \_\_\_\_\_

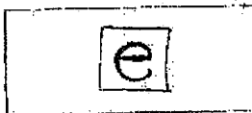
The HIGH Power \_\_\_\_\_

This top portion will be divided into two sections to help students visualize the permanence of the eyepiece magnification and the variable magnifications of the objective lenses.

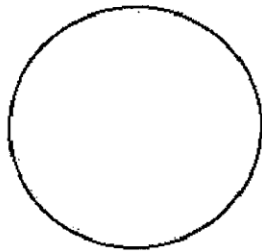
**Preparing a wet mount of the letter "e".**

1. With your scissors cut a small piece of newspaper.
2. Follow the procedure which describes its location. The placement of a teacher check at this point ensures students view the image correctly and thus make accurate observations about how the image is perceived under the microscope.
3. Turn on the microscope. Make sure the slide is facing the nosepiece and the microscope is in focus and the letter can be seen clearly.
4. Sketch the letter "e" in the circle. Sketch your "e" to scale. (i.e. Sketch it exactly how it appears as you look at it through the microscope)

This picture will immediately follow the step in the procedure which describes its location. The placement of a teacher check at this point ensures students view the image correctly and thus make accurate observations about how the image is perceived under the microscope.



making sure the "e" Using the course until the "e" can



Scanning : Total Magnification \_\_\_\_\_

**Comment [m6]:**  
These statements will be rewritten as questions to focus students' attention.

Students will be required to show the math of calculating total magnification to reinforce the concept of magnification using a compound light microscope. Students will also better understand the difference between the magnification of the eyepiece and the magnification of the objective lens.

The lab will be divided into two parts to distinguish between two types of lab techniques-using the microscope and preparing a wet mount. The Living Environment curriculum has a section devoted to various laboratory skills students should possess at the conclusion of the course. In addition, the Regents exam includes questions pertaining to the two aforementioned techniques. Students will view a brief animation to clarify how to prepare a wet mount.

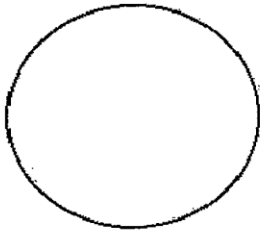
The procedure will be scaffolded and have teacher checks placed throughout it. Students will continually be monitored to avoid misconceptions regarding the backwards and opposite nature of the compound light microscope. Students who struggle with conceptualizing the function of the lenses will be able to address these conceptions by observing images firsthand (Franke & Bogner, 2011).

The wet mount technique will be emphasized because of its frequent appearance on the Regents exam.

5. Looking through the eyepiece, move the slide to the upper right area of the stage. What direction does the image move?

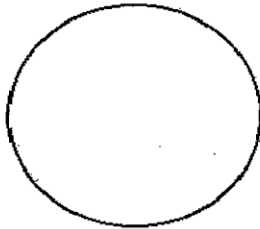
6. Now move it to the lower left side of the stage. What direction does the image move?

7. Re-center the slide and change the scope to medium power. You will notice the "e" is out of focus. Refocus and sketch your results below:



Medium: Total Magnification \_\_\_\_\_

8. Focus the slide on high power. **Do Not touch the coarse focus knob, instead use the fine focus to resolve the picture. Draw what you see in the space below.**



High: Total Magnification \_\_\_\_\_

**Comment [m7]:**

The steps of the procedure will be reworded to decrease student confusion. Analysis questions will follow each change in magnification to allow students to make the connection better between their observations and the nature of the compound light microscope immediately. It will further allow students to view how the size and quantity of the image changes as magnification is increased.

The insertion of lines following each question serves as a visual reminder to students that they need to answer a question in addition to completing each direction.

Requiring students to answer a question about what knob they do not use on high power makes the students more accountable for his or her use of the microscope. Students may skim over such an important reminder in the directions but a question will force them to acknowledge it.



Answer true or false to each of the statements

- \_\_\_\_\_ On high power, you should use the coarse adjustment knob.
- \_\_\_\_\_ The diaphragm determines how much light shines on the specimen.
- \_\_\_\_\_ The low power objective has a greater magnification than the scanning.
- \_\_\_\_\_ The fine focus knob moves the slide up and down.
- \_\_\_\_\_ Images viewed in the microscope are always upside down.
- \_\_\_\_\_ For viewing, microscope slides are placed on the objective.
- \_\_\_\_\_ In order to switch from one objective to another, you must rotate the nosepiece.
- \_\_\_\_\_ The total magnification of a microscope is determined by adding the eyepiece power to the objective lens power.

This section will be removed because the important concepts are addressed in the procedure.

**Comment [m8]:**  
 This chart accesses the lowest level of Bloom's taxonomy and will be removed from the modified lab. Application questions will be utilized to access higher levels of thinking.

**Analysis Questions:**

1. Describe the function of each of the microscope parts listed below.

Microscope Part	Function
Eyepiece	
Body Tube	
Course Adjustment	
Fine Adjustment	
Arm	
Nosepiece	
Low Power Objective	
High Power Objective	
Stage	
Stage Clips	
Lamp	

**QUESTIONS:**

- How do you calculate the total magnification when looking through microscopes? (The eye piece alone has a magnification of 10x)
 

Students address these questions in the procedure and the conclusion.
- What is the total magnification of your microscope when you are using low power? Show your work.
- When you move the slide away from you on the stage, how does the "e" appear to move when looking through the eyepiece?
- When you move the slide toward you on the stage, how does the "e" appear to move when looking through the eyepiece?
- Do you see more or less detail when you switch to high power after examining it under low power?
- If you need to move a slide to bring an object, which objective would be the best to use and why?

CEI: Write your CEI based on the crime scene evidence you observed. Use your guideline sheet.

**Interpretation Question:** What other evidence from the crime scene could be observed under the microscope?

1. Label the diagram of the microscope on the right.  
Identify these parts on your own microscope.

The concept of a crime scene is inconsistent with the purpose of this lab. Students' objectives are to know how to use a microscope and understand how and why the image is viewed as such when looking through a compound light microscope. The conclusion will be scaffolded to address these purposes of the lab.

Revised Lab #3  
Microscope Lab

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

### Microscope Lab

#### Pre-lab: Part 1

##### Directions

1. Read the description of the microscope.
2. Answer the questions that follow.
3. Highlight or underline the text in which you found the answer to each question.

"Micro" refers to tiny, "scope" refers to view or look at. Microscopes are tools used to enlarge images of small objects so as they can be studied.

1. What does "micro" mean?
2. What does "scope" mean?
3. How do microscopes change the image of what you are looking at?

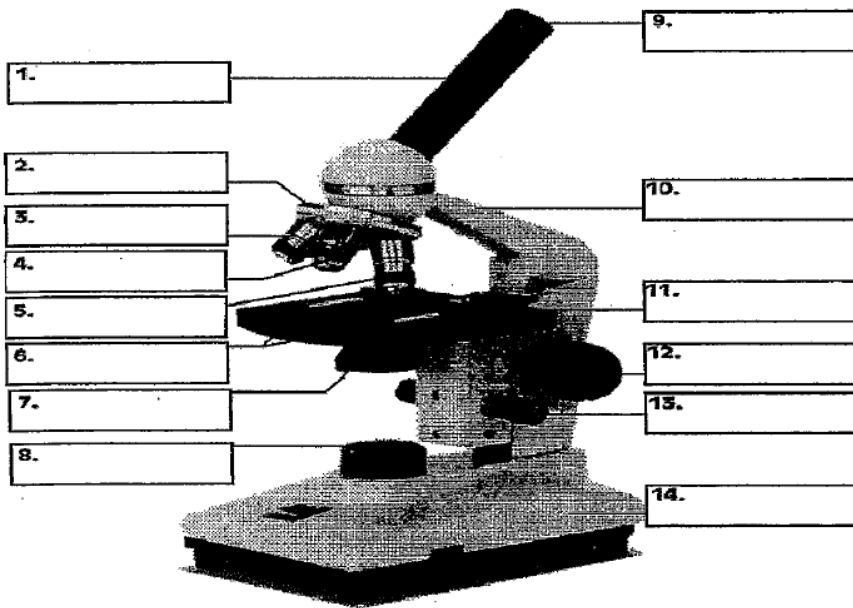
The compound light microscope is an instrument containing two lenses, which magnifies, and a variety of knobs to focus the picture. Because it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to as being a light microscope.

1. What do the two lenses in a microscope do?
2. What focuses the picture you see?
3. How many lenses does a compound microscope use?

**Pre-lab: Part 2**

Directions

Use the vocabulary sheet at the end of this packet to help you label each part of the microscope in the diagram below.



Teacher Check

**Purpose**

--

**Part 1: Understanding the Microscope**

Directions:

Look at the microscope at your table to complete the following tasks.

1. What is the magnification written on the ocular lens (eyepiece)?

\_\_\_\_\_ X

2. Fill in the chart below

Objective	Magnification (X)
Low	
Medium	
High	

3. Find the total magnification for each of the following objectives. **SHOW YOUR WORK!**  
(Hint: **Multiply the ocular lens magnification by the objective magnification**)

Objective	Work (ocular lens x objective lens)	Total Magnification (X)
Low		
Medium		
High		

Teacher Check

--

## Part 2: Preparing a wet mount

Before you begin...

1. Watch the animation of preparing a wet mount.
  2. Why do you need to place the cover slip on at a 45° angle?
- 

3. Gather the following materials from the back table:

- Newspaper
- Scissors
- Beaker of water
- Pipette
- Slide
- coverslip

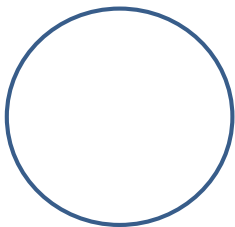
Teacher Check

### Directions

1. With your scissors, cut out a small lowercase "e" from the newspaper.
2. Prepare a wet mount of the letter "e" that you cut out.
3. Place the slide on the stage so it looks like this:



4. Turn the microscope on and find the "e" under low power.
5. Sketch the letter "e" as it appears under **low** power.



6. What do you notice about the letter "e" when you see it underneath the microscope?

---

7. Calculate the **total magnification** of the letter "e" under low power.

Total magnification= \_\_\_\_\_ X

8. Look through the eyepiece and move the slide to the upper right area of the stage. What direction does the image move?

---

9. Now move the slide to the lower left of the stage. What direction does the image move?

---

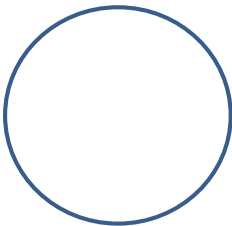
10. What can you conclude about the direction the slide moves when it is looked at underneath a microscope?

---

11. Place the slide in the center of the stage again with the letter "e" facing normal reading position on the stage.

12. Switch the objective lens from low power to medium power and focus the letter "e."  
(Hint: Think of what part of the microscope helps you focus the image!)

12. Sketch the letter "e" as it appears under medium power.



13. Calculate the **total magnification** of the letter "e" under **medium** power.

Total magnification = \_\_\_\_\_ X



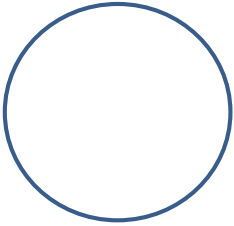
14. What knob do you NEVER use under high power? Point to it when your teacher comes over.

\_\_\_\_\_

Teacher Check



15. Switch to high power to view the letter "e." Sketch what you see in the circle below.



16. Calculate the **total magnification** of the letter "e" under **high** power.

Total magnification = \_\_\_\_\_ X

17. Why do you think you see the image you do for the letter "e" under high power?

\_\_\_\_\_

### Conclusion

**Claim:** How does the compound light microscope change the way you view an image?

**Support:** Describe 1-2 pieces of evidence from the lab that support your claim.

**Analysis:** Why are the images you see underneath the microscope different from how you placed them?

## Parts of the Microscope Vocabulary

eyepiece-where you look through to see the image of your specimen.

body tube-the long tube that holds the eyepiece and connects it to the objectives.

nosepiece-the rotating part of the microscope at the bottom of the body tube; it holds the objectives.

low power objective lens-the shortest objective lens attached to the nosepiece; the lowest power or magnification

medium power objective lens-the middle-sized objective lens attached to the nosepiece; medium power or magnification

high power objective lens-the longest objective lens attached to the nosepiece; the highest power or magnification

arm-part of the microscope that you carry the microscope with.

coarse adjustment knob-large, round knob on the side of the microscope used for focusing the specimen; it may move either the stage or the upper part of the microscope.

fine adjustment knob-small, round knob on the side of the microscope used to fine-tune the focus of your specimen after using the coarse adjustment knob.

stage-large, flat area under the objectives; it has a hole in it (see aperture) that allows light through; the specimen/slide is placed on the stage for viewing.

stage clips-shiny, clips on top of the stage which hold the slide in place.

diaphragm-controls the amount of light going through the aperture (hole) of the stage.

light-source of light usually found near the base of the microscope; the light source makes the specimen easier to see.

base- The bottom of the microscope, used for support

Comment [m9]:

This title is confusing and will be replaced by "Pig Decomposition Lab" which is more clear and utilizes academic vocabulary (Common Core Learning Standards Shift #6: Academic Vocabulary).

The purpose will be left blank for students to fill in as I introduce the lab. This will increase student participation in the rationale for the lab.

The "Before Reading" section will be addressed in a warm up activity that accesses prior knowledge of decomposers. The warm up activity will be completed prior to the lab.

This lab will be divided into two sections: observations of a decomposing pig and a text describing the role of decomposers in an ecosystem. The pictures and observations will be the first part of the lab to engage students. The second part of the lab will consist of the text and will explain how decomposers function and how they were responsible for the physical changes observed in the pig.

Excerpts of this text will be used in a closed reading activity. There are several pieces of information that do not apply to the Living Environment curriculum. Although most of this text will be excluded in the modified version presented in this thesis project, it could be included in a modified version for high-achieving students.

NAME \_\_\_\_\_

# THE MAGIC CARCASS RIDE

LAB # \_\_\_\_\_  
# OF LAB MINUTES \_\_\_\_\_

**PURPOSE:**  
TO UNDERSTAND THE ROLES DECOMPOSERS PLAY IN RECYCLING NUTRIENTS BACK INTO THE ECOSYSTEM.

**BEFORE READING:**  
WHAT DOES DECOMPOSE MEAN?  
  
WHAT DO YOU KNOW ABOUT DECOMPOSERS?

**DURING READING:**  
As you read the following selection, please underline 2-3 important points about each decomposer.

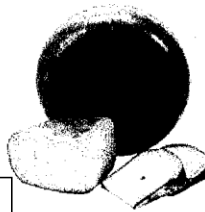
## Decomposers

**Back to the Beginning**  
When plants and animals die, they become food for decomposers like bacteria, fungi and earthworms. Decomposers or **saprotrophs** recycle dead plants and animals into chemical nutrients like carbon and nitrogen that are released back into the soil, air and water.

**The Mighty Bacteria**  
Bacteria can be found everywhere. They live in the water, in the soil, and in the bodies of animals. Bacteria are **prokaryotic**, which means they don't have a nucleus or a mitochondrion.

Bacteria are among the smallest forms of life on Earth. In fact, you may have up to 100 million bacteria in your body right now! Some bacteria are harmful and cause diseases like typhoid and cholera. Other bacteria are helpful.

You have bacteria in your digestive tract that kills more harmful bacteria. Some herbivores like moose, sheep, cows and deer have bacteria in their stomachs that help them digest plants. Bacteria help turn milk into cheese, cucumbers into pickles and cabbage into sauerkraut. Other bacteria help decompose dead plants and animals.



B. Fuller, Olympia 2009

There is a lot of irrelevant information about bacteria that removes students' focus from the role of bacteria in decomposition.

This vocabulary is not necessary in the Living Environment curriculum.

## Fabulous Fungi

Fungi like mushrooms, mildew, mold and toadstools are not plants. They don't have chlorophyll so they can't make their own food. Fungi release enzymes that decompose dead plants and animals into nutrients from the organisms they are decomposing! There are over 100,000 species of fungi. Most fungi are very, very small! There are many fungi that penicillin and other antibiotics are made from fungi. Some fungi like mushrooms, truffles and yeast are edible or used in making food. Other fungi are harmful.



Now go to the following link and watch the time lapse video of the pig decomposing:

**[WWW.DEATHONLINE.NET/DECOMPOSITION/DECOMPOSITION/INDEX.HTM](http://WWW.DEATHONLINE.NET/DECOMPOSITION/DECOMPOSITION/INDEX.HTM)**

### AFTER READING:

For your After Reading Strategy, please answer the following questions and complete the graphic organizer.

1. ~~WHAT ARE THE SYNONYMS TO DECOMPOSE?~~

The text concerning synonyms will be removed as well as this question.

2. WHAT WOULD EARTH BE LIKE IF THERE WERE NO DECOMPOSERS?

3. ~~WHAT IS THE DIFFERENCE BETWEEN DECOMPOSERS AND SCAVENGERS?~~

This question will be referenced at the conclusion of the lab.

4. ~~PREDICT HOW MANY DAYS IT WILL TAKE FOR OUR ORGANISM TO DECOMPOSE.~~

Students will brainstorm this answer in the warm up that precedes this lab.

#### Comment [m10]:

Only information about fungi as decomposers will be used in the modified version of the lab. In addition, a labeled picture of bacteria and fungi will follow the text to provide a visual cue to students when completing the observation portion of the lab.

The time-lapsed video will be replaced with time-lapse pictures of a pig decomposing. Students will make observations of the pig at various stages of decomposition.

Text-based questions will follow the chunked text to reinforce pertinent information. (Common Core ELA Shift #4)

ORGANISM	IMPORTANT POINTS
<b>DECOMPOSER GENERAL INFO</b>	<ul style="list-style-type: none"> <li>▶</li> <li>▶</li> <li>▶</li> </ul>
<b>BACTERIA</b>	<ul style="list-style-type: none"> <li>▶</li> </ul>
<b>FUNGI</b>	<ul style="list-style-type: none"> <li>▶</li> <li>▶</li> <li>▶</li> </ul>

**Comment [m11]:**  
 This chart does not support Common Core State Standards because it is not text-based. Students can write down three pieces of information they deem "important points." However, this does not require students to interact with the text in a meaningful way in which they extrapolate the necessary information. The reformatting of the text and questions provides students with the opportunity to find and label the information they need to know that supports the curriculum and the purpose of the lab.

**PROCEDURE:**

1. WE WILL BE OBSERVING A FRESHLY KILLED RAT DECOMPOSE OVER THE NEXT WEEK. YOU WILL NEED TO OBSERVE THE MAJOR PHYSICAL CHANGES IN THE CARCASS AS WELL AS ANY ORGANISMS (VISIBLE OR NOT...REMEMBER YOUR BACKGROUND RESEARCH!)
2. FIRST, OBSERVE THE FRESHLY KILLED RAT. NOTE ALL MAJOR PHYSICAL CHARACTERISTICS (AMOUNT OF FUR, COLOR OF FUR, ETC.). FEEL THE RAT AND MAKE SKETCHES OF THE CARCASS; THIS MAY HELP YOU IDENTIFY CHANGES THAT YOU WITNESS OVER THE NEXT WEEK.
3. THE RAT CARCASS IS TO BE KEPT IN A BINDER SO THAT ANY ORGANISMS CAN BE OBSERVED FROM THE BOTTOM. ALSO, A CHICKEN WIRE CAGE IS TO BE SET OVER THE RAT CARCASS SO THAT ANY LARGER ANIMALS (SCAVENGERS) WILL NOT DISTURB IT. WE WILL HOPEFULLY ONLY BE WITNESSING THE NATURAL DECOMPOSITION OF THE RAT CARCASS BY DECOMPOSERS.
4. WE WILL COME OUT AND OBSERVE THE RAT CARCASS (RAIN OR SHINE) FOR THE NEXT SEVERAL CLASSES. PLEASE BE PREPARED WITH YOUR LAB NOTES.

**Comment [m12]:**

The rate at which an organism decomposes is dependent on many variables such as weather and location. Students may not notice many differences in appearance over the course of one week and will certainly not notice all the effects of a decomposer on a dead organism during this small time frame. Rather, students will be given several pictures of a pig at different stages of decomposition. Students will be instructed to record 2-3 qualitative observations for each stage. This interpretation of pictures supports visual learners, is engaging, and provides real-life applications of course content.

**Comment [m13]:**  
The data table for this lab will be created to reflect the new procedure. Students learned about quantitative and qualitative observations in the previous unit and the revised chart will reinforce how to make observations.

**DATA:**

DAY	OBSERVABLE CHARACTERISTICS	WHAT ORGANISMS COULD YOU SEE?	MAJOR CHANGES
DAY 1 DATE: _____			<b>SKETCH HERE:</b>
DAY 2 DATE: _____			
DAY 3 DATE: _____			
DAY 4 DATE: _____			
DAY 5 DATE: _____			
DAY 6 DATE: _____			
DAY 7 DATE: _____			
DAY 8 DATE: _____			

**DATA ANALYSIS:**

1. WHAT WERE 3 MAJOR PHYSICAL CHARACTERISTICS THAT CHANGED OVER THE COURSE OF YOUR OBSERVATIONS OF THE RAT?

>

>

>

2. WHAT WERE THE MOST PREVALENT ORGANISMS THAT YOU COULD OBSERVE ON THE DECOMPOSING RAT?

3. WHAT ORGANISMS WE KNEW WERE PRESENT THAT YOU COULDN'T SEE?

**Comment [m14]:**

These analysis questions will be addressed in the revised analysis sections of the Pig Decomposition Lab.



4. EXPLAIN THE ROLE DECOMPOSERS PLAY IN OUR ECOSYSTEM?

5. GIVE REASONS (AT LEAST 2) WHY ARE DECOMPOSERS IMPORTANT?

>

>

6. PREDICT WHAT OUR WORLD WOULD LOOK LIKE IF THERE WERE NO DECOMPOSERS? EXPLAIN. (GIVE AT LEAST 2-3 EXAMPLES)

**Comment [m15]:**

These analysis questions are also addressed in the revised analysis sections of the lab. The placement of these questions scaffolds the reading for all students and accommodates students with classroom modifications on their Individualized Education Plans.

**CEI CONCLUSION:**

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This CEI does not give students any direction. Since this lab will be completed at the beginning of the school year, the lab conclusion will be scaffolded for students to learn my expectations. Students will be given two statements that negate each other. They will be asked to circle the statement that is true. This will help students become familiar with an appropriate claim statement. The Evidence/Support portion of the lab will require students to choose three pieces of data from their observation table that support the statement they circled. The Interpretation/Analysis portion will help the students identify applications to the real world.

Revised Lab #4  
Pig Decomposition Lab

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



## Pig Decomposition Lab

Purpose

### Part 1: Observations

Directions

You will view several pictures of a pig at different stages after it dies. Make observations in the chart below.

Days After Death	Observations
0-3 Days	
4-10 Days	
10-20 Days	
20-50 Days	
50-365 Days	

## Part 1 Analysis Questions

1. What overall changes did you notice in the pig after it died?
2. What do you think happened to cause these changes over time after the pig died?

## Part 2: Types of Decomposers

### Directions

1. Read the following article about decomposers.
2. Answer the questions that follow each section of reading.
3. Highlight or underline where in the text you found that answer.

When plants and animals die, they become food for decomposers like bacteria and fungi. Decomposers recycle dead plants and animals into chemical nutrients like carbon and nitrogen that are released back into the soil, air, and water.

1. What are two types of decomposers?

- 
- 

2. What do decomposers do?



← Bacteria

Fungi →



Bacteria can be found everywhere. They live in the water, in the air, and on land. Bacteria are among the smallest forms of life on Earth. Some bacteria are harmful and can cause diseases. Other bacteria are helpful though and can help decompose dead plants and animals to release nutrients back into the ecosystem.

1. Where can bacteria be found?
2. What is 1 way that bacteria can be helpful?

Fungi like mushrooms, mildew, and mold are not plants. They release enzymes that decompose dead plants and animals. Fungi absorb nutrients from the organisms they are decomposing.

1. How do fungi decompose dead plants and animals?
2. What substance do fungi absorb from the organisms they are decomposing?

#### Part 2 Analysis Questions

1. What do you think Earth would look like if there were no decomposers?
2. Why do you think decomposers aren't part of the food web even though they are part of the ecosystem?

## Conclusion

CLAIM: Circle the statement below that is true.

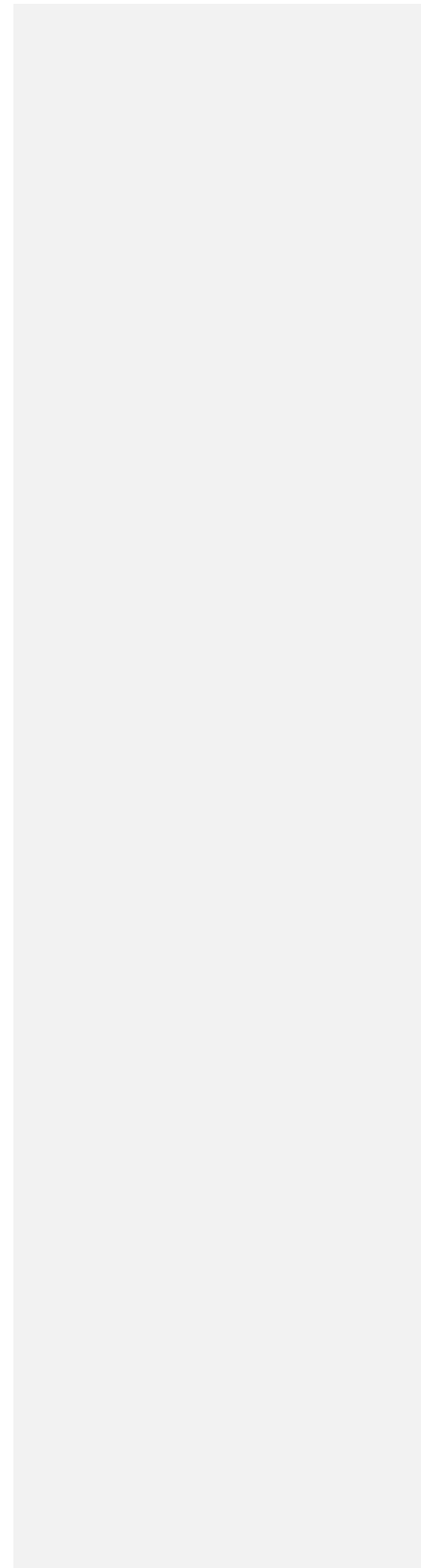
Decomposers were responsible for the changes I noticed in the pig after it died.

Decomposers were **not** responsible for the changes I noticed in the pig after it died.

SUPPORT: Write 3-4 sentences describing why you circled the statement in the CLAIM above. Use evidence from both parts 1 and 2 in this lab. 😊

ANALYSIS: Why is it important for you to know about decomposers?

Pig Decomposition Lab  
Days 0-3



Pig Decomposition Lab  
Days 4-10





Pig Decomposition Lab  
Days 10-20



Pig Decomposition Lab  
Days 20-50

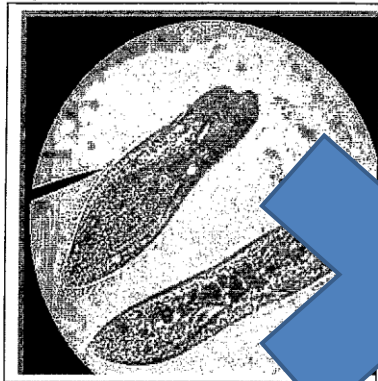


Pig Decomposition Lab  
Days 50-365



## Virtual Population Lab

**Introduction:** Paramecium consists of unicellular species of protists (single celled organisms) that live in freshwater environments.



When paramecia have enough food, water, and space-populations of these species grow rapidly and follow a pattern known as exponential growth. Exponential growth is extensive population growth in which the total number of organisms increases with each generation. However, populations of organisms do not increase in size forever. Eventually, limitations on food, water, and other resources will cause the population to level off and stop increasing.

When a population arrives at the point where its size remains stable, it has reached the carrying capacity of the environment. The carrying capacity is the greatest number of individuals a given environment can sustain. Competition for the necessary resources among members of a population places limits on population size. This competition can lead to the elimination of one species in that area. This means that no two species can occupy the same niche.

In this lab, you will examine a small ecosystem containing two kinds of protists, *Paramecium aurelia* (*P. aurelia*) and *Paramecia caudatum* (*P. caudatum*). Using a virtual lab you will determine what happens to their populations when both species, *P. aurelia* and *P. caudatum* are placed into the same habitat.

### Pre-Lab:

1. What are protists? Where do they live?
2. What is exponential growth? How does it differ from linear growth?
3. Explain why a species might exhibit exponential growth of its population for a short time but not forever.
4. Explain the terms carrying capacity and competition.
5. Write a purpose for this lab on your Vee Form.

**Hypothesis:** You will complete the hypothesis, control, independent variable and dependent variable parts for this lab on lab day. DO NOT complete them now.

### Comment [m16]:

The introduction to this lab describes how a population of paramecium grows over time. The revised lab will include texts that supports the concept of population growth but will include organisms students can relate to more easily. Science labs need to be practical for students to benefit from them. Research into science education has demonstrated a decrease in student interest as they progressed through school (Barmby, Kind, & Jones, 2008).

The text in the revised lab will be chunked to focus students' attention on the information they are reading. Chunking the text will also accommodate students with classroom modifications on their IEPs or 504s.

The chunked text will be followed by questions directly relating to it. Students will be required to answer the questions then highlight or underline where in the text they found that answer. This pre-lab activity supports Common Core Learning Standards Shift #4: Text-based answers.

An additional reason the subject of this lab will be changed is because students may feel intimidated by names of the species. It is likely that students will struggle with pronouncing the names of the species and will feel there is no connection to their lives. By using forest species in the revised labs, students will be able to develop a more meaningful connection to the lab.

The introductory text as it is currently written contains a lot of information. Students may struggle when answering the pre-lab questions if they lack reading strategies.

The Vee form is used by some teachers at Greece Athena High School. It is a scaffolding tool but will not be used in the revision of this lab because it does not reflect the format of a lab report.

Students will complete simulations of population growth by manipulating different populations and variables. Simulations allow students to manipulate a number of parameters and determine the outcomes immediately (Lefkos, Psillos, & Hatzikraniotis, 2011).

Students will complete these portions of the lab throughout the simulations.

**Materials:** computer, pen, paper, and lab instructions

**Procedure:**

1. Go to Mrs. McCabe's webpage and click on **Ecology Chapters 3-6** then in the list of links click on **Population**
  2. Use only the instructions **here DO NOT use the instructions in the computer procedure**
  3. You WILL NOT use the online journal, table or graph. You will need to record all information on your Vee Form.
  4. Now you need to fill your test tubes with the paramecia. Follow these directions, **NOT the ones in the procedure online.**
    - Use the virtual pipettes to place 10ml (2 pipettes full) of *P. caudatum (PC)* into test tube 1.
    - Use the virtual pipettes to place 10ml (2 pipettes full) of *P. Aurelia (PA)* into test tube 2.
    - Use the virtual pipettes to place 5ml (1 pipette full) of *P. caudatum* AND 5ml of *P. aurelia* into test tube 3.
- \*\* Rice is in each test tube for the paramecia to eat.
5. Now use the instructions written below to make slides and look at your paramecia. **DO NOT follow the procedure on the computer.**
    - Click the microscope on the back shelf of the virtual lab.
    - Click the clean microscope slides, then click the test tubes to prepare slides.
    - Now drag the slides one at a time to the microscope to look at the paramecia.
    - Count the number of paramecia on each slide and multiply that number by two. Now record this number in the correct column of your data table.
    - Click the Clear Slides button to clean the slides and Click on the calendar once to advance 2 days.
    - \*\* As the populations of paramecia get larger, you will need to click on the GRID ON button on the microscope. It will put lines into the microscope view to help you count/estimate populations of paramecia.
    - REPEAT the steps to make and view slides and count paramecia. Continue to do this until you have data for 16 days.
  6. Now get graph paper and make a line graph of your data. Be sure to use a different color for each population (4 in all).

**Comment [m17]:**

This is a computer simulation so there will be no required materials.

Students will be given the direct website to go to for the computer simulation.

The procedure as it is currently written is indicative of an expository lab. One benefit of computational modeling is the ability of the students to manipulate several variables and observe the consequences. Students do not have the autonomy to do so in the current lab. The revised lab will consist of three simulation opportunities for students to complete in which they manipulate and record the parameters of their choice. Students will view the change in size of several populations, draw the graph representing these changes, and interpret the graphs. Although this computer simulation is not truly authentic, students do have the opportunity to "create" a real life scenario. Students who conduct authentic laboratory work demonstrated increased learning of science concepts (Thomas, 2012).

If this procedure were to remain in the revised lab, students would benefit more from viewing slides underneath a microscope rather than on the computer. Students would still be able to complete the activity described in step 5.

Students will create qualitative line graphs in the revised lab.

**Data Analysis:**

1. What is the source of food for the paramecia in all test tubes?
2. On what day did the Paramecium caudatum (PC) (Test tube 1) population reach the carrying capacity of the environment? How do you know?
3. On what day did the Paramecium Aurelia (PA) (Test tube 2) population reach the carrying capacity of the environment when it was grown alone? How do you know?
4. Describe what happened when the Paramecium populations were mixed in the same test tube. Why did one population decrease/disappear?
5. Explain how this experiment demonstrates that no two species can occupy the same niche.

**Conclusion:** Complete the Claim, Support and Analysis sections on your Vee Form. Be sure to use the Yellow Vee Form as a guide!!

**Comment [m18]:**

This is a knowledge level question according to Bloom's taxonomy and does not engage students' high level thinking skills.

Students will interpret the graphs they drew during the computer simulations in the revised lab.

These questions will be modified to reflect the content of the revised lab. They require students to think critically and understand the relationship between components of a system.

The revised lab will consist of students forming conclusions as they complete each simulation; there will be no summative conclusion.

Revised Lab #5  
Population Lab

Population Lab

Pre-lab

1. Read the background information from "An Introduction to Population Biology" by Laura Klappenbach.
2. Answer the questions that follow.

Populations change over time due to births, deaths, and the dispersal of individuals between separate populations. When resources are plentiful and environmental conditions appropriate, populations can increase rapidly.

List 3 reasons populations change over time.

- 
- 
- 

What happens to the size of a population when resources are plentiful?

In most instances, resources are not unlimited and environmental conditions are not optimal. Climate, food, habitat, water availability, and other factors keep population growth in check due to environmental resistance. The environment can only support a limited number of individuals in a population before some resource runs out or limits the survival of those individuals. The number of individuals that a particular habitat or environment can support is referred to as the carrying capacity.

List 4 factors that keep population growth in check.

- 
- 
- 
- 

What is carrying capacity?

Teacher Check

Purpose

The purpose of this lab is to simulate population growth in an ecosystem based on limiting factors.

Directions

1. Go to the website <http://www.learner.org/courses/envsci/interactives/ecology/ecology1.html>

2. You will see a screen that looks like this:



3. As we discuss the various parts of this simulation, label the parts in the spaces above.

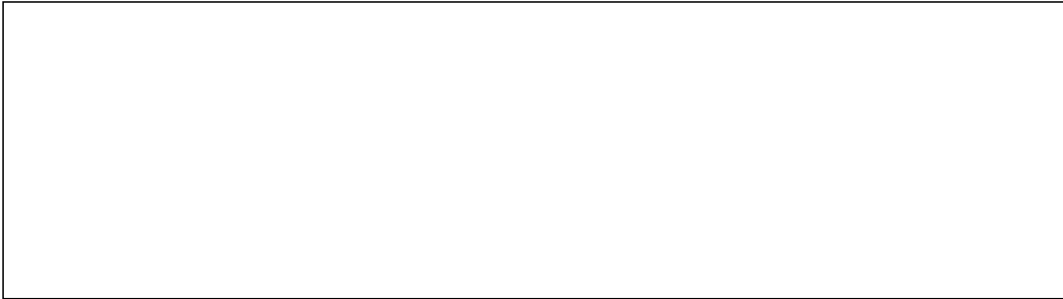
4. Complete 3 different combinations of simulations for 10 years and record your data in the following 3 data tables.

Simulation #1

Organism	What it eats
Top predator	
Omnivore A	
Omnivore B	
Herbivore A	
Herbivore B	
Herbivore C	



Run the simulation for 10 years. Draw the graph you see below. Use different colored pencils and make a key!




Write a 3-4 sentence conclusion about the relationships between the organisms in the simulation you selected.

CLAIM:

SUPPORT:

ANALYSIS:

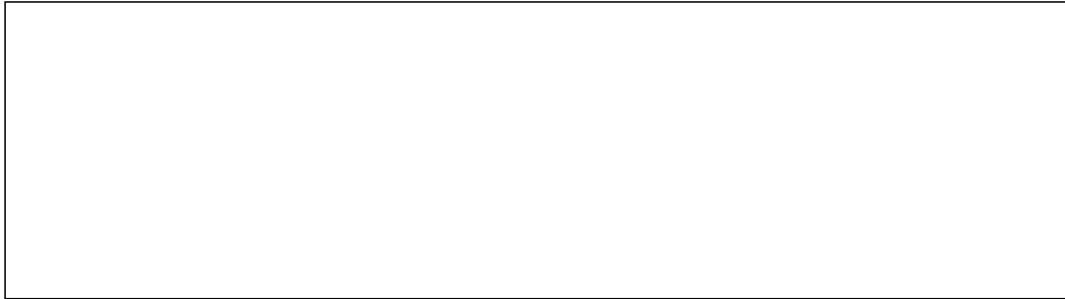
Teacher Check



### Simulation #2

Organism	What it eats
Top predator	
Omnivore A	
Omnivore B	
Herbivore A	
Herbivore B	
Herbivore C	

Run the simulation for 10 years. Draw the graph you see below. Use different colored pencils and make a key!



Write a 3-4 sentence conclusion about the relationships between the organisms in the simulation you selected.

CLAIM:

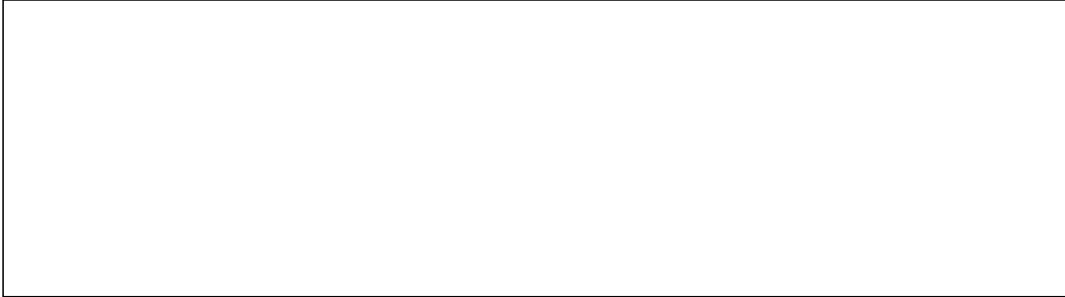
SUPPORT:

ANALYSIS:

### Simulation #3

Organism	What it eats
Top predator	
Omnivore A	
Omnivore B	
Herbivore A	
Herbivore B	
Herbivore C	

Run the simulation for 10 years. Draw the graph you see below. Use different colored pencils and make a key!



Write a 3-4 sentence conclusion about the relationships between the organisms in the simulation you selected.

CLAIM:

SUPPORT:

ANALYSIS:

Comment [m19]:

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



## The Menstrual Cycle



**Purpose:**

**Before** you read the background information, fill in the **K** (what you already know) and the **W** (what you want to know) part to the 3 column chart regarding the menstrual cycle. **After** reading of the background, underline the new information that you learned about the menstrual cycle. **After** you finish, add what you learned to the last column of your 3 column chart.

What I think I <u>know</u> ...	What I <u>want</u> to know...	What I <u>learned</u> after reading...
--------------------------------	-------------------------------	--

This portion of the KWL chart is open-ended and does not focus students' attention on a particular aspect of the menstrual cycle. It may be difficult for students to identify what they know when they have little previous academic experience with the content.

Access to prior knowledge and students' understanding of the reading will be assessed using an anticipation guide.

Students may feel uncomfortable with the topic of menstrual cycle. If so, it would be unlikely that students would share what they want to know if they were curious about anything.

The purpose will be placed after the introduction to the lab to transition between the pre-lab reading and the lab. Students' successful completion of the pre-lab will provide them with the purpose of the lab.

Students will not complete this KWL. Specific reasons for exclusion of this chart follow each section.

The content in this lab is especially relevant to female students. It is important that science labs be practical because interest in science often decreases as students progress through school. This is more common among female students (Barby, Kind, & Jones, 2008).

## Background:

In order for reproduction to occur, the *gametes* (~~sperm and egg~~) from each parent must meet at the appropriate time and in the proper environment, this is fertilization. From this point embryonic growth and development occur. In mammals, because offspring develop internally, not only must the sperm and egg meet at the appropriate time, but the uterus must be prepared to accept and nourish the *zygote* (~~fertilized egg~~).

In humans, periodic or cyclic changes in the ~~uterine lining~~ (endometrium) and the ovary occur. These changes make up the menstrual cycle.

A sexually mature human female is capable of producing mature eggs about once every 28 days. This female cycle involves several different hormones. The main hormones involved in the growth and release of egg from the ovary as well as in preparation of the uterus to receive the zygote and in maintaining pregnancy are follicle stimulating hormone (FSH), luteinizing hormone (LH), *estrogen*, *progesterone*, and human gonadotropin (HCG). They will be discussed in this lab.

In this lab you will dissect a bovine (cow) ovary. Then you will analyze graphs of the major hormones involved in the menstrual cycle as well as in pregnancy and determine when each hormone are present. In addition, you will relate the gross structures observed while dissecting and to diagrams of the ovary which are occurring to the uterine lining.

Students will not dissect an ovary. The main purpose of this lab is to graph and analyze how four hormones change throughout the menstrual cycle. Students will view diagrams of the ovary and endometrium to understand the relationship between the fluctuations in hormone levels and the changes in the ovary and endometrium.

### Comment [m20]:

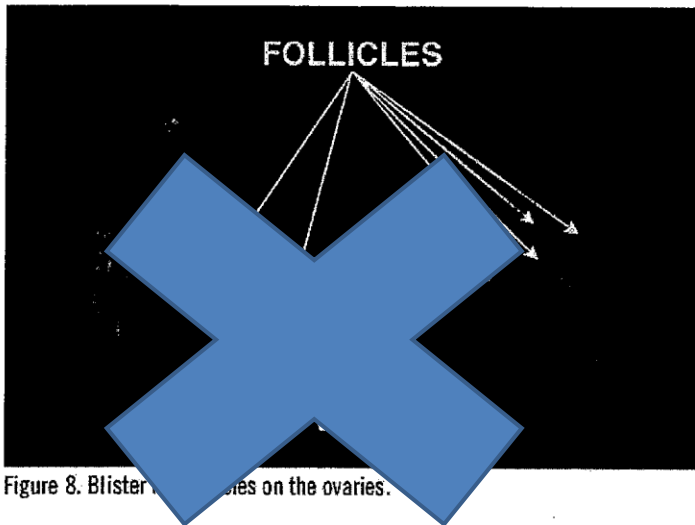
The background information will be labeled "Pre-lab" to be consistent with other lab formats. It will also be placed at the beginning of the lab rather than following the purpose of the lab.

Using a consistent lab format will help students become familiar with the steps of the scientific method. In terms of pre-lab readings, it will reinforce to students that scientists research a topic before they conduct an experiment. It also supports Common Core ELA Shift #4: Text-based answers.

A "Vocabulary Helper" will be included at the end of the text to support student understanding of the pre-lab reading. This supports Common Core ELA Shift #6: Academic Vocabulary.

The last paragraph of the background information offers several purposes for the lab. Students will be given the purpose of the lab after completion of pre-lab assignment.

## Part 1, Ovary Dissection:



1. Examine the bovine ovary provided to you. Each ovary was collected at different stages of the cycle.
2. Examine the outside of the ovary. You should see small round purple structures, called **follicles**. Follicles produce eggs.
3. You may see a raised, yellow bump called the **corpus luteum (CL)**. The corpus luteum forms after ovulation. It produces the hormone progesterone to maintain pregnancy. Since it is common of cows to have twins, you may see 2 corpus luteum.
4. The last thing you might see is a large, deep purple fluid filled structure. These are abnormal structures called **follicular cyst**.

→WHAT DO YOU SEE ON YOUR OVARY? MAKE A LIST HERE:

Students' observations may not reflect what they actually see and could result in misconceptions of its structure.

### Comment [m21]:

Students will not complete the ovary dissection but rather view images of an ovary as an extension of the lab.

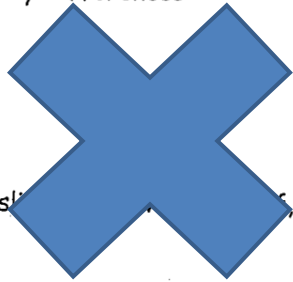
Potential problems of an ovary dissection include the following:

1. The quality of the ovaries is inconsistent.
2. Student safety is a concern because of the use of scalpels.
3. The act of dissecting an ovary does not support the Living Environment curriculum.

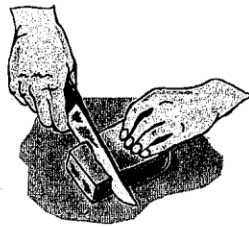
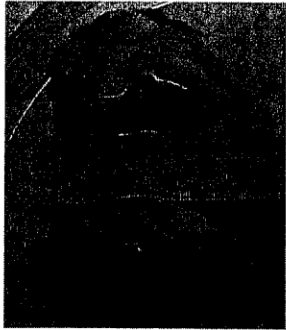
The instructions for the ovary dissection inform students of what they will see. A more meaningful approach to understanding the structures of the ovary that relates to the purpose of this lab is to observe images of the ovary at various stages in the menstrual cycle. Students can then safely observe the follicle and corpus luteum throughout the 28-day menstrual cycle.

This slight modification to the lab procedure makes it less of an expository lab and more of a guided inquiry lab. Students who completed inquiry labs rated a higher confidence in science than when they completed expository labs (Corsi, 2012).

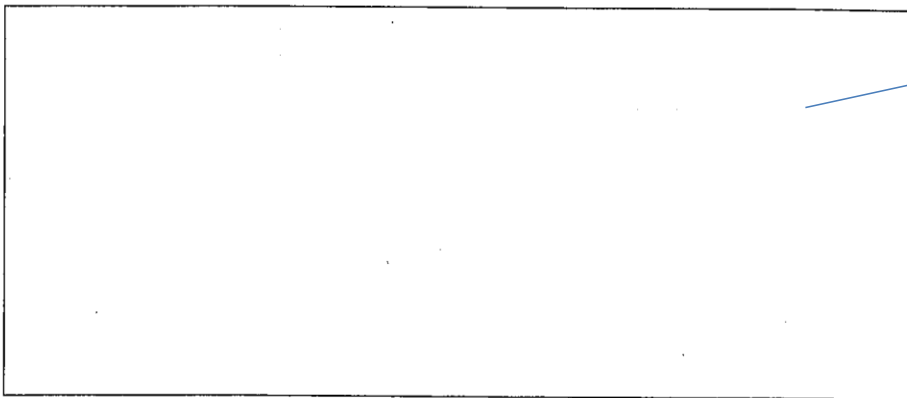
5. Now compare your findings with other group's ovaries. Are they the same? Describe any differences:



6. Using a scalpel, slice lengthwise, as if you were slicing a bagel.



→ Draw what you see. Color and label the structures which are visible. When you have done that go and compare your ovary with other groups.



**Comment [m22]:**

Comparing the findings helps students to think critically but does not support the revised purpose of the lab.

Although this direction will be eliminated, it is important to note that this question is culturally biased and may unintentionally exclude some students. There are most likely cultures who do not eat bagels.

Students will view images of the ovary at various stages of the menstrual cycle to help make connections between the changes in the ovary, endometrium, and hormone levels.

7. Does the inside (medulla) or the surface (cortex) have more follicles?  
Why do you think that this is true?

These questions will be eliminated  
because they detract from the overall  
purpose of the lab.

8. Contrast the appearance of a follicle and a corpus luteum (include  
color, size, and location in the ovary). Describe how they differ in  
function.

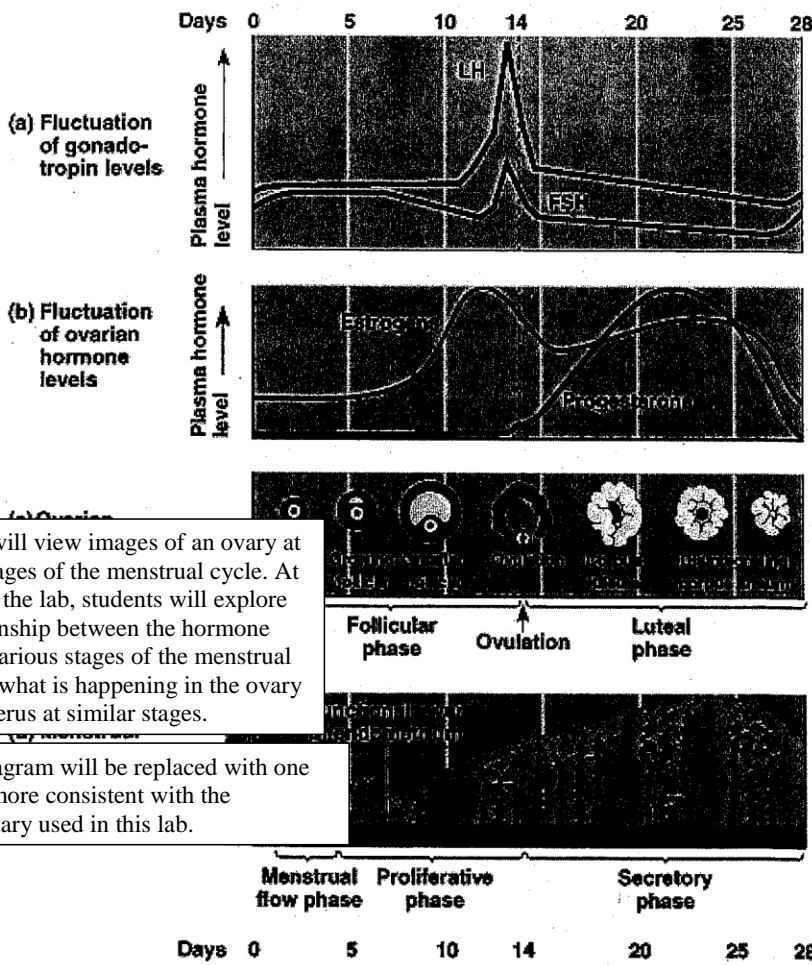
Follicle	Corpus Luteum



**Part 2: Hormone Levels**

**Data Analysis:**

Analyze the graph below. Be sure to compare the hormone levels with the changes in the uterine lining and changes in the ovary.



Students will view images of an ovary at various stages of the menstrual cycle. At the end of the lab, students will explore the relationship between the hormone levels at various stages of the menstrual cycle and what is happening in the ovary and the uterus at similar stages.

This diagram will be replaced with one that is more consistent with the vocabulary used in this lab.

**Comment [m23]:**

Students will be given a data table with levels for four hormones responsible for the changes in the menstrual cycle. They will graph the four hormones then analyze them by answering a series of questions. This task reviews graphing skills and allows students to interact more closely with the patterns found among the hormone levels. The graph students create will allow them to visualize the relationship of the four hormones simultaneously.

**Comment [m24]:**

The analysis questions will be placed throughout the lab in the appropriate section following the graph/diagram. Additional questions will be added to provide opportunities for critical thinking and real-world applications.

1. When the LH is at its peak, describe what is happening in the ovary and the uterus.
2. Which two hormones appear to be responsible for the development of the egg? Support your claim.
3. Which two hormones appear to be responsible for the development of the uterine lining? Support your claim.
4. The breaking down of what structures causes **menstruation** (the female "period")? Why?
5. Why aren't all the 4 hormones at their peak at the same time?

6. Fill in the table below:

Day	What is happening in the ovary?	What is happening in the uterus?
4		
13-14		
18-20		
26-28		

**Conclusion:** Write a CEI conclusion that summarizes this lab

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This lab is completed by students towards the end of the school year. Thus, they have a lot of experience writing lab conclusions. Students will be required to write this lab conclusion with minimal scaffolding. In addition, the lines currently provided for writing the conclusion will be removed to reduce students' anxiety about how long the conclusion should be.

**Comment [m25]:**  
 Students will complete a modified version of this table that will help them form the "Support" section of the conclusion. This portion will be optional but available to accommodate students of varying learning abilities. Essentially, students will be scaffolding their own work.

Revised Lab #6  
The Menstrual Cycle Lab

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

The Menstrual Cycle Lab

**Pre-lab:** Anticipation Guide

**Directions**

1. Read the following statements. If you think the statement is true, write "True" on the line **before** the statement. If you think the statement is false, write "False" on the line **before** the statement.

True/False	Statement	True/False
_____	Fertilization can happen anytime in any type of conditions.	_____
_____	Menstruation is caused by cyclic changes in the uterine lining and ovary.	_____
_____	Females produce eggs every 72 days.	_____
_____	Follicle stimulating hormone and leutenizing hormones are involved in maintaining pregnancy.	_____

2. Read the background information on the menstrual cycle. Highlight or underline where these statements are discussed.

In order for reproduction to occur, the gametes from each parent must meet at the appropriate time and in the proper environment. This meeting is called fertilization. From this point on, embryonic growth and development must occur. Because offspring develop internally, the uterus must be prepared to accept and nourish the zygote.

In humans, periodic or cyclic changes in the uterine lining and the ovary occur. These changes make up the menstrual cycle.

A sexually mature human female is capable of producing mature eggs about once every 28 days. This female cycle involves several different hormones. The main hormones involved in the growth and release of egg from the ovary as well as in preparation of the uterus to receive the zygote and in maintaining pregnancy are follicle stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone.

3. Complete the column **after** the statement identifying each statement as "True" or "False."

### Vocabulary Helper

Gamete: sex cell (sperm, egg)  
Zygote: fertilized egg

Fertilization: when the sperm and egg join  
Endometrium: uterine lining

#### Purpose

1. Graph and analyze how 4 hormones change throughout the menstrual cycle.
2. Observe and analyze images of the ovary at different stages throughout the menstrual cycle.

#### Part 1

The following data table provides levels of 4 hormones involved in the menstrual cycle. Plot this data on a separate sheet of graph paper using 4 different colored pencils.

#### Key

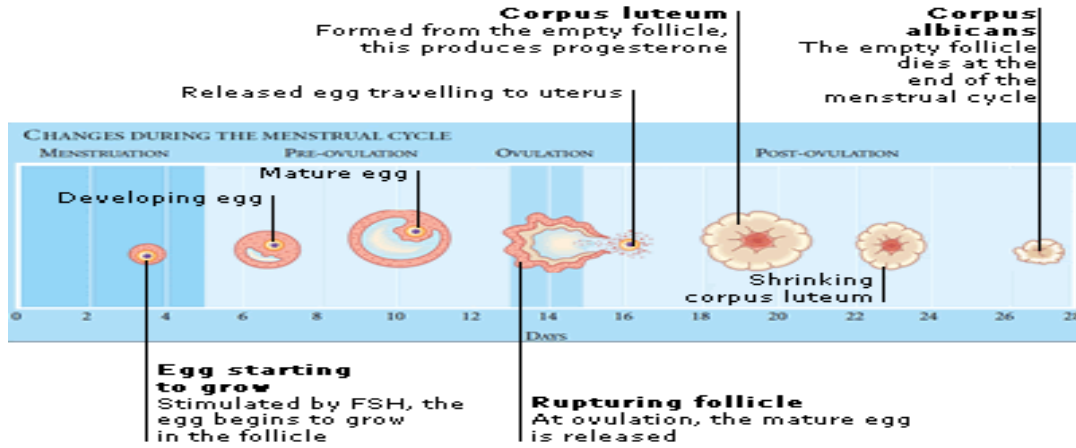
FSH: follicle stimulating hormone  
LH: leutenizing hormone

Day	FSH	Estrogen	LH	Progesterone
1	9	30	9	0.6
2	11	40	12	0.8
3	13	50	16	1.0
4	14	70	18	1.0
5	15	80	19	1.0
6	14	100	16	1.0
7	14	130	12	1.2
8	15	140	19	1.2
9	13	180	15	1.3
10	11	200	16	1.5
11	9	220	20	1.5
12	18	230	30	1.6
13	13	220	75	1.8
14	9	200	58	2.0
15	9	180	30	2.3
16	8	150	14	3.7
17	8	120	10	5.8
18	8	100	9	8.3
19	8	50	7	10.4
20	7	30	5	12.0
21	7	25	3	12.0
22	6	25	3	11.8
23	5	25	2	10.3
24	5	25	3	7.2
25	6	20	3	4.0
26	7	20	4	3.0
27	7	25	5	1.5
28	8	25	7	0.8

After you graph...

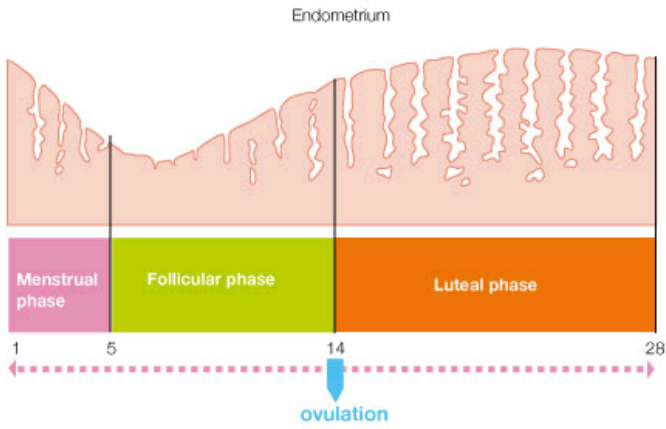
1. How many days are in the menstrual cycle?
2. What 2 hormones peak during ovulation (day 14)?
3. Describe any patterns you see in the four hormone levels you graphed.

## Part 2: Ovary Diagram



1. What hormone helps the egg begin to grow?
2. What happens to the egg at ovulation?
3. What hormone does the corpus luteum produce?
4. What happens to the empty follicle at the end of the menstrual cycle?

### Part 3: The Endometrium



1. Is the lining of the endometrium getting thicker or thinner during the menstrual phase?
2. What is happening to the lining of the endometrium during the follicular phase?
3. At what phase is the endometrium the thickest and ready for pregnancy?

### Putting it All Together

#### Directions

Use the graph and diagrams from Parts 1, 2, and 3 to answer the following questions.

1. When leutenizing hormone is at its peak, what is happening in the ovary and the uterus?
2. What hormones have the most significant role during ovulation? How do you know?
3. What hormones are responsible for the development of the egg? How do you know?

4. What conditions must be met in the uterus, ovary, and endocrine system in order for a woman to become pregnant?

- Uterus-
- Ovary-
- Endocrine system-

5. Why don't all 4 hormones peak at the same time?

Conclusion

Claim: Write one statement that summarizes what you learned from this lab.

Support: Highlight 5 pieces of evidence from the 3 sets of data you have to support the claim you wrote. (\* Do you need help?)

Analysis: Describe a scenario in which the information you learned in this lab would be relevant to someone's life.

\*If you need help with the Support portion of the Conclusion, fill out the table below to help you!

Day	What's happening in the ovary	Thickness of Endometrium	Hormones that are peaked
4			
13-14			
18-20			
26-28			



Original Lab #7  
Gel Electrophoresis Lab

Comment [m26]:

Prior to the lab, students will view a video clip of a court case in which a person is found guilty with the use of DNA evidence. Students will hypothesize how the DNA was used to find a suspect guilty of a crime. This will engage students and increase their interest in the upcoming lab. This activity will also be cross-curricular with history because it will be a real world example in which gel electrophoresis was used.

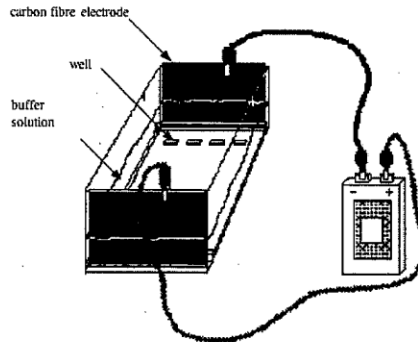
The introduction will be rewritten as chunked text to accommodate all learners, in particular those with classroom modifications requiring chunked text. In addition, questions will follow each chunked section requiring students to identify the portion of the text that pertains to the answer they provided. This accommodates Common Core Learning Standards Shift #4: Text-based answers. The questions following each section of text will be written with similar but not identical vocabulary to help students develop their understanding of the relationship between text and questions.

Because this is typically the first time students learn about gel electrophoresis, they will view a narrated animation describing the technique to help visualize the text. Students who complete Web-based learning programs demonstrate an increase in learning and academic achievement (Wang, et. al, 2010).

Rather than determining the paternity of Electra, the scenario will be changed to a crime scene to make this sensitive topic less personal for students. Students from different socioeconomic backgrounds may have different experiences with paternity issues in the family. Minority, in particular African American students, experienced feelings of negative self-image and isolation more often when attending schools of a high socioeconomic status (Crosnoe, 2009). The use of scenarios at the beginning of a lab engage students (Haugwitz & Sandmann, 2010).

Name \_\_\_\_\_  
Living Environment

## Gel Electrophoresis Lab



### Introduction

Electrophoresis is a technique used in the laboratory that separates DNA based on size. In this lab, we are separating molecules in dye that represent DNA. DNA is a negatively charged molecule, and is moved by electric current through a gel.

You may be wondering what exactly a gel is... A gel is a semi-solid matrix much like "Jello" only more firm. Imagine you are a DNA molecule. If you were inside an agarose gel, your environment would resemble a very dense spider web. The bigger the DNA pieces are, the slower they move through the gel and do not get as far across. The smaller the DNA pieces are, the faster they move and get almost to the other side!

The gel is then submersed in a tank filled with a salt solution that conducts electricity (buffer). Using a pipette, DNA samples are loaded in the slots made in the agarose gel. The DNA samples are colorless but scientists add a dye to the DNA so they can visually track the DNA movement through the gel. The gel electrophoresis tank is then plugged into a power supply causing the negatively charged DNA to move toward the positive pole of the electrophoresis chamber. The DNA is then separated by size in the agarose gel.

### Purpose

The purpose of this lab is to simulate gel electrophoresis of DNA and to determine who the father is for "Electra".

## Procedure

1. When setting up the agarose gel into the electrophoresis box, make sure the wells are toward the negatively charged black end.
2. Obtain the DNA samples - Push the top of the pipette down as you put the tip into the DNA to suck it up into the pipette and then release.
3. Now, load DNA into the correct lane (see below). Place the pipette into the small hole in the gel (the well) and push the button at the top of the pipette down. Hold the button down until you pull the pipette out of the well. Discard the tip.
4. Repeat for all solutions. Make sure to use one pipette for each sample. Be careful not to puncture the bottom of the well.

Lane #1	Electra
Lane #2	Daddy 1
Lane #3	Daddy 2

5. Pour buffer on sides of agarose gel until it just covers the top of the gel.
6. Clean up any spilled buffer or any other liquid surrounding the gel box thoroughly.
7. Make sure that the power supply is unplugged and switched off before proceeding.
8. Carefully place the lid on the gel box (first making sure it is clean and dry).
9. Connect the red (positive) patch cord to the red terminal on the power supply. Similarly, connect the black cord to the black terminal. Each power supply will run two gel boxes. Notice what channel you have plugged your box into.
10. Wait until the group that is sharing your power supply has completed steps 1 - 10 before proceeding.
11. **IMPORTANT!** Have your lab instructor look over all of your connections before plugging in the power supply.
12. Plug in the power supply and turn on the machine.
13. Turn the voltage indicator knob to 120V. Observe the bubbles that form along the platinum electrodes.

### Comment [m27]:

This procedure is more appropriate for an AP Biology course than a Living Environment course.

Rather, students will be given four different strands of DNA to represent the standard, crime scene DNA and the DNA of two suspects. Students will be given instructions from the "police station" with the restriction enzymes they will use to separate the DNA into fragments. I will have video clips set up on the SMARTBoard for students to access if they need a reminder of how to use restriction enzymes.

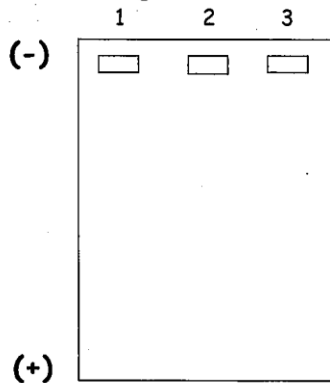
Students will be given a large sheet of paper that is already numbered with the scale they should use when creating their gel. Ordinarily, students would be expected to create their own scale. However, there are many new concepts in this lab including the use of restriction enzymes and arrangement of DNA on a gel. By eliminating the task of creating the scale, students can focus on the new techniques and feel less overwhelmed with the lab. Students spend most lab time assembling laboratory equipment and completing paper and pencil work and the least amount of time performing calculations and conducting analyses of quantitative data (Thomas, 2012). Difficulty of the lab and its efficiency had the greatest impact on students' attitudes about that particular lab (Baseya & Francis, 2011).

The scissors students use will be labeled Hind III to represent the restriction enzyme students will use to cut the DNA. Having the scissors labeled will help students remember that restriction enzymes cut DNA.

14. Let your gel run undisturbed for 20 - 40 minutes. Keep checking your gel to assure that the dyes do not run off the end of the gel into the buffer compartment. During this time complete the attached activity sheet.
15. When the dyes reach approximately 2 cm from the ends of the gel, turn off the power supply. Then disconnect the patch cords from the power supply and unplug the unit.
16. Carefully remove your gel tray. Tip tray over gel box to return excess buffer solution into the TBE compartment (can be re-used). Record your observations (dye location, distance traveled) on the activity sheet.
17. Follow your lab instructor's instructions for clean-up. The gel is discarded into the biohazard can. Gel boxes and trays must be rinsed in water and air dried. Do not use paper towel to dry inside the boxes! Please be careful with the equipment.
18. Wash hands thoroughly and clean lab station before leaving the lab

**Data :**

For each known sample, add to this diagram the bands where the sample migrated.



Lane 1 - Electra

Lane 2 - Daddy 1

Lane 3 - Daddy 2

How many bands did Electra have? \_\_\_\_\_

How many bands did Daddy 1 have? \_\_\_\_\_

How many bands did Daddy 2 have? \_\_\_\_\_

Who is Electra's Daddy? \_\_\_\_\_ How did you know? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Comment [m28]:**

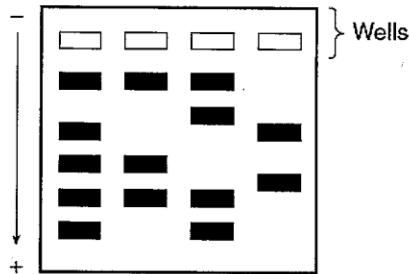
Previous experience with this lab has demonstrated the difficulty of successfully running a gel for a number of reasons. To ensure students understand the concept of gel electrophoresis, they will model it. [Making a model of an abstract concept helps students understand it more accurately \(Haugwiz & Sandmann, 2010\).](#)

The data will be recorded on a large sheet of paper. The tactile activity of actually creating model of a gel will increase students' understanding of this technique. Upon completion of the gel, students will be required to obtain a teacher check to ensure they correctly created the model.

Similar analysis questions will be written for students to interpret the gel they created. These questions will access various levels of understanding according to Bloom's taxonomy.

## Analysis Questions

Look at the picture below and answer questions 1 and 2.



1. State *one* way the information obtained by this technique can be used. [1]  

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2. The results of which laboratory technique are represented in the diagram?
  - (1) chromatography
  - (2) manipulation of genes
  - (3) genetic engineering
  - (4) gel electrophoresis
3. In preparation for an electrophoresis procedure, enzymes are added to DNA in order to
  - (1) convert the DNA into gel
  - (2) cut the DNA into fragments
  - (3) change the color of the DNA
  - (4) produce longer sections of DNA

### Comment [m29]:

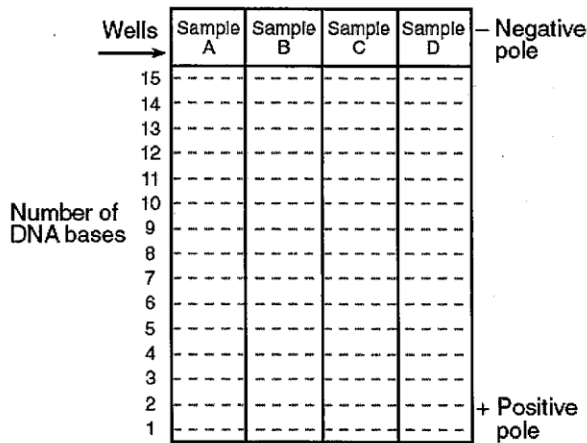
Students will be assessed on their understanding of gel electrophoresis in the lab conclusion. Because the interpretation of gels is a significant portion of Regents questions pertaining to genetic technology, students will also be given Regents questions to answer. This additional analysis will help students make the connection between the lab and the course content.

In an investigation, DNA samples from four organisms, A, B, C, and D, were cut into fragments. The number of bases in the resulting DNA fragments for each sample is shown below.

Data Table

Sample	Number of Bases in DNA Fragments
A	3, 9, 5, 14
B	8, 4, 12, 10
C	11, 7, 6, 8
D	4, 12, 8, 11

4. The diagram below represents the gel-like material through which the DNA fragments moved during gel electrophoresis. Draw lines to represent the position of the fragments from each DNA sample when electrophoresis is completed. [1]



5. Which *two* DNA samples are the most similar? Support your answer using data from this investigation. [1]

Samples \_\_\_\_\_ and \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Comment [m30]:**

These questions effectively address the desired outcomes and objectives of this lab so they will remain.

6. Electrophoresis is a method of

- (1) separating DNA fragments
- (2) changing the genetic code of an organism
- (3) indicating the presence of starch
- (4) separating colored compounds on a strip of paper

7. State *one* specific use for the information obtained from the results of gel electrophoresis. [1]

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**CEI conclusion**

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**Comment [m31]:**

Students will defend their identification of the suspect in this lab conclusion. The claim will state the person guilty of the crime. The support will be the data from the gel that identifies this person as the guilty one. The analysis of this conclusion will require students to do brief research on a court case in which a suspect was found guilty because of DNA evidence. This analysis of the lab will help students make authentic connections between the lab and how the technique of gel electrophoresis is used in the real world. Students will be exposed to careers which utilize the scientific method, lab procedures, other scientific skills (Hein, 2003).

Revised Lab #7  
Gel Electrophoresis Lab

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

Gel Electrophoresis Lab

**Pre-lab**

Before

Watch the video clip to see why the man was found guilty. Take notes that will help you answer this question.

After

Why was the man found guilty of the crime?

Let's understand this better!

Directions

1. Read the following text and answer the questions that follow.
2. Highlight or underline where in the text you saw that answer.

Electrophoresis is a technique used in the laboratory that separates DNA based on size. DNA is a negatively charged molecule and is moved by electric current through gel to the positive end.

1. DNA is separated based on what characteristic?
  
2. What direction does DNA move?

A gel is a semi-solid substance similar to Jello. Because of this structure, the bigger pieces of DNA move through the gel more slowly and do not go as far. The smaller pieces of DNA can fit through the gel so they move farther.

Why do some pieces of DNA move further in the gel than others?

This information can be pretty confusing so let's watch a video clip of what this really looks like. Use the space below to write 2 things about gel electrophoresis that are mentioned in the video clip.

- 1.
- 2.

## Lab

### Scenario

You have just been hired as a detective at police station. You and your partner are assigned to solve the crime of the missing science textbooks. Whoever stole the books must have cut herself on the bookcase because blood was left behind! Your boss gives you the following materials:

1. DNA found at the crime scene
2. DNA from Suspect 1: Mrs. McCabe
3. DNA from Suspect 2: Mrs. Meager
4. Restriction Enzyme Hind III

Your job is to analyze the DNA to find out who stole the science textbooks.

What is the purpose of this lab?

How are you going to accomplish this?

Teacher Check

### Procedure

1. The restriction enzyme Hind III recognizes the following sequence:

AAGCTT

2. Underline each part of the DNA that Hind III recognizes.



3. Hind III cuts between the As of the sequence you underlined. Highlight where the restriction enzyme will cut on each of the DNA strands.

Teacher Check

4. Use Hind III to cut each strand of DNA.

5. Determine how big each piece of DNA is.

6. Arrange the DNA onto the gel given to you. DO NOT TAPE YET!!!

Teacher Check

7. Tape the pieces of DNA onto the gel.

### Analysis Questions

1. Who stole the science textbooks?
2. What evidence do you have that this person stole the science textbooks?
3. What is the purpose of having the standard on your gel?
4. Why did some pieces of DNA move further than others?
5. What causes the DNA to leave the well and move throughout the gel?

Conclusion

**Claim:** Who stole the science textbooks? Answer in a complete sentence!

**Support:** What evidence do you have that this person stole the science textbooks? Answer in 2-3 complete sentences!

**Analysis:** Research a court case in which a suspect was found guilty or not guilty because of DNA evidence. Write your information in the space below.

Name of court case: \_\_\_\_\_

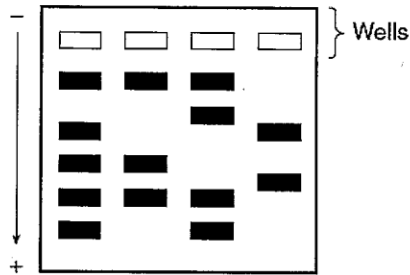
Description of how DNA evidence was used:

**MORE PRACTICE!!!**

When you are finished, complete the homework on the last 2 pages of this lab. These are all questions from old Regents exams. 😊

## Analysis Questions

Look at the picture below and answer questions 1 and 2.



1. State *one* way the information obtained by this technique can be used. [1]  

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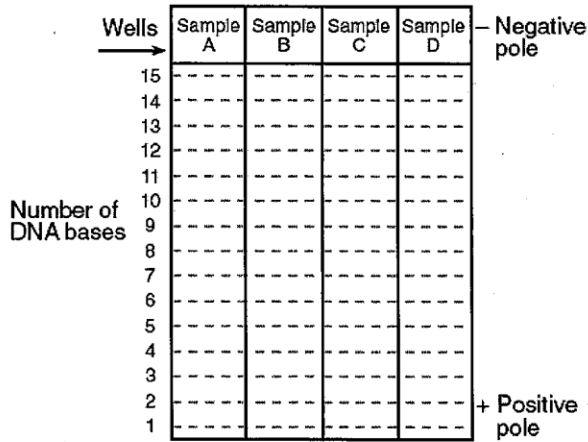
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2. The results of which laboratory technique are represented in the diagram?
  - (1) chromatography
  - (2) manipulation of genes
  - (3) genetic engineering
  - (4) gel electrophoresis
3. In preparation for an electrophoresis procedure, enzymes are added to DNA in order to
  - (1) convert the DNA into gel
  - (2) cut the DNA into fragments
  - (3) change the color of the DNA
  - (4) produce longer sections of DNA

In an investigation, DNA samples from four organisms, A, B, C, and D, were cut into fragments. The number of bases in the resulting DNA fragments for each sample is shown below.

Data Table

Sample	Number of Bases in DNA Fragments
A	3, 9, 5, 14
B	8, 4, 12, 10
C	11, 7, 6, 8
D	4, 12, 8, 11

4. The diagram below represents the gel-like material through which the DNA fragments moved during gel electrophoresis. Draw lines to represent the position of the fragments from each DNA sample when electrophoresis is completed. [1]



5. Which *two* DNA samples are the most similar? Support your answer using data from this investigation. [1]

Samples \_\_\_\_\_ and \_\_\_\_\_

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# Evidence of Evolution Lab

## Background:

Evolution is the change of species over time, the process by which an organism becomes more sophisticated over time and in response to its environment. Evolution is driven by natural selection. Natural selection is the result of **OVCSR - Overproduction, Variation, Competition, Survival of the Fittest, and Reproduction**. In other words, organisms that possess the best variations survive and reproduce and pass on those advantageous traits onto their offspring.

How do we know that evolution has occurred? It is only a theory but scientists have discovered several pieces of evidence that support this theory of Evolution. Some pieces of Evidence for Evolution are:

1. the fossil record
2. comparative anatomy
3. comparative embryology
4. vestigial structures
5. DNA and protein similarities
6. the recorded genetic changes in living organisms over many generations

## Purpose:

- To analyze these 6 different pieces of evidence that support the theory of evolution and decide which one is the BEST for determining which organisms are more closely related.

**Hypothesis:** Take a look at the 6 pieces of evidence of evolution listed above. Write a hypothesis predicting which piece of evidence is the BEST for determining which organisms share common ancestors.

### Comment [m32]:

The current title, "Evidence of Evolution Lab," makes a bold statement supporting the role of evolution in the variation of species. This may offend students whose families hold strong religious beliefs concerning the origin and variation of species. Therefore, the title will be changed to "Species Relationship Lab" to emphasize that scientists use several pieces of evidence to show that species have a common ancestor and thus are related.

The background information will be removed from the beginning of this lab. Students will read brief background information of six different pieces of evolutionary evidence throughout the lab. Doing so will help focus students' attention on ways the relatedness of species can be determined.

The lab will begin with a scenario. In this scenario, students are bored and download a new app for their iPhone in which the goal is to find out which two species out of four unknown species are the most closely related. [The use of scenarios increases student engagement and interest in the lab \(Haugwitz & Sandmann, 2010\).](#)

This is typically students' first exposure to terms such as anatomy, embryology, and vestigial so they have little to no prior knowledge of the vocabulary. Students will learn these terms intermittently during the lab to help reduce the frustration they may experience from not understanding several new vocabulary words.

The written purpose of this lab is to decide which piece of evidence is best for determining which organisms are more closely related. Doing so assumes the theory of evolution is true and species evolved from one another. By eliminating the mention of evolution, students may feel more comfortable using evidence to compare species without it conflicting with their religious beliefs.

The purposes of the revised lab will be to determine which two species are most closely related based on four different types of analyses and then to determine which analysis provided the most scientific information in the student's determination.

Because students do not understand what these pieces of evidence consist of, they cannot make an accurate hypothesis of which would be best to predict which species share common ancestors or are most closely related. Students will form hypotheses analyses concurrently during the revised lab.

Station 1 - The Fossil Record

Remains of animals and plants found in sedimentary rock give us a record of past changes through time. This evidence shows the fact that there has been a tremendous variety of living things. Some extinct species had traits that were in between major groups of organisms. Their existence confirms that species are not fixed but can evolve into other species over time. Now go to this website:

change

[www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/B3.html](http://www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/B3.html)

Answer these questions:

1. At the top of the page in green letters, the title states that "Fossils help us understand how organisms are \_\_\_\_\_." (click more)
2. When you click on the *A...* *...* what did you find? \_\_\_\_\_
3. When you click on the *A...* *...* what did you find? \_\_\_\_\_
4. Are birds related to dinosaurs? \_\_\_\_\_
5. Trilobites are tiny organisms that went extinct 245 million years ago. Which relative do they have living today? \_\_\_\_\_

Ask your teacher about the surprise he/she has to show you!

5. Observe the organism and write down the observations below

6. Do fossils provide evidence to show if 2 organisms are related? \_\_\_\_\_

Comment [m33]:

Students will not complete the lab as stations. Rather, each "station" will be identified as "Analysis." Restructuring this lab will allow students the opportunity to work at a self-paced curriculum and yield a greater number of successful outcomes.

The term "Analysis" will also reinforce the students' purpose for completing each section of the lab. In addition, students will identify which two species are the most related based on the evidence they have for each analysis. They will defend their choice by annotating data from each analysis that supports their claim. Completing the analysis throughout the lab will help students be more cognizant of their actual understanding of the data presented and make the conclusion at the end of the lab easier to complete.

The background information will remain mostly unchanged and used to support Common Core Learning Standards Shift #4: Text-based answers. The term "evolve" will be changed to "change" to support the revised purpose of the lab.

The current version of this lab consists of six different stations in which students analyze six different pieces of evidence using a different group of organism each time. To make the relevance and usefulness of the analyses more meaningful and consistent, students will complete all four analyses using the same four species.

Students will view images of fossils for four different species: human, bat, cat, and whale. However, the four species will consistently be identified as Species A, Species B, Species C, and Species D because students should analyze the species based on the evidence presented to them and not what they already know about that particular species.

As students view the images, they will make observations. This activity supports the Common Core Learning Standards of text-based answers using non-text print.

The current questions for this lab require a low level of thinking skills. Making observations will require students to interact more with the images.

At the conclusion of Analysis 1, students will determine which two species they believe are most related and highlight which observations they used to form their conclusion.

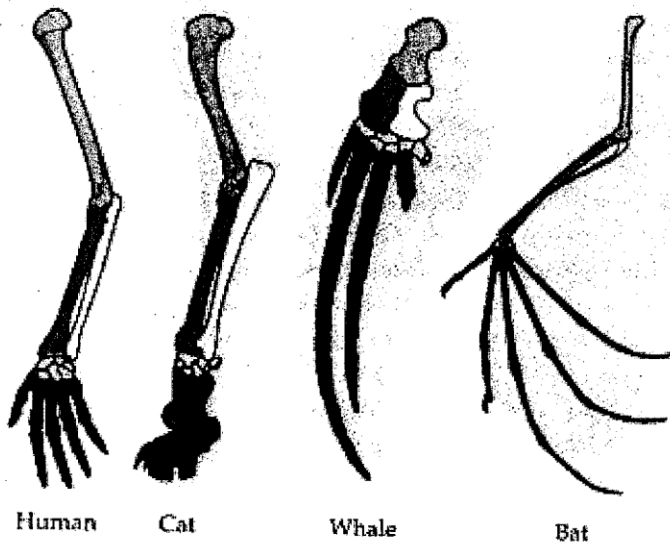
This portion of the station would be interesting if there were fossils available to analyze but that typically is not the case.

Analysis

Station 2 - Comparative Anatomy

Scientists can look at body parts to see evidence of evolution as well. These structures may include the heart, digestive system, bones, and teeth. Take a look at the limbs of the different organisms show below.

Start by coloring each of these human bones a different color: fingers, wrist, 2 bones of lower arm, and bone of the upper arm. Then color the corresponding bone of each animal the same color as you did on the human.



1. Do these 4 organisms all possess the same bone structure? \_\_\_\_\_
2. Do you think they may all have a common ancestor? \_\_\_\_\_
3. Even though these organisms have the same bone structures, there are differences in bone size, length, and function. Pick 1 organism and explain why the bones have evolved differently than ours? \_\_\_\_\_

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Comment [m34]:

The phrase "evidence of evolution" will again be changed to "if two species are related" to support the revised purpose of the lab.

Images of the bone structure of the four species will be labeled with select bone sets. Students will be required to color in the corresponding bones for each of the species using the same color. The act of coloring will help students visualize the similarity in location, structure, and quantity of the bones in each of the species being compared.

If at all possible, students would have a valuable experience at the Seneca Park Zoo. There are models of skeletons for various species in one part of the zoo. Students could compare and contrast the structure of the various skeletons. This experience would be more authentic than simply looking at pictures and may increase student engagement and learning of science concepts in the lab (Thomas, 2012).

The first question is confusing for students because they have a similar bone structure but not identical. At this point in science, they do not understand homologous structures.

The second question requires a "yes" or a "no" response and does not allow for student explanation. It therefore accesses a low, if any, level of thinking.

The third question will be reworded to address all four species and force students to use critical thinking skills.

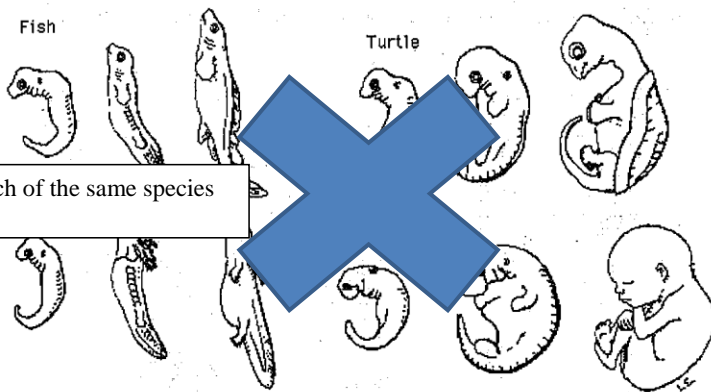
At the conclusion of this analysis, students will be asked to choose which two species are most closely and explain what information they used from this station to form that conclusion.

Analysis

Station 3 - Comparative Embryology

shows how species are related.

The science of embryology provides evidence to the process of evolution. During development, the embryo passes through stages which resemble its evolutionary ancestors. All embryos undergo a process of differentiation to construct their different body parts. Study the diagram below and note 3 similarities in embryonic development.



One image for each of the same species will be used.

1. List 3 similarities between the four embryos pictured above:

- 
- 
- 

2. Now go to this website: <http://www.purposegames.com/game/f16816ec>

A name of the organism will come up in the box. You need to scroll down and click on the circle of that organism. How did you do? \_\_\_\_\_

- Was it difficult to determine the differences between embryos? \_\_\_\_\_
- Why do you think this? \_\_\_\_\_

2. Do you think that these 4 organisms may share a common ancestor? \_\_\_\_\_

Comment [m35]:

The phrase "provides evidence to the process of evolution" will once again be changed to "shows how species are related" to support the revised purpose of the lab. The focus of this lab is on scientific evidence and not the origin of the species.

The term "evolutionary" will be eliminated.

Students will be asked to explain differentiation in the Common Core piece of this station because the term is used in the Genetics unit.

Students have minimal experience identifying embryologic structures. Rather, students will view one image of the four species and circle the parts they have in common with each other. The purpose of this analysis is for students to see the similarities in structures of embryos; knowing the nomenclature of the parts is unnecessary at the Living Environment level.

This portion of the current lab can be addressed in the revised version of the lab by asking students to evaluate the structures they see relative to each other.

At the conclusion of this analysis, students will be asked to determine which two species are most closely related based on the images of the embryos they observed. Similar to the other analyses, students will once again highlight the evidence from the images that supports their claim. Being consistent with the species in this lab will help students understand that there are different ways to compare the same species. Some analyses are more scientific than others and thus provide more reliable data.

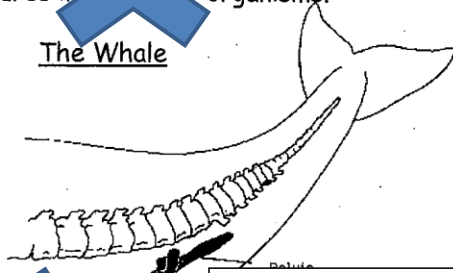


Analysis

Station 4 - Vestigial Structures

Vestigial structures are those that have lost their function over time. Below are some vestigial structures in different organisms.

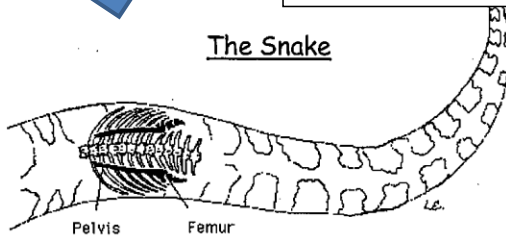
The Whale



Replaced by:

1. What is the function of X?
2. How does X move?
3. Do you think X is still needed by the organism?
4. Why or why not?

The Snake



3. What is the vestigial structure in the snake? \_\_\_\_\_
4. Why do you think it is there but not used anymore? \_\_\_\_\_
5. List 3 Vestigial Structures in humans \_\_\_\_\_ and \_\_\_\_\_.
6. How do vestigial structures give evidence to evolution? \_\_\_\_\_
7. Are organisms that have similar vestigial structures related? \_\_\_\_\_

Comment [m36]:

The analysis for vestigial structures will only be included in some labs for students to serve as an extension piece. This form of differentiated instruction will benefit high achieving students.

The background information provided for vestigial structures will be replaced with text that elaborates on the function of various structures. Students will mostly like have no prior knowledge about the femur or the pelvis thus making it unlikely students will correctly identify the vestigial structure in each organism.

As described in the rationale for the other analyses, students will view images of the same four species.

The purpose of this question is to correlate structure with function but this is not clear to the students. Therefore, the question will be scaffolded to help the student arrive at the intended conclusion.

This question would serve better as an extension question at the conclusion of the lab. It does not directly relate to the purpose of the lab and may suggest that humans evolve which is a controversial topic due to its sensitive nature and religious affiliations.

This question will be reworded as "What do vestigial structures suggest about the relationship of the four species you have been analyzing?" Student responses will access critical thinking skills while allowing them to answer in such a way that is comfortable for them.

Analysis

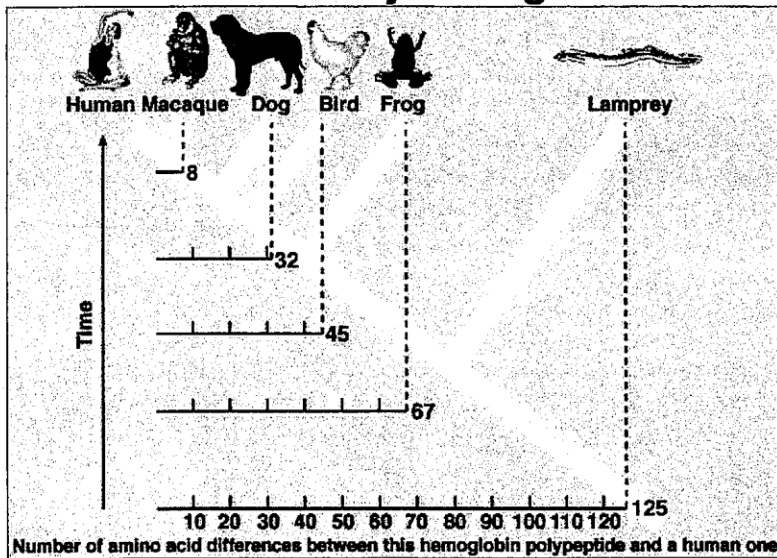
*look at the pictures of vestigial structures found at your table!*

### Station 5: DNA and Protein Similarities

If two organisms have similar DNA molecules, they will make similar proteins. Similar proteins have similar amino acids since amino acids are the building blocks for proteins. The more similar DNA suggests a common origin. The more similar the DNA of 2 living organisms, the more closely related they may be to one another.

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### Evolutionary Divergence



The diagram above shows the number of differences between amino acids of human and 5 other organisms. How many differences do each of these organisms possess?

1. Which organism has the most differences? \_\_\_\_\_ Least? \_\_\_\_\_
2. Which organism is most closely related to humans? \_\_\_\_\_
3. Analyzing DNA and Proteins provides the BEST evidence for evolution. Why is this? \_\_\_\_\_

#### Comment [m37]:

Students will do this part in the revised analysis portion of the lab.

This text reinforces important concepts students learned in the Genetics unit including protein synthesis and evolutionary trees. It will remain as the background information students read interpret to support Common Core Learning Standards Shift #4: Text-based answers.

The term "indicates" will be replaced by "suggested" to remove bias towards the theory of evolution.

This chart already provides the number of differences between various species. Students do not need to think very much to determine which species are closely related. The revised lab will require students to interpret a portion of a protein, develop a tree that represents the data, then analyze degree to which the species are related. The revised activity involves a much higher level of understanding and application.

Additional questions will be included that require students to extrapolate quantitative data from the diagram. From these questions, students will then be asked which two species are most closely related.

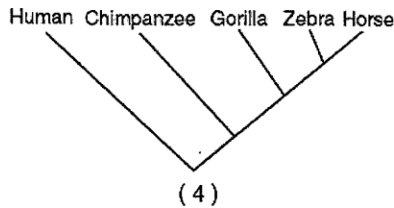
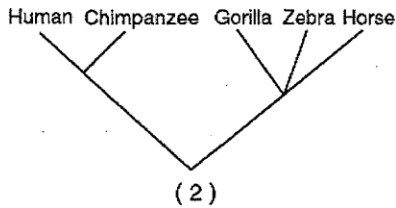
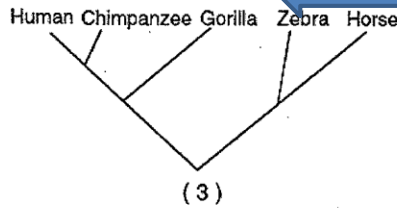
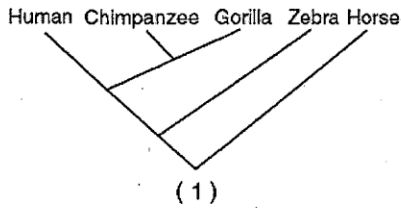
Question 2 will be eliminated because it is controversial and detracts from the revised purpose of the lab.

As it is currently written, question 3 does not allow for students to arrive at the conclusion that DNA and proteins are the best evidence for evolution. Additionally, the term "best" is not defined. The ...

The title will be replaced with a less verbose one-“Portion of Protein for Unknown Species.”

Species	Sequence of Four Amino Acids Found in the Same Part of the Hemoglobin Molecule of Species
human	Lys-Glu-His-Phe
horse	Arg-Lys-His-Lys
gorilla	Lys-Glu-His-Lys
chimpanzee	Lys-Glu-His-Phe
zebra	Arg-Lys-His-Arg

68 Which evolutionary tree best represents the information in the chart?



5. Explain your answer to the multiple choice question above. \_\_\_\_\_

6. What do proteins, amino acids, and DNA all have to do with evolution? \_\_\_\_\_

**Comment [m38]:**

The amino acid codes will be replaced with ones representing the four species utilized in the revised lab.

Students will be required to develop their own evolutionary tree based on the data table for the amino acid sequence of the four species. They will describe their rationale for the arrangement of species and provide evidence to support their rationale.

Modifying the evolutionary tree problem in the current lab will access a higher level of thinking than the current question 5.

Question 6 will be rewritten to ask students what the relationship is between proteins, amino acids, and DNA without mention of evolution.

### Station 6 - Genetic changes in living organisms over many generations

The earth's environment is constantly changing. When the changes are so great that as to go beyond what most members of a population of organisms can tolerate, widespread death occurs. As Charles Darwin observed, however, not all individuals always die. Fortunately, populations have genetic diversity. Those individuals whose characteristics allow them to survive an environmental crisis are the only ones able to reproduce and pass their traits on to the offspring.

This process of natural selection resulting in evolution can be demonstrated over a 24 hour period in a laboratory Petri dish of bacteria. When a lethal dose of antibiotic is added, there will be a mass die-off. However, a few of the bacteria usually are resistant and survive. The next generation is mostly resistant because they have inherited the resistant trait from the survivors. Take a look at the picture below:

A bunch of bacteria, including a resistant variety...

...get bathed in antibiotics. Most of the normal bacteria die.

The resistant bacteria multiply and become more common.

Eventually, the entire infection evolves into a resistant strain.



● normal bacterium      ● dead bacterium  
○ resistant bacterium

Picture 1 - At the beginning there are more \_\_\_\_\_ bacteria.

Picture 2 - Antibiotics are added and now there are more \_\_\_\_\_ bacteria but one \_\_\_\_\_ survives!

Picture 3 - There are more \_\_\_\_\_ bacteria because this bacteria reproduced and passed on the \_\_\_\_\_ trait to its offspring.

Picture 4 - Over time, all the \_\_\_\_\_ bacteria die out and only the \_\_\_\_\_ bacteria is left.

#### Comment [m39]:

This station will be eliminated because it is addressed during the concept of natural selection. The genetic changes observed reflect the overall change in a species but does not demonstrate the relationship of the four species to support the revised purpose of the lab.

**Comment [m40]:**

This is part of station 6 and will therefore be eliminated from the revised lab.

This question will become the analysis for the conclusion. The term "best" will be replaced by "most scientific."

This question will be rewritten as a constructed response question with the word "evolutionary" removed. The task of "describe" accesses a higher level of thinking according to Bloom's taxonomy.

This questions will be rewritten as "What is a benefit of genetic variation among a species?" This open-ended question will require students to utilize information from the previous unit on genetics and expand on their understanding of natural selection and the relationship between species.

Now go to this website: <http://www.pbs.org/wgbh/evolution/survival/clock/>

- At the beginning, you have an empty petri dish.
- Click start and the man \_\_\_\_\_ spreading the streptococcus bacteria (Strep Th) in the air and \_\_\_\_\_ on the dish.
- Wait 30 sec
- Record Current pop \_\_\_\_\_ and No. (Number) of Mutations \_\_\_\_\_
- Why do you think the \_\_\_\_\_ color? \_\_\_\_\_

Is Evolution happening \_\_\_\_\_ quickly with \_\_\_\_\_ bacteria? \_\_\_\_\_

If the environment remains stable, will evolution occur? \_\_\_\_\_

**Analysis Questions:**

1. What piece of evidence - fossils, comparative anatomy, comparative embryology, vestigial structures, DNA and proteins, or Genetic changes in living organism - is the **BEST** useful to determine what organisms have common ancestors. Explain your answer

2. Which observation could best \_\_\_\_\_ indicate an evolutionary relationship between two species?

- (1) They have similar \_\_\_\_\_.
- (2) They have \_\_\_\_\_.
- (3) They inhabit \_\_\_\_\_ geographic regions.
- (4) They occupy \_\_\_\_\_ same niche.

Describe three different analyses that can be used to show that species are related.

3. If the environment changes, what organisms \_\_\_\_\_

4. In an area of Indonesia where the ocean floor is littered with empty coconut shells, a species of octopus has been filmed "walking" on two of its eight tentacles. The remaining six tentacles are wrapped around its body. Scientists suspect that, with its tentacles arranged this way, the octopus resembles a rolling coconut. Local predators, including sharks, seem not to notice the octopus as often when it behaves in this manner. This unique method of locomotion has been observed in this species for many generations due to

- (1) competition between octopuses and predators
- (2) ecological succession in marine habitats
- (3) the process of natural selection
- (4) selective breeding of this octopus species

Conclusion: Write a CEI conclusion summarizing your findings from this lab.

The conclusion will be scaffolded:

Claim: Identify the two species that are the most closely related.

Support: Describe the evidence you used to form this claim. Hint...Use the data you annotated!

Analysis: What analyses provided the most scientific and useful data to help form your claim?

**Comment [m41]:**

Multiple choice questions such as this will be used on a warm up activity or an exit ticket after the lab is completed to serve as reinforcement of natural selection. This particular question is not relevant to the purpose of the revised lab.

Upon completion of this lab, students will participate in small group discussions regarding the conclusions they arrived at. These conversations will help students better understand the analyses they completed and understand someone else's point of view when asked to perform the same task (Sampson, Grooms, & Walker, 2009).

Revised Lab #8  
Species Relationship Lab

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

Species Relationship Lab

**Scenario**

You and your friend are bored one day so you decide to find a new app for your iPhone. You find a really cool one about four species where you have to complete different analyses to find out which two are most closely related.

Purpose

The purpose of this lab is to \_\_\_\_\_

---

Analysis 1: Fossil Record

Directions

1. Read the text.
2. Answer the questions that follow the text.
3. Highlight or underline where in the text you found that answer.

Remains of animals and plants found in sedimentary rock give us a record of past changes through time. This evidence shows the fact that there has been a tremendous variety of living things. Some extinct species had traits that were in between major groups of organisms. Their existence confirms that species are not fixed but can change into other species over time.

1. Why are the remains of animals and plants important?
2. How do we know that species change over time?

The first part of the app you downloaded gives you these fossil pictures. Make observations for each one.



Species A

Observations Species A



Species B

Observations Species B



Species C

Observations Species C



Species D

Observations Species D



1. Based on the pictures and your observations, what two species do you think are most closely related?

Letter \_\_\_\_\_ and Letter \_\_\_\_\_

2. Why did you pick these two species?

3. What other pieces of information would be helpful for you to have to correctly choose the two species that are related?

### Analysis 2: Comparative Anatomy

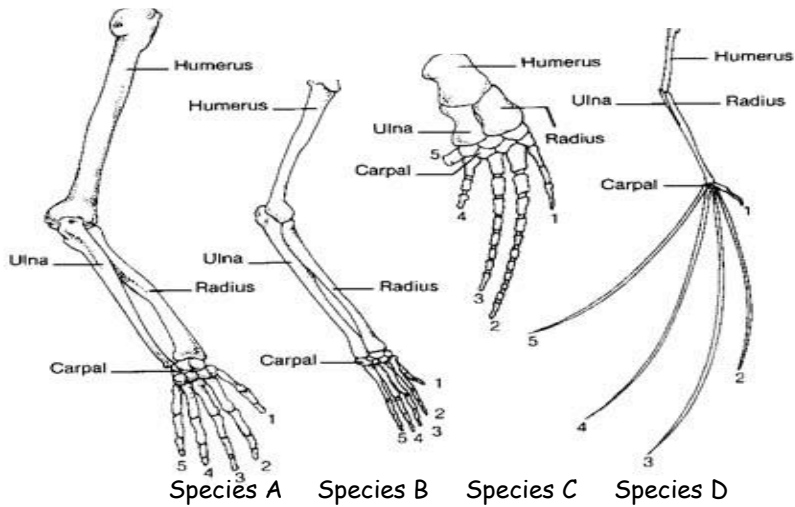
The app you downloaded gives you this information about how to see if two species are related.

1. Read the text.
2. Answer the questions that follow the text.
3. Highlight or underline where in the text you found that answer.

Scientists can look at body parts to see if two species are related. These structures may include the heart, digestive system, bones, and teeth.

What can scientists compare to see if two species are related?

Look at the limbs of the four animals on the next page. The names of the bones have been labeled for you. Color each of the corresponding bones in the same color on Species A, Species B, Species C, and Species D.



1. What is the difference in bone structure among the four species?

2. Why do you think these differences in bone structure exist?

3. Based on the observations from Analysis 2, which two species do you think are most closely related?

Letter \_\_\_\_\_ and Letter \_\_\_\_\_

4. Why did you pick these two species?

### Analysis 3: Comparative Embryology

The app also gives you this helpful information to find out what species are most closely related.

#### Directions

1. Read the text.
2. Answer the questions that follow the text.
3. Highlight or underline where in the text you found that answer.

During development, the embryo passes through stages which resemble other species it is related to. All embryos undergo a process of differentiation to construct their different body parts.

1. What can we infer if an embryo resembles an embryo of another species?
2. What process allows the embryo to develop all of its body parts?

Look at the pictures of the embryos for each of the four species as various stages in their development. Make observations in the box next to each species.



Species A

Observations Species A



Species B

Observations Species B



Species C

Observations Species C



Species D

Observations Species D

1. List two similarities you notice in the embryos.

- 
- 

2. List two differences you notice in the embryos.

- 
- 

3. Based on the data you collected from Analysis 3: Comparative Embryology, what two species do you think are most closely related?

Species \_\_\_\_\_ and Species \_\_\_\_\_

4. Why did you pick these two species?

#### Analysis 4: DNA and Protein Similarities

The last analysis you have to complete is below!

##### Directions

1. Read the text.
2. Answer the questions that follow the text.
3. Highlight or underline where in the text you found that answer.

If two organisms have similar DNA molecules, they will make similar proteins. Similar proteins have similar amino acids since amino acids are the building blocks for proteins. The more similar DNA suggests a common relationship. The more similar the DNA of 2 living things, the more closely related they may be to one another.

1. How do you know if two organisms will make similar proteins?

2. What is one possible way to tell if two species may be related?

Portion of Protein for Unknown Species

Species	Sequence of 4 Amino Acids
A	Lys-Glu-His-Phe
B	Arg-Lys-His-Lys
C	Lys-Glu-His-Lys
D	Lys-Glu-His-Phe

##### Directions

1. Construct an evolutionary tree in the space below to demonstrate how Species A, Species B, Species C, and Species D are related.

2. Explain the arrangement of your evolutionary tree.

3. Based on the data you collected from Analysis 4: DNA and Protein Similarities, what two species do you think are most closely related?

Species \_\_\_\_\_ and Species \_\_\_\_\_

4. Why did you pick these two species?

#### CONCLUSION

**Claim:** Identify which two species are most closely related. Write a sentence!

**Support:** Describe evidence from the analyses that SUPPORT your claim. Write sentences!

**Analysis:** When would it be helpful to know if two species are related?



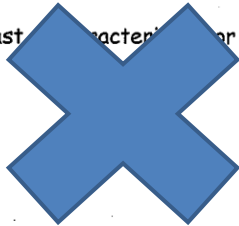
Characteristics of Life Lab

# ARTIFICIAL LIFE

Essential Question: How do you know if something is alive?

List at least \_\_\_\_\_ characteristics or actions of something that is alive.

- 
- 
- 
- 
- 



Making a list requires a low level of thinking according to Bloom's taxonomy. The revised pre-lab activity will require students to analyze images, interpret their meaning, and relate it to the Living Environment curriculum.

### Introduction:

What is life? What does it mean to be alive? How is something made "living"? These are all pertinent questions when discussing the origin of life. Scientists have identified nine basic characteristics of life. For something to be described as living, that something must display all nine of these characteristics. Although scientists and people have many different opinions about what "living" means, the nine characteristics were designated "characteristics of living things" with the consensus of the scientific community.

### Comment [m42]:

The purpose of this lab is to make observations of an unknown object and determine if it is alive using the characteristics of life learned in the previous lesson.

The title, "Artificial Life," will be replaced with "Characteristics of Living Things Lab." Although engaging, the current title suggests to students the sample is alive without them completing the lab. The revised title reinforces the purpose of the lab and what students should be focused on as they complete it.

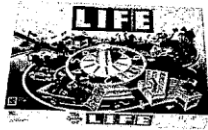
This essential question will remain part of the lab to focus students' attention on the purpose of the lab.

Students will complete a pre-lab activity that has two purposes. The first purpose is to support Common Core Learning Standards Shift #4: Text-based answers using non-print text. Students will be given eight pictures that represent eight characteristics of life. They will be required to identify which characteristic of life is represented by each picture. In addition, they will describe what part of the picture they used when determining that particular characteristic of life.

The second purpose of the revised pre-lab activity is to prepare students for making observations during the lab and analyzing what they see to identify it as a potential characteristic of life.

This content is addressed in previous lessons of the unit. The pre-lab activity in the revised lab will review this content thus the original paragraph will be removed.

# Look who's coming to life!



The 9 life functions you MUST know for ALL living organisms

## The 6 "Tions" (shuns)

Circulation - the movement of materials within an organism

Digestion - the ability to obtain and process food

Excretion - the ability to remove waste (Carbon Dioxide, Water & Urea)

Organization - made up of one or more cells

Reproduction - the ability to produce offspring of their own kind

Respiration - the ability to break down food into energy

## The 2 "Tions"

Homeostasis - the ability to maintain a stable internal environment

Anabolism - the ability to put together small molecules to make larger ones  
(ex: amino acids are put together to make proteins)

## The 1 "Tion"

Growth and Repair - the ability to increase in size and create new cells

Comment [m43]:

Students will utilize class notes from a previous lesson to support the lab. Doing so will hold students accountable for previous work.



If something follows one or just a few of the ones listed above, it does not necessarily mean that it is living. To be considered a living organism, an object must exhibit **all** of the characteristics of living things. Sugar crystals growing on the bottom of a syrup container is a good example of a nonliving object that displays at least one criteria for living organisms.

Can you give another example of a nonliving object that displays at least one criteria for living organisms?

### Background:

On a recent voyage to the moon, an Astronaut gathered samples. He noticed that one particular sample exhibited characteristics of life so he decided to give this sample to the University of Rochester laboratory to analyze. Fortunately, I have a very close friend who is an employee at the University of Rochester and she was able to give me a piece of this sample for you to investigate. Your job is to determine if this unknown object is alive or not.

Purpose of this lab:

Hypothesis: (If...then...because statement) Create your own hypothesis in this space provided.

### Procedure:

1. Your teacher will put your sample into a cup of sodium silicate (water like solution).
2. Observe your unknown sample from the moon for 5-7 minutes.
3. Record as many observations as you can in the left hand side of the data table on the following page.

### Comment [m44]:

This content is addressed in a different lesson that occurs before this lab.

Students will give an example of something that shows a characteristic of life but is not alive when they complete the analysis portion of the conclusion.

To increase student engagement, I will share with students a letter I "received" from the University of Rochester that is addressed to them. In this letter, researchers from the Astronomy department tell students that they need the students' help in identifying an unknown substance they found in the galaxy because they heard that my class is very accurate in identifying characteristics of life.

Students will use the letter they received from the University of Rochester to write their purpose.

Students will list the characteristics of life they expect to see without the use of any aid. This approach to forming a hypothesis requires a higher level of cognition because they need to understand what the characteristics of life mean and whether or not they can easily be observed.

The procedure will be organized into two sections: Initial observations and Final observations. Students will view a "galaxy sample" in a petri dish. (It is really a piece of ferric chloride.) After they complete initial observations, they will place the galaxy sample into a "special liquid" and make observations for a total of five minutes. (The liquid is sodium silicate.)

Data:

ARTIFICIAL LIFE OBSERVATION DATA TABLE	
Observer: _____ Record your observations below:	Evaluator: _____ Indicate the type of statement
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Did you really make an OBSERVATION?

Scientists must be aware of the distinction between true observations, inferences, and opinions. Carefully consider the following definitions when recording information as part of an investigation.

- **Observations:** Data collected with any of the senses or tools such as thermometers, graduated cylinders, balances, rulers.
- **Inferences:** Conclusions drawn from observations; they may be very subtle and you may at first be making them.
- **Opinions:** Everyone has them and should be respected, but let's leave them out of our data collection.

Now go back to your data table above and classify your original observations as OBSERVATIONS, INFERENCEs, or OPINIONS. Make sure to keep in mind the definitions.

**Comment [m45]:**

The purpose of the revised lab is to identify the characteristics of living things in an unknown sample from the "galaxy." Students should have prior knowledge of observations and inferences. This portion of the current lab will be eliminated and will be replaced by a task requiring students to interpret their observations as a characteristic of life or not a characteristic of life. If the observation does represent a characteristic of life, students will use a code to identify which characteristic is represented. The revision of this task will allow students the opportunity to evaluate the quality of their own observations and engage students in a higher level of cognitive thinking. At a later point in the lab, students will revisit the codes they assigned for their observations and explain their rationale. This will give students the time to process their thinking while holding them accountable for their work and preventing them from simply choosing any code for the particular observation.

Now that you have completed your observations, you need to organize your data. Which observations will be helpful in determining if the sample is alive? Which observations, while true, are of no value in determining your ultimate goal?

Observations which are helpful in determining if the sample is alive.	Observations which are <u>not</u> helpful in determining if the sample is alive

Go back and reread the \_\_\_\_\_ page 3. From the reading, fill in the blank...  
For an object to be \_\_\_\_\_ must exhibit \_\_\_\_\_ characteristics of life.

What are the \_\_\_\_\_ characteristics of life?

**Comment [m46]:**

Students will reflect on the quality of their observations when they assign each one a code for the characteristic of life. The revised lab will require students to select one observation they made that supported the galaxy sample being characterized as alive and one observation that suggested otherwise. This will help the students when they write the lab conclusion.

Students will revisit the beginning of the lab by rereading the characteristics of life they expected to observe and circling the ones they actually observed. This will provide students with an additional opportunity to tie the whole lab together. Students will then explain why they observed or didn't observe each of the characteristics they initially listed.

**Data Analysis:**

1. Go back to the first page of the lab where you listed 6 characteristics or actions of something that is alive. After you are done with the lab, how have your original thoughts changed? BE SPECIFIC!!!
2. What observations did you make that helped you determine if the sample was alive or not?
3. If we had more time and/or materials available, what else would you like to do with your specimen from another galaxy to determine if it is alive?
4. After careful analysis, is this unknown sample from the University of Rochester alive? Explain and BE SPECIFIC.
5. How might you apply the skills that you learned in this lab to the real world?

**Comment [m47]:**

These questions will be addressed as previously noted in Comment 43.

This question will be rewritten to access a higher level of thinking and reduce ambiguity. Students will respond to the question, "Why did you not observe all the characteristics of life?"

Students will answer this question as the "Claim" to their conclusion.

This question is vague. Students will be asked in the "Analysis" portion of the lab to identify something that exhibits characteristics of living things but is not alive. They will explain their response.

**CONCLUSION:**

Formulate a minimum of one paragraph that provides a summary of this investigation use the CEI format. The CEI must include the following:

- **Claim**-A specific statement based on the lab that is linked back to the purpose of the lab.
- **Evidence**-Specific examples from the lab that support the claim.
- **Interpretation**-Explanation of what the evidence reveals and how this connects to the real world and/or future applications.



The lines will be eliminated to reduce student anxiety about how long the response should be. Rather, students will be provided with a space to write their answers following each part of the lab conclusion.

**Comment [m48]:**

The "Claim" will be to simply identify if the sample is alive or not.

The "Support" will be to provide three specific pieces of evidence that support the student's claim. This will already have been scaffolded for them by this point because they completed it in the previous analysis questions.

The "Analysis" portion of the lab will require students to think critically. They will be asked to identify a nonliving thing that exhibits nonliving characteristics and describe what those characteristics are.

Revised Lab #9  
Characteristics of Life Lab

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

Characteristics of Life Lab

**Pre-lab**

Directions

1. Look at the following pictures.
2. Identify the characteristic of life represented by each picture.
3. Explain what part of the picture helped you decide what characteristic of life it represented.

1.



Characteristic of Life:

What part of the picture helped you decide this?

2.



Characteristic of Life:

What part of the picture helped you decide this?

3.



Characteristic of Life:

What part of the picture helped you decide this?

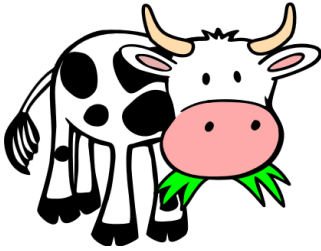
4.



Characteristic of Life:

What part of the picture helped you decide this?

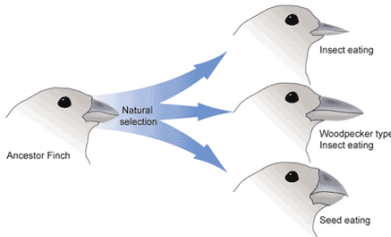
5.



Characteristic of Life:

What part of the picture helped you decide this?

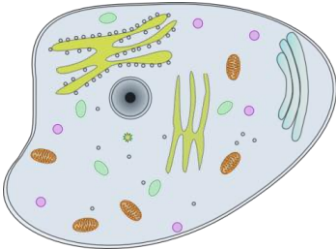
6.



Characteristic of Life:

What part of the picture helped you decide this?

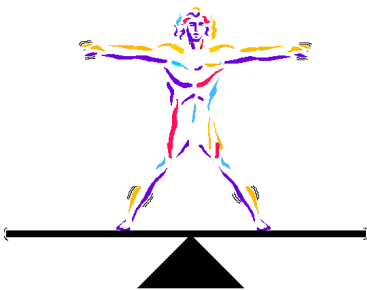
7.



Characteristic of Life:

What part of the picture helped you decide this?

8.



Characteristic of Life:

What part of the picture helped you decide this?

Teacher Check

**Scenario**

Mrs. Evershed has just received a very important email. Read below!

*Dear Living Environment class,*

*My colleagues and I at the University of Rochester have recently been made aware that you know how to characterize living things. We need your help. We found a sample from the galaxy and we have no idea if it is alive or not! Please help!*

*Thank you,*

*The Astronomy Department  
University of Rochester*

**Purpose**

The purpose of this lab is to \_\_\_\_\_

**Hypothesis**

If the galaxy sample is alive, then I will see the following characteristics of life:

Teacher Check



**Procedure**

1. Look at the galaxy sample. DO NOT TOUCH! Record your initial observations in the space below. (THE "LIFE CHARACTERISTIC CODE" IS FOR AFTER THE LAB)

Initial Observations	Life Characteristic Codes

2. Using the forceps, **carefully** place the galaxy sample into the special liquid. Watch it for 5 minutes. Record your observations in the data table below. (THE "LIFE CHARACTERISTIC CODE" IS FOR AFTER THE LAB)

Final Observations	Life Characteristic Codes

**Analysis**

1. Use the following codes to label each observation in both data tables as one or more of the following characteristics of living things. If the observation is none of these, write "None."

UGC=universal genetic code

GD=grow and develop

RE=respond to environment

R=reproduce

MH=maintain homeostasis

OUME=obtain and use material and energy

C=made up of cells

E=a group of living things evolves

2. Look at the observations you wrote in the two data tables. Choose 1 that made you think the galaxy sample was alive:

- 

3. What about this observation made you classify it as biotic?

4. List one observation you made that made you think the galaxy sample was not alive.

- 

5. What about this observation made you classify it as abiotic?

6. How many of the 8 characteristics of living things must something show to be considered biotic?

7. Look at the characteristics of life you listed in your hypothesis. Circle the characteristics you observed during the lab.

Check here when finished \_\_\_\_\_

8. Why did you not see all of the characteristics you listed in your hypothesis?

### **Conclusion**

**Claim:** State whether the galaxy sample is biotic or abiotic. **WRITE A SENTENCE!**

**Support:** List 3 specific pieces of evidence **from your 2 data tables** that support your claim. **WRITE SENTENCES!**

**Analysis:** Identify one other thing that seems alive but actually isn't. What characteristics of life does it show? What characteristics of life does it not show?

Name \_\_\_\_\_

Chemistry

Lab # \_\_\_\_\_

## ~~Chemical Nature of Enzymes Lab~~

### ENZYMES MAKE THE WORLD GO 'ROUND

We often talk about **reactions** and the molecules that change in those reactions. Those changes don't happen all by themselves, they need Enzymes! Enzymes are the biological substance (proteins) that act as **organic catalysts** and help speed up reactions everywhere in life.

### LOCKS AND KEYS

When you go home at night and find your door locked, can it open itself? Nope. You need a key that is just the right shape to fit in that lock. Otherwise, you're stuck in the cold. Enzymes work in a similar way (locks and keys). Enzymes complete very specific jobs and do nothing else.



Two things that enzymes are responsible for in your body are: breaking down a large molecule into smaller molecules (digestion), and putting together small molecules to make a bigger one (synthesis). In this lab we are going to use the carbohydrate starch and your saliva to show how digestion takes place and to prove that without the special enzyme *salivary amylase* the starch would not be broken down.

Purpose of the lab:

This text will follow the pre-lab. Students will use the information in this paragraph to extrapolate the purpose of the lab.

#### Comment [m49]:

The title of the lab will be changed to "Chemistry of Enzyme Lab" to clarify the relationship between chemistry and biology.

A more formal text will be used to support the Common Core Learning Standards for English Language Arts: Shift #4: Text-based answers.

This analogy will be used in a lesson prior to the lab but will not be included in the Common Core insert of the revised lab.

A simplified diagram of substrates, enzymes, and active sites will be included in the revised lab to support the text.

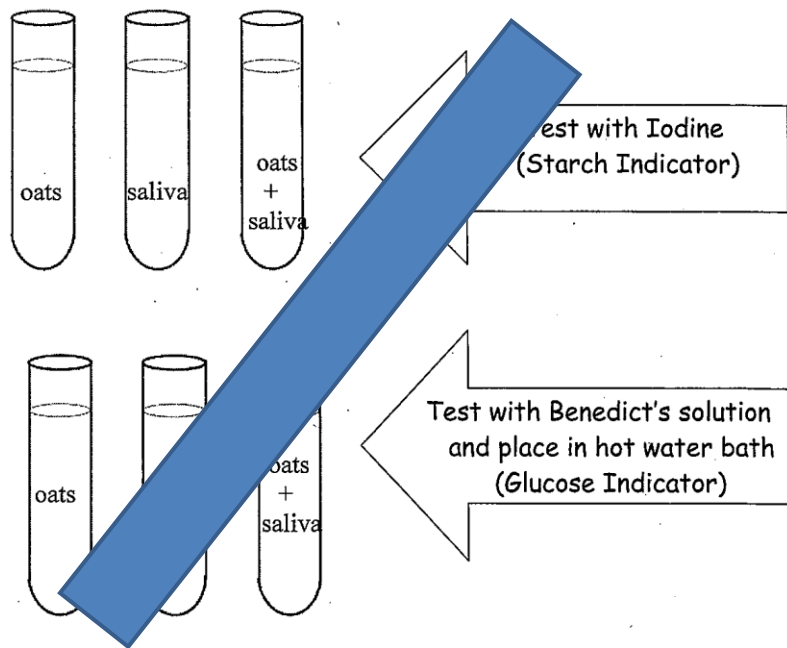
Following the pre-lab and prior to beginning the lab, students will view an animation of enzyme activity. A Web-based learning environment results in higher retention of science content (Yu, She, & Lee, 2010).

By the time students begin this lab, they will have been exposed to the concept of enzymatic activity three different ways.

Hypothesis:

**PROCEDURE:**

1. Obtain 6 test tubes
2. 2 (oats only), 2 (saliva only), 2 (oats + saliva)
3. Let sit for 20 minutes *next page in the lab and complete the activity*
4. Test 3 of the test tubes (1 saliva, 1 oats + saliva) with Iodine (starch indicator)
5. Record results in data table
6. Test 3 of the test tubes (1 oats, 1 saliva, 1 oats + saliva) with Benedict's solution (glucose indicator) and place in hot water bath
7. Record results in data table



**Comment [m50]:**

Students will form a hypothesis that references the indicators used and the colors changed. The purpose of the lab is to observe if saliva digests starch to glucose therefore students need to review how they know if the digestion occurred.

The current procedure is a "cookbook" lab procedure. It requires minimum thinking from students. The revised lab will be structured as a guided inquiry lab in which students are provided with the purpose of the lab and the materials available to them. They will design a procedure in which they use the given information to determine if saliva digests starch to glucose. *Students who completed inquiry labs rated a higher confidence in science than when they completed expository labs (Corsi, 2012).*

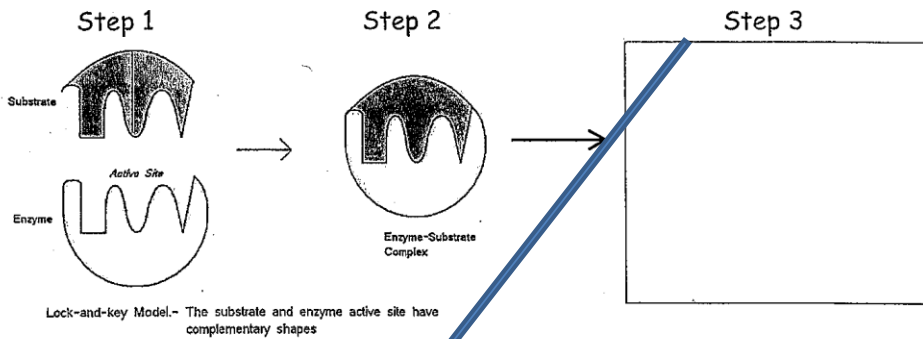
Students will be given two hints to help them get started. The hints would ideally reduce student frustration and help them successfully design the procedure. *Difficulty of the lab and its efficiency had the greatest impact on students' attitudes about that particular lab (Baseya & Francis, 2011).*

A modification that could be used for students with learning disabilities would include pictures of six test tubes and ask students to label the materials that would be found in each one that would allow them to determine if starch and glucose were present. The visual depiction of the procedure would allow students to participate and express their understanding of the lab.

This diagram will be eliminated because it doesn't allow students to think about why they are setting the lab up this way.

### ENZYME MODEL ACTIVITY:

There are three steps in the process of an enzyme working. Look at the picture below which is showing digestion of a starch molecule. Draw a picture of what the substrate and enzyme would look like after digestion is complete (hint: starch breaks down into 2 glucose molecules) and then write out the three steps based on what you see!



Step 1:

Step 2:

Step 3:

#### Comment [m51]:

The steps of digestion are addressed in the pre-lab of the revised lab.

Students will complete a simulation of enzyme activity while they are waiting for the saliva to digest the oats. The simulation will consist of a diagram of starch and three different enzymes. Students will be asked to select the enzyme that will act on the starch and defend their choice. This will reinforce the concept that enzymes are shape-specific. Students will draw the starch molecule and the enzyme separately, bound at the active site, then the starch freed into glucose molecules. [Structure-Behavior-Function models help students understand natural systems \(Vattam, et. al, 2011\).](#)

The structures of starch and glucose will be reinforced many times in the biochemistry unit to help pre-teach the Diffusion Through a Membrane state lab. This particular state lab should help students visualize that small molecules can often diffuse through a selectively permeable cell membrane while larger molecules usually cannot. Students continually struggle with this concept. Completing the enzyme simulation in the revised version of this lab will provide students with an experience they can reference at a later point in the Living Environment curriculum.

### Data Table

	Oats	Saliva	Oats + Saliva
Iodine Test (test for starch)			
Benedict's Test (test for glucose) **needs to be heated**			

#### DATA ANALYSIS:

glucose

1. Which of the test tubes tested positive for ~~sugar~~?

starch

2. Since we did not add sugar to any of the test tubes where did the sugar come from?

3. Why did we need to test the oats and saliva alone as well as together?

4. Based on what you know about enzymes why would salivary amylase NOT digest protein?

5. Why are enzymes so important to the human body?

#### Comment [m52]:

Students will create their own data table.

The term "sugar" could refer to either a monosaccharide such as glucose or polysaccharide such as starch which may confuse the student so the terms "starch" and "glucose" will be used. The first analysis question will therefore be separated into two analysis questions.

This question will be reworded so students must reference the previous question in their response.

This is a good question as it targets the purpose of testing oats and saliva alone to serve as controls.

This question will be placed in the analysis of the revised lab's Part 2 section in which students do an activity that simulates an enzyme acting on a substrate. This change in placement will provide a visual to represent the shape specificity of enzymes.

This is a vague question and will be reworded to focus students' attention on the role on enzymes in the homeostasis of the digestive system. This question will be removed from the data analysis section of the current lab and placed as the analysis of the revised lab conclusion. It will be reworded as such, "Describe one specific example in which an enzyme is not working properly in the human body." This will most likely require students to do additional research and make a connection between the lab and a real-life application.

**CONCLUSION:**

Complete the CEI conclusion based on what you learned about enzymes. Make sure you use the data you recorded in your experiment to support your claim and also explain the importance of enzymes in the human body!



**Comment [m53]:**

The instructions for the conclusion in the current lab do not provide specific direction to students. The write up will be scaffolded to focus students' attention on the purpose of the lab and the data they collected. The task of "describe" in the conclusion will also access a higher level of thinking than simply stating facts.

In addition, the current directions for the conclusion may be difficult for students who have classroom modifications on their IEP that require information to be chunked for them. Enzymes are a difficult concept for some students to grasp and they may feel overwhelmed with the format of the current lab conclusion.

The revised lab conclusion will be formatted as follows:

**CLAIM:** Describe the role of salivary amylase in digestion.

**SUPPORT:** Describe three pieces of evidence from your data table that support the claim you wrote.

**ANALYSIS:** Describe one specific example in which an enzyme is not working properly in the human body. What problems does this cause for the person? (Hint...you may have to look this up!)

Revised Lab #10  
Chemistry of Enzymes Lab

Name \_\_\_\_\_

Date \_\_\_\_\_

Chemistry of Enzymes Lab

**Pre-lab**

Directions

1. Read the text.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found that answer.

Enzymes are a group of chemicals that exist in all living systems. They speed up chemical changes that would take much longer to occur if the enzyme were not present. This is why they are called organic catalysts.

1. What do enzymes do?
2. What is another name for enzymes?

There are many enzymes in the digestive system. People eat different forms of starch which do not change easily or quickly into sugar unless the proper enzyme is present to speed up the reaction. An enzyme which can change starch into glucose is present in your saliva. It is called salivary amylase.

1. What body system contains enzymes?
2. What does starch digest into?
3. What enzyme in the saliva breaks down starch?



## Purpose

The purpose of this lab is to design an experiment to answer the following question:

*How do we know saliva breaks starch down into glucose?*

## Materials

You will only have the following materials available to you:

Water	oats	saliva	iodine	Benedict's solution
Test tubes		beaker	hot plate	safety glasses

**Hypothesis** (use if...then...)

## PART 1: EXPERIMENTAL DESIGN

### Procedure

Develop a procedure to test your hypothesis.

**\*Hint #1: The starch and enzyme together must wait for at least 20 minutes.**

**\*Hint #2: You will need 6 test tubes.**

Teacher Check

Complete PART 2 while you are waiting your 20 minutes. 😊

## Data

Create a data table in the space below to record your results.

## Analysis

1. What substance did the oats test positive for?
2. What evidence in your data table supports your answer to question #1?
3. What substance did the oats and saliva test positive for?
4. What evidence in your data table supports your answer to question #3?
5. Why did you get 2 different answers for question #1 and question #3?
6. Why was it necessary to test the starch and saliva alone before combining them?

**Conclusion** (write sentences!)

**CLAIM:** Describe the role of salivary amylase in digestion.

**SUPPORT:** Describe 3 pieces of evidence from your data table that support the claim you wrote.

**ANALYSIS:** Describe one specific example in which an enzyme is not working properly in the human body. What problems does this cause for person? (Hint...you may have to look this up!)

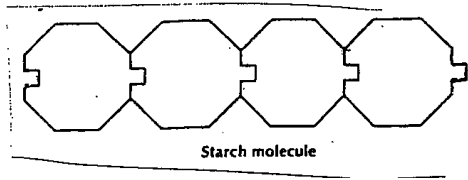
PART 2 is on the next page!

## PART 2: DEVELOPING A MODEL FOR AMYLASE

### Directions

1. Read the text below.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found that answer.

The model below represents a starch molecule.

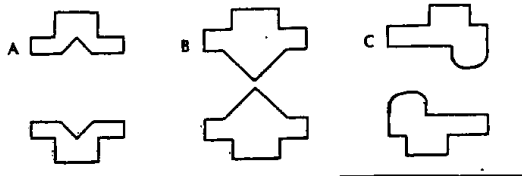


The specific action of an enzyme with a single substrate can be explained using a "Lock and Key" analogy. In this analogy, the lock is the enzyme and key is the substrate. Only the correctly shaped key (substrate) fits into the key hole (active site) of the lock (enzyme).

Keys that are a different shape or are positioned incorrectly do not fit into the lock (enzyme). Only the correctly shaped keys open a particular lock.


1. Does one enzyme work on all substrates?
2. What characteristic of an enzyme is most important for it to work?

The picture below represents three different enzymes. Circle the enzyme that will digest the starch.



1. What letter did you circle?
2. Why did you circle this letter?

Use the information you learned in Part 2 of this lab to complete the following activity that simulates the digestion of starch.

Task	Picture
1. Draw starch	
2. Draw amylase	
3. Draw amylase attached to starch at each active site.	
4. Draw starch after it is digested.	
5. Label each glucose molecule in picture 4.	

The lab will be renamed "Factors Affecting Enzymes Lab" to focus students' attention on the purpose of the lab.

Students will complete a pre-lab reading in which they answer questions based on the text. This activity supports Common Core Learning Standards Shift #4: Text-based answers.

The pre-lab reading will consist of this text and a diagram to support the text.



Students will complete various simulations that help them arrive at these important characteristics of enzymes. This shift to a constructivist learning approach will benefit students in their understanding and retention of concepts.

Name: \_\_\_\_\_  
Living Environment Period # \_\_\_\_\_

Factors Affecting Enzymes Lab

## Enzyme Basics

### What are enzymes?

**Enzymes** are **proteins** which regulate the speed of chemical reactions within the body. They are most commonly referred to as **catalysts**. A catalyst speeds up chemical reactions in living organisms, but they are not consumed in those reactions.

### How do they work?

Enzymes work by binding to a *specific* substrate (or substrates). **Substrates** are the substances that enzymes act on. The physical binding of the enzyme and substrate occurs at the **active site**. The active site has a unique shape that is complementary to the shape of a substrate molecule, similar to the fit of puzzle pieces. This means that enzymes specifically react with only one or a very few similar compounds. The binding of the substrate to the enzyme causes the reactions to take place, which leads to the formation of products. The products are released from the enzyme surface and can be used again for another reaction cycle.

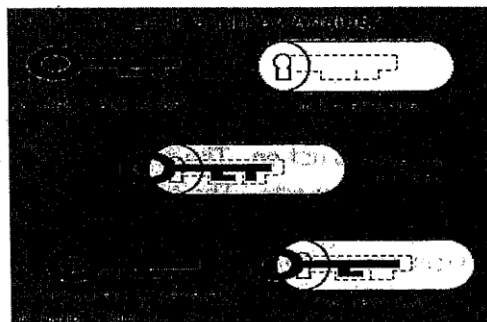
### Here are some important things you should know about enzymes:

- Enzymes are effective in small amounts
- Enzymes are not used up in the reaction that they are working on.
- Enzymes are specific to the reactions they catalyze, that is, each enzyme only works on a specific chemical reaction. (Lock and key)
- Most enzymes end in -ase (example: protease - enzyme that breaks down proteins)

### Things that affect enzymes:

- o Temperature
- o pH
- o Amount of enzyme available
- o Amount of "stuff"/ (substrate) to work on

### Lock and Key Analogy:



The specific action of an enzyme with a substrate can be explained using a **Lock and Key** analogy. The lock is the enzyme and the key is the substrate. Only the **correctly shaped key (substrate)** fits into the **key hole (active site)** of the lock (enzyme).

Smaller keys, larger keys, or keys with incorrectly shaped teeth on keys (incorrectly shaped or sized substrate molecules) do not fit into the lock (enzyme). Only the correctly shaped key opens a particular lock. This is illustrated in graphic on the left.

#### Comment [m55]:

Students will simulate each of these four factors that affect enzyme activity. The current lab consists of simulations for each of these factors except pH. Therefore, students will complete a computer simulation in which pH is manipulated and students observe the effects on reaction time.

Analogies are a successful strategy to use when helping students learn new abstract concepts. This text will be excluded from this particular revised lab but will be placed in a different lab about enzymes (Chemistry of Enzymes Lab).

**Purpose:** A simulated study of enzyme reactions and the factors that effect their rate of reaction.

**Vocabulary:** Define each of the following terms in your own words.

1. Enzyme:

2. Substrate:

3. Active site:

4. Digest/break-down:

5. Synthesis:

**Scenario:**

Product

Enzyme Substrate Complex

People - are acting as the enzymes

Paper - is the substrate

2 pieces of equal sized sheets of paper

A person folding and tearing a sheet of paper

The # of sheets torn into 2 equal pieces

toothpicks

**Comment [m56]:**

The purpose of the lab will be provided as a scenario describing students acting out simulations of the various factors that affect enzyme activity. The scenario will describe the roles students will participate in.

Students will define these vocabulary words in the pre-lab reading. This supports Common Core Learning Standards Shift #6: Academic vocabulary.

The scenario will be described in more detail in the revised lab.

Toothpicks will be used to represent the substrate.



Procedure:

The Effect of Substrate Concentration on Reaction Time

Question #1: How does substrate concentration affect enzyme activity?

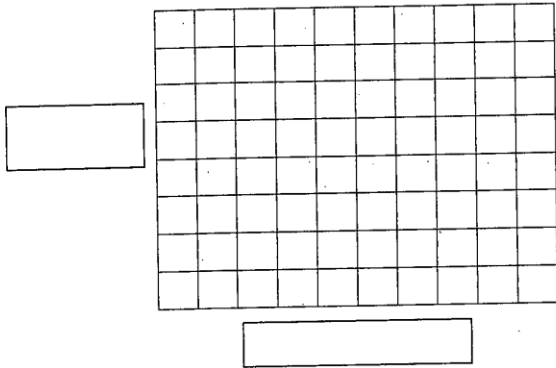
- a. One enzyme will digest 5 pieces of substrate. Record the reaction time in the chart below.
- b. Repeat the above step using 10, 15 and 20 pieces of substrate.

DATA TABLE

Substrate Concentration	Enzyme Activity (Reaction Time)
5	
10	
15	
20	

- c. Graph the data in the space below. Don't forget to label the axes!

The Effect of Substrate Concentration on Enzyme Activity



- d. How does the amount of substrate present affect the rate of reaction?

\_\_\_\_\_

Comment [m57]:

The revised lab will be organized into four parts to represent four different factors that affect enzyme activity. The title for each part will be reworded as a statement rather than a question to demonstrate that there is a relationship between two factors.

Students will write a hypothesis determining the relationship that exists between the independent variable and the dependent variable. This will allow them to acknowledge their current understanding and reconcile it with the data they collect. Presenting a new conception or contradiction to students about a concept increases their level of understanding (Franke & Bogner, 2011).

The directions for steps a and b will be rewritten more clearly to provide scaffolding for students.

The data table will be provided and labeled for students to serve as a model for the remainder of the lab when they need to create their own data tables.

Being consistent with the language of the format of labs will reinforce to students the relationship between the independent variable and dependent variable.

Students will be reminded to label the axes with the independent variable and the dependent variable.

This question will be reworded to help students interpret the graph they created.

Students will answer additional analysis questions from the graph to make an immediate connection between the data and the concept of enzymes.

Students will be asked to think about the reason for the pattern they observed after each simulation.

The Effect of Enzyme Concentration on Reaction Rate

Question #2: How does enzyme concentration affect reaction rate?

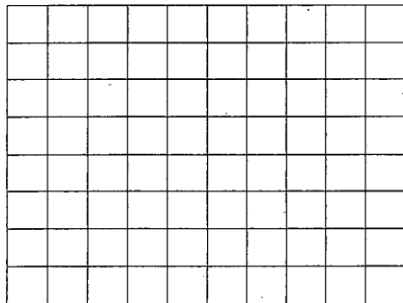
- a. One enzyme will digest 30 pieces of substrate. Record the reaction time in the chart below. Don't forget to label the column!
- b. Repeat the above step using 2 enzymes, 3 enzymes and 4 enzymes.

DATA TABLE



- c. Create a graph based on your table. Don't forget to label the title and axes.

(title)



d. How does the enzyme concentration affect the rate of reaction?

Comment [JE58]:

Question 2 will be labeled Part 2 and rewritten as "The Effect of Enzyme Concentration on Reaction Rate." To focus students' attention on the variable being manipulated in this portion of the lab.

Students will develop a hypothesis for the relationship between enzyme concentration and reaction rate.

Students will assign roles amongst each other to hold each other accountable for participation in the simulations.

Students will label the data table independently.

The directions will be scaffolded to clarify the procedure.

Students will continue to label the title independently. Students can reference the graph from Part 1 if they need help developing a title. Having a model will increase student autonomy during the lab.

Students will describe the relationship between enzyme concentration and reaction time in a statement. This requires interpreting a graph, an activity which support Common Core Learning Standards Shift #4: Text-based answers from a non-print source.

Additional questions will be inserted into the revised lab which require students to analyze data immediately that will be used to write the support section of the conclusion. Students will thus scaffold their lab conclusion.

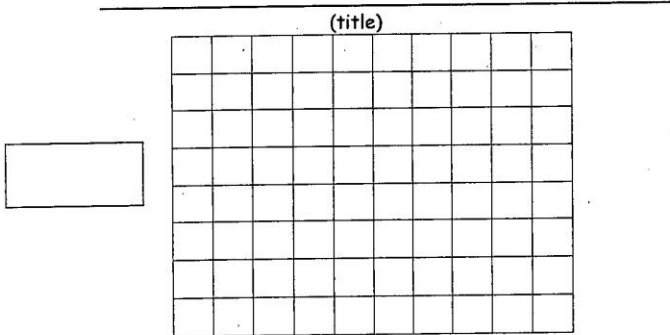
~~e. What would cause the rate of reaction to level off no matter how much enzyme was added?~~

**Question #3: How does temperature affect enzyme activity?**

- a. One enzyme will digest substrates for 1 minute at room temperature. Record the number of substrates digested in the data table below.
- b. One enzyme will digest substrates for 1 minute after soaking hands in cold water. Record the number of substrates digested in the data table below.

	Room Temperature	Cold
# of substrates digested		

c. Create a bar graph of the data collected. Don't forget to include a title and label the axes.



~~d. How does decreasing the temperature affect the rate of reactions for enzymes?~~

**Comment [m59]:**

This question will be reworded to focus students' attention on the factors which affect reaction rate. Previous experience with this lab has demonstrated that students do not make the connection between enzyme concentration and substrate concentration because each of these two factors part of the lab focuses on the relationship between each factor and reaction time.

Question 3 will be reworded as a statement, "The Effect of Temperature on Enzyme Activity."

Students will again assign the role for Enzyme. This is often a good opportunity to review controls in an experiment to ensure accurate data collection.

The procedure for part 3 will be modified:  
-students will choose 1 enzyme to "digest" toothpicks  
-timekeeper will time how long it takes the enzyme to "digest" 20 toothpicks  
-the student acting as enzyme will place his/her hands out the window for one minute rather than placing his/her hands in the water (water would change two variables-temperature and moisture for enzyme)  
-student enzyme will be timed during digestion of 20 toothpicks

Students will continue to complete the graph independently.

Students will write a statement describing the relationship between temperature and enzyme activity.

e. What would happen to reaction time if you put your hands in boiling water before you "digested" the substrate?

---

**CEI**

**Claim:** List 3 factors that affect the rate of reaction of enzymes.

**Evidence:** List 3 pieces of evidence from the lab that describe how these factors affect the rate of reaction of enzymes.

**Interpretation:** How does this apply to the real world?

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**Comment [m60]:**

This question will be included in the revised lab because it requires students to think critically. They observed how a decrease in temperature affected reaction time so they must hypothesize how reaction time would change if the temperature were increased.

A section for pH will be inserted at this point in the revised lab. Students will complete a computer simulation to represent how change in pH affects enzyme activity.

Students can use the titles for the four parts of the lab to write their claim.

The support portion will already be scaffolded for students throughout the lab when they complete the analysis questions.

The analysis portion of the lab will require students to research a disease or disorder in which an enzyme is not functioning properly in the body. They will identify and describe one negative consequence of not having this particular enzyme function correctly. Giving students tasks relating to the real world increases learning of science concepts (Lefkos, Psillos, & Hatzikraniotis, 2011).

Revised Lab #11  
Factors Affecting Enzymes Lab

Factors Affecting Enzymes Lab

**Pre-lab**

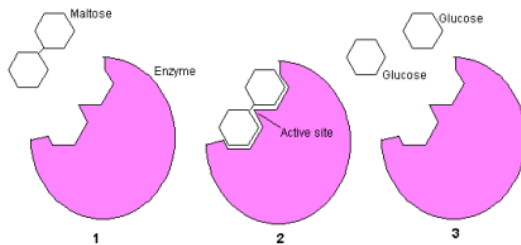
Directions

1. Read the text.
2. Answer the questions that follow each section of text.
3. Highlight or underline where in the text you found that answer.

Enzymes are proteins that regulate the speed of chemical reaction for various systems in your body. They are most commonly referred to as catalysts. A catalyst speeds up chemical reactions in living organisms but they do not run out.

1. What class of biomolecules are enzymes?
2. What do enzymes do?
3. Can enzymes be reused?

Enzymes work by binding to a specific substrate. Substrates are the substances that enzymes act on. The physical binding of the enzyme and the substrate occur at the active site. The active site has a unique shape that is complementary to the shape of a substrate molecule similar to the fit of puzzle pieces. This means that enzymes specifically react with only one or very few similar compounds. The binding of the substrate to the enzyme causes the reactions to take place, which leads to the formation of products. The products are released from the enzyme surface and the enzymes can be used again for another reaction cycle.



1. What is a substrate?
2. What is the active site?
3. Why can enzymes only react with some compounds?

## Scenario

You and your classmates will take turns acting as enzymes to show how different factors affect the rate of "digesting" toothpicks.

We will use the following roles in each group:

1. enzyme
2. data recorder
3. time keeper

### PART 1: THE EFFECT OF SUBSTRATE CONCENTRATION ON REACTION TIME

## Hypothesis

If I increase the number of substrates, the rate of digestion will increase/decrease because

---

## Directions

1. Complete the following table to assign roles for this simulation.

Role	Person Taking this Role
Enzyme	
Data Recorder	
Timekeeper	

2. The enzyme will "digest" 5 toothpicks by breaking them in half, one at a time.

3. Record the reaction time in the table below.

4. Repeat Step 2 with 10 toothpicks, 15 toothpicks, and 20 toothpicks.

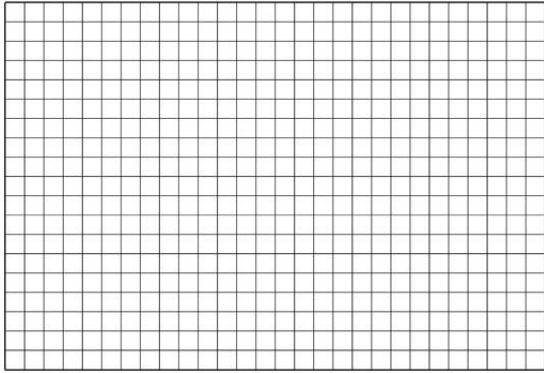
Number of Toothpicks	Reaction Time (seconds)
5	
10	
15	
20	

5. Graph the data on the next page. Label the axes!

\*Hint #1: Which column of the data table goes on the x-axis?

\*\* Hint #2: Which column of the data table goes on the y-axis?

## The Effect of Substrate Concentration on Reaction Time of Enzymes



### Analysis

1. What happened to the reaction time as the number of substrates increased?
2. Provide 2 pieces of evidence from the data table that support your answer to question #1.
  - 
  -
3. Why do you think pattern occurred?

Teacher Check

## PART 2: THE EFFECT OF ENZYME CONCENTRATION ON REACTION TIME

### Hypothesis

If I increase the number of enzymes, the rate of digestion will increase/decrease because

---

### Directions

1. Complete the following table to assign roles for this simulation.

Role	Person Taking this Role
Enzyme #1	
Enzyme #2	
Enzyme #3	
Data Recorder	
Timekeeper	

2. Enzyme #1 will digest 30 toothpicks by breaking each one in half, one at a time.

3. Record the time it takes for Enzyme #1 to digest 30 toothpicks in the data table below. (You are purposely not given the title of the data table columns...think about it!)

4. Repeat Steps #2 and #3 using 2 enzymes and then 3 enzymes.

DATA TABLE

(Title!)	(Title!)

5. Graph the data on the next page.

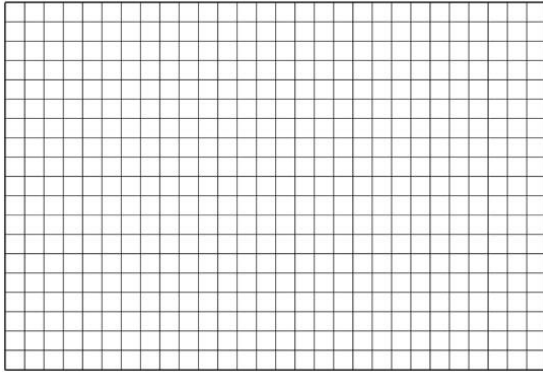
\*Hint #1: Which column in your data table is the **independent variable**?

\*\*Hint #2: Which column in your data table is the **dependent variable**?



---

(title)



**Analysis**

1. What happened to the reaction time as the number of enzymes increased?

2. Provide 2 pieces of evidence from the data table that support your answer to question #1.

- 
- 

3. Why do you think pattern occurred?

Teacher Check

### PART 3: THE EFFECT OF TEMPERATURE ON REACTION TIME

#### Hypothesis

If the temperature in an enzyme's environment is changed, then the enzyme will/will not work correctly because \_\_\_\_\_

#### Directions

1. Complete the following table to assign roles for this simulation.

Role	Person Taking this Role
Enzyme	
Timekeeper	
Data Recorder	

2. One enzyme will digest 20 toothpicks.

3. Record the time it takes to digest 20 toothpicks for room temperature in the data table.

4. The same enzyme will then put his/her hands outside the window for one minute.

5. After one minute, the enzyme will digest 20 toothpicks.

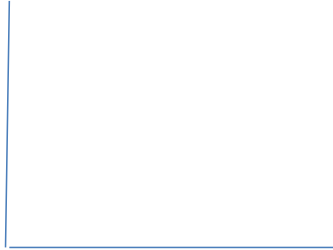
6. Record the time it takes for the enzyme to digest 20 toothpicks in the cold using the data table below.

DATA TABLE

	Reaction Time
Room Temperature	
Cold Temperature	

7. Create a **bar graph** of the data table for Part 3: Temperature. Label the axes!

The Effect of Temperature on Reaction Time



**Analysis**

1. What is the relationship between temperature and enzyme activity?
2. What do you think would happen to the reaction time if an enzyme functioned in a really hot temperature instead of a really cold temperature?
3. Why did you create a bar graph for Part 3 and not a line graph?

Teacher Check

#### PART 4: THE EFFECT OF pH ON ENZYME ACTIVITY

##### Hypothesis

If the pH in an enzyme's environment is changed, then the enzyme will/will not work correctly.

##### Directions

1. Go to the following website:

<http://www.lpscience.fatcow.com/jwanamaker/animations/Enzyme%20activity.html>

2. Answer the following questions by completing the animation.

- What determines how an enzyme works?
- What affect does pH have on the shape of an enzyme?
- Why is denaturing a problem for enzymes?

3. Circle the graph below that best represents the function of enzymes at various pH levels.

Teacher Check

## Conclusion

**CLAIM:** List 4 factors that affect the rate of reaction of enzymes. Write in a sentence!

**SUPPORT:** Provide 3 pieces of quantitative evidence from your data tables in Parts 1, 2, and 3 to support your claim. Provide 1 piece of qualitative evidence from Part 4 to support your claim. Write in sentences!

Part 1 Evidence:

Part 2 Evidence:

Part 3 Evidence:

Part 4 Evidence:

## ANALYSIS:

1. Research one disease or disorder in which a person's enzymes are not functioning correctly.

Name of disease/disorder \_\_\_\_\_

Enzyme not functioning correctly \_\_\_\_\_

2. What would be a negative consequence of not having this enzymes function correctly in the human body? Be specific!

Comment [m61]:

The purpose as currently written can be accomplished without completing the lab. Therefore, the revised purpose will be to observe and compare/contrast structures within plant and animal cells. Comparing and contrasting accesses higher levels of understanding according to Bloom's taxonomy.

The Living Environment teachers at Greece Athena High School place the unit on cells during second quarter. Students have previous experience using the microscope from the Microscope Lab completed during first quarter. The Plant and Animal Cell Lab will require students to access prior knowledge and technique in order to successfully complete the lab. Because it is review, this part of the current Plant and Animal Cell Lab will be eliminated in the revised lab.

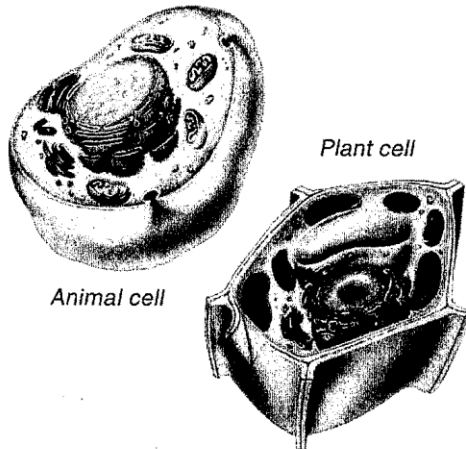
Name \_\_\_\_\_

Lab # \_\_\_\_\_

## Plant and Animal Cell Lab

### PURPOSE:

To describe ~~and explain the differences in structure and function of plant and animal cells.~~



### BACKGROUND:

One of the most important tools invented by scientists is the microscope. We will be using a compound light microscope in class. ~~Make sure you understand how to effectively use a microscope.~~

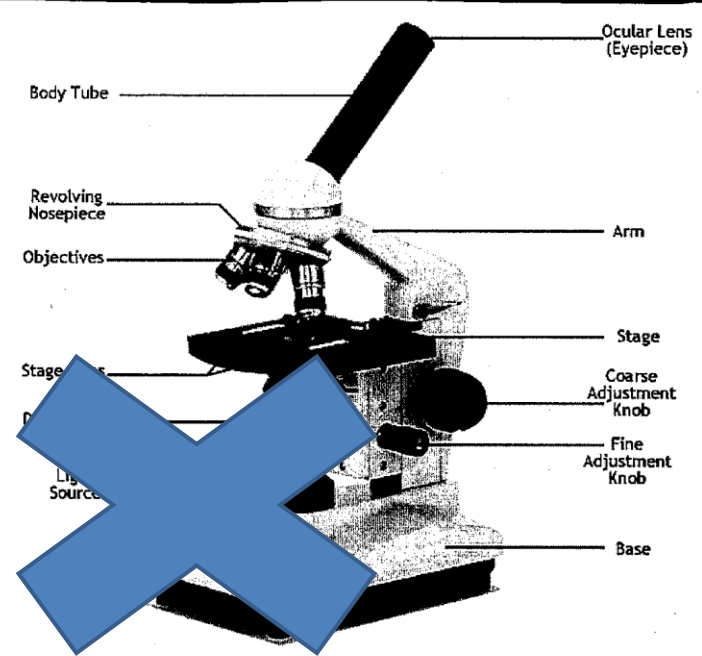
### PROCEDURE PART I: REVIEW OF THE MICROSCOPE

Below is a diagram of a microscope similar to the ones we will be using in class. You also have a microscope at your table in front of you. Please carefully examine your microscope and make sure you can identify and describe the function of all the parts listed. Your teacher will be traveling around and asking you questions about the parts and will check off when you have proved you are able to do this successfully!

**Comment [m62]:**

Students will complete a warm-up activity prior to the lab to review this information.

Successful completion of microscope check:



Ocular lens → the lens you look through, magnifies the specimen

Base → supports the microscope

Revolving Nosepiece → holds objective lenses and lets you switch objectives

Objectives → lenses that magnifies the specimens - low (40), medium (100), and high (400)

Arm → supports parts of the microscope, used to carry the microscope

Fine adjustment knob → used to focus when using the high power objective

Stage → where the slide is placed

Diaphragm → regulates the amount of light reaching the objective lens **\*\*must know\*\***

Coarse adjustment knob → used to focus when using the low power objective **ONLY**

Light source → provides light

Stage clips → hold slide in place on the stage

**Comment [m63]:**

This part will also be eliminated in the revised Plant and Animal Cell Lab because students did this activity in the Microscope Lab.

**MICROSCOPE MAGNIFICATION**

There are three different lenses on your microscope. You must calculate the total magnification. To do this multiply the number on the ocular lens times the number on the objective lens. (\*\*HINT the number on the ocular is 10x so the number you use is \_\_\_\_\_ and the numbers on the objective are either 4, 10, or 40\*\*)

Calculate the total magnification for your compound microscope for low, medium and high power.

Low power \_\_\_\_\_ x \_\_\_\_\_ = \_\_\_\_\_  
Medium power \_\_\_\_\_ x \_\_\_\_\_ = \_\_\_\_\_  
High power \_\_\_\_\_ x \_\_\_\_\_ = \_\_\_\_\_

**STEPS TO USING A MICROSCOPE**

You are required to be able to get a specimen under high power. Below is a list of things that must be done. In the blanks use the appropriate step listed - you will need to use many steps more than once!!!

- |                         |                     |                    |                    |                |                |                |
|-------------------------|---------------------|--------------------|--------------------|----------------|----------------|----------------|
| → fine adjustment       | → coarse adjustment | → rotate nosepiece | → rotate objective | → rotate stage | → rotate stage | → rotate stage |
| → Use course adjustment | → Center slide      |                    |                    |                |                |                |

**Step 1:** Make a wet mount

**Step 2:** Place slide on the microscope stage

**Step 3:**

Low Power	_____
	_____
	_____

**Step 4:**

Medium Power	_____
	_____
	_____

**Step 5:**

High Power	_____
	_____
	_____



### HOW TO MAKE A WET MOUNT

A wet mount is a temporary slide you make. It is tricky to avoid air bubbles in a wet mount. Draw pictures below including a minimum of 3 steps on how to make a wet mount without bubbles!!!



NOW...Make a wet mount without any bubbles. Hair or pocket lint or something you can easily get onto a slide. You need to get the specimen in focus under high power. REMEMBER TO FOLLOW THE STEPS FROM ABOVE!!! Once you get your specimen under high power please call the teacher over to be sure you are looking at the correct thing and they will check off that you have completed this part...THEN complete the chart below:



For the chart below you need to compare the low and high power:

	Low power	High power
Does the object look large or small?		
Is there a lot of detail or a little detail?		
How much of the specimen can you see?		
How much light do you need to see the specimen?		
How close is the lens and slide?		

#### Comment [m64]:

Students learned how to prepare a wet mount during the Microscope Lab. An animation will be available on the SMARTBoard for students who need a reminder of how to prepare a wet mount slide.

This part of the lab will also be eliminated because it was completed during the Microscope Lab.

## PROCEDURE PART II: OBSERVING PLANT & ANIMAL CELLS

**QUESTION:** Can you tell the difference between a plant and an animal cell by looking at it under the microscope?

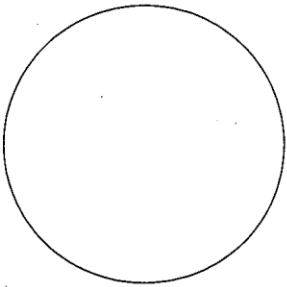
**HYPOTHESIS:**

### PROCEDURE:

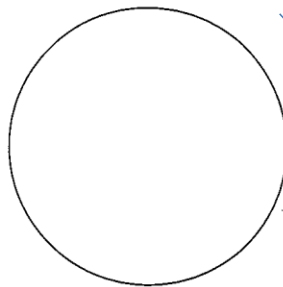
You will be making a wet mount of 3 different specimens - Onion Cells, Elodea Cells, and Cheek Cells. After getting the cells in focus under high power draw them in the spaces provided and label 3 organelles that you can see in EACH of your drawings.

### DATA:

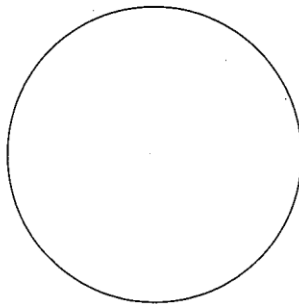
Onion Cell



Elodea Cell



Cheek Cell



### Comment [m65]:

Students will complete a reading about the difference between plant and animal cells. They will answer questions that pertain to the structure and function of various organelles. This activity supports Common Core Learning Standards Shift #4: Text-based answers and Common Core Learning Standards Shift #6: Academic Vocabulary. In addition, it focuses students' attention to how and why organelles look the way they do.

The question as it is currently written allows for a yes or a no response. Students are not required to think about how they would distinguish one type of cell from the other. The revised lab will exclude this question.

The hypothesis in the revised lab will be reworded as such: If the cell I observe is a plant cell, then I will see the following organelles:

This hypothesis guides the student's focus for what structures to observe with the following slides.

Students will be given a purpose of the lab: to identify each unknown specimen. They will be required to develop a procedure that would allow them to accomplish the purpose of this lab. *Students who completed inquiry labs rated a higher confidence in science than when they completed expository lab (Corsi, 2012). Conducting authentic laboratory work increased student learning of science concepts (Thomas, 2012).*

Students will obtain a teacher check after developing their procedure. Doing so makes the students more accountable for their work and decreased frustration later in the lab because they have received proper guidance. *Difficulty of the lab and its efficiency had the greatest impact on students' attitudes about that particular lab (Baseya & Francis, 2011).*

Students will be given a list of three different species the unknown specimen could be followed by a brief description.

Doing so will eliminate any cultural bias that may be present in the lab. The three unknown specimens are chicken, Elodea, and onions. Some cultures may not be familiar with all three. By providing a brief description, all students will have the same pertinent knowledge to complete the lab successfully.

Students will be required to develop their own method to collect data based on the procedure they developed.

**DATA ANALYSIS:**

1. What are 3 ways that you can tell the difference between a plant and animal cell by looking at them under the microscope?

- 
- 
- 



2. The onion cell is considered a plant cell but we were unable to see chloroplasts. Why is this true for the part of the onion we were looking at?

3. Organelle means "little organ" which makes sense because they have very important jobs for the cell just like human organs. In the chart below describe the life function that the organelle has as well as what human organ performs a similar job.

Organelle:	Performs this Life Function:	Like this human organ:
Nucleus		
Cell Membrane		
Chloroplast		
Mitochondria		

4. Choose 2 or the organelles from above and describe how they work together in the cell.

**Comment [m66]:**

Students can answer this question without completing the lab. To make this data analysis question more relevant to the lab, students will analyze each unknown specimen as they complete the lab. They will be asked to identify the following information:  
1. whether it is a plant cell or an animal cell  
2. the organelles they observed which helped them identify the specimen as an animal or plant

This is a good high level thinking question. However, not all students will have the same background knowledge about onions. To address this potential cultural bias, students will be provided with a description of where onions are located before they are harvested.

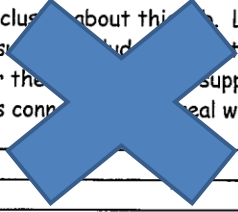
The claim that "Organelle means 'little organ' which makes sense..." is the opinion of the lab's author and not the student's. Reading a statement such as this may encourage any negative perceptions students may already have about science.

Students will not have completed the unit on human body systems when they do the Plant and Animal Cell Lab. They will have already learned about the life functions performed by various organelles. Therefore, this chart will be excluded in the revised lab.

The purpose of this lab is to identify an unknown cell as a plant cell or an animal cell based on observations under a microscope. While it is important that students make the connection between the function of organelles, they will focus on this at a later point in the Cells unit. Therefore, this question will be eliminated from the revised lab.

**CONCLUSION:**

Use CEI format to write a conclusion about this lab. Look back at the purpose of this lab to help formulate a claim. Be sure to include evidence about what you observed (DATA) when looking at the cells under the microscope to support your claim. For your interpretation explain how this connects to the real world or investigations in the future.



Lined writing area for the student's conclusion.

**Comment [m67]:**

Students completed analyses of the specimens throughout the lab so there will be no summative conclusion. However, students will complete an extension of the lab. They will view an animation titled, "Inner Life of a Cell" at the conclusion of the lab. This animation was developed by Harvard professors who teach cell biology and is meant to be an engaging way for students to see the various organelles in the cell. As students view the animation, they will record the organelles they observe. At the end of the animation, students will determine if the cell was a plant cell or an animal cell. They will then support their choice with observations they made from the animation. The analysis activity supports Common Core Learning Standards Shift #4: Text-based answers from a non-print source and is an extension of the lab. Students will be able to visualize the complexity of the cell and gain a deeper appreciation for all of its interacting parts.

Revised Lab #12  
Plant and Animal Cell Lab

Plant and Animal Cell Lab

**Pre-lab**

Directions

1. Read the following text.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found each answer.

The main difference between an animal cell and a plant cell is that, plant cells have a cell wall, which the animal cell lacks. The cell wall which is made up of cellulose gives the plant cell rigidity resulting in a fixed, rectangular shape.

Why do plant cells look rectangular?

Animal cells lack the rigidity hence, they tend to have a round and irregular shape. Animal cells tend to vary greatly in appearance.

Do all animal cells look the same?

The cell wall allows high pressure to build inside of the plant cell without bursting. Due to this, the plant cell is able to accept large amounts of liquid through osmosis without bursting. Animal cells, which only have a thin membrane restricting access to the cell, tend to burst if they absorb too much extra water.

Why can plant cells hold a lot of water but animal cells can't?

Chloroplasts, structures within a green plant cell, are oval or disk-shaped organelles. A function of these organelles is to absorb light energy which is converted to chemical energy during the process of photosynthesis.

1. What do chloroplasts look like?
2. What process occurs in the chloroplasts?

### Purpose

The purpose of this lab is to determine the identity of the unknown species using a compound microscope.

### Background

The unknown species can be any of the following:

1. Elodea- a plant that lives in the water near the surface
2. Onion- a plant that grows underground
3. Chicken- animal that lives on a farm

Elodea



Onion



Chicken



### Hypothesis

If the species is a plant, I will observe the following organelles: \_\_\_\_\_

\_\_\_\_\_

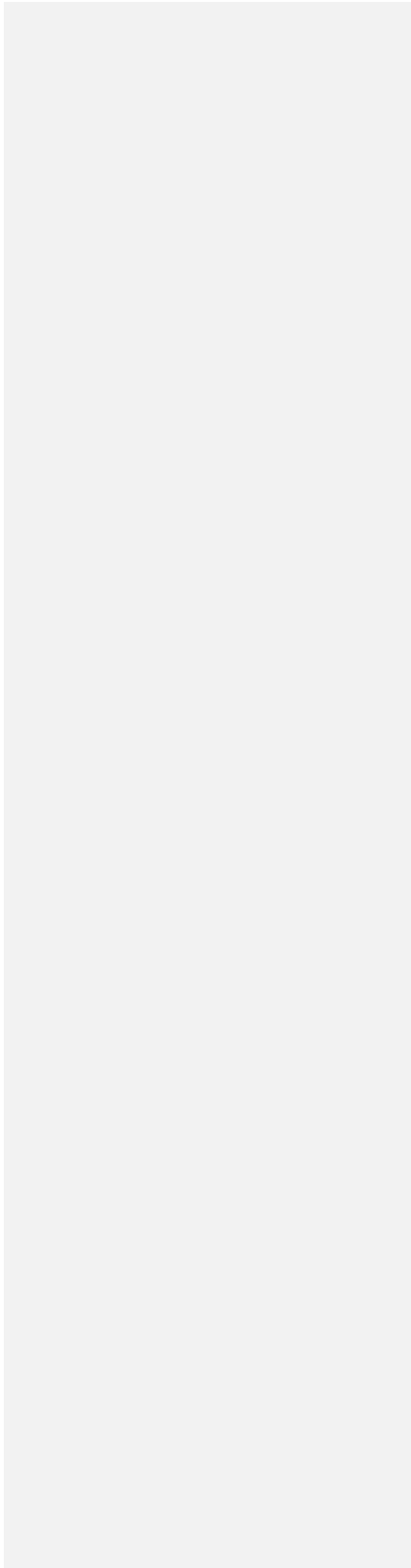
**Procedure**

Develop a procedure to determine the identity of Species A, Species B, and Species C. Write your procedure in the space below.

Teacher Check

**Data**

Use the space below to record data.



## Data Analysis

### Species A

1. Is Species A a plant or an animal?
2. What organelles did you observe/not observe that helped you arrive at your conclusion?
3. Is Species A the Elodea, onion, or chicken?

### Species B

1. Is Species B a plant or an animal?
2. What organelles did you observe/not observe that helped you arrive at your conclusion?
3. Is Species B the Elodea, onion, or chicken?

### Species C

1. Is Species C a plant or an animal?
2. What organelles did you observe/not observe that helped you arrive at your conclusion?
3. Is Species C the Elodea, onion, or chicken?



### **Analysis Questions**

1. What makes a plant cell different from an animal cell?
  
2. Even though the Elodea and onion are both plants, why don't their cells look alike?
  
3. Watch the animation titled, "Inner Life of a Cell."
  - List the organelles you observe.
  
  - Is the cell in the animation a plant cell or animal cell?
  
  - Describe why you identified the cell as a plant cell or animal cell.
  
  - Why do you think you saw more organelles in the animation than you did underneath the microscope?

## Original Lab #13

### How do Abiotic Factors affect Seeds? Lab

#### *How do ABIOTIC Factors affect Seeds?*

A seed certainly looks dead. It does not seem to move, to grow, nor do anything. In fact, even with tests for the metabolic processes we associate with life (respiration, etc.) the rate of these processes is so slow that it is difficult to determine whether there really was anything alive in a seed.

Indeed if a seed is not allowed to germinate (sprout) in some certain length of time, the embryo inside will die. Assuming the seed is still viable; the embryo inside the seed coat needs something to get its metabolism activated to start the embryo growing. The process of getting a seed to germinate can be simple or complicated.

What do seeds need in order to germinate?

- These are considered ABIOTIC factors because they are NONLIVING.
- The seeds themselves would be considered BIOTIC factors because they are \_\_\_\_\_.

Sometimes chemicals can enter into the ground accidentally and are added to the soil. These chemicals (often times called contaminants) may have a positive or negative effect on seed germination. List some contaminants below and tell whether they will have a positive or negative effect on seeds.

#### Comment [m68]:

The title of the lab will be changed to "The Effect of Contaminants on Radish Seed Growth" to align with the specific purpose of the lab. The term "contaminant" will be defined for students at the beginning of the lab.

This text is informal and reflects the opinion of the original author. The text will be replaced with more factual information and chunked. Chunked text will help students focus their attention to a specific amount of information at one time and will support students who require chunked text in their IEPs.

Questions pertaining to each section of text will immediately follow the text. Students will answer the questions based on the text and highlight or underline where in the text they found that answer. This activity support Common Core Learning Standards Shift #4: Text-based answers.

This part of the current lab will be eliminated because students will most likely not have a lot of background knowledge about environmental issues. Students will complete the lab with various contaminants and determine the effect they have on germination based on the data they collect.

**Purpose:** To determine how different contaminants affect the germination of radish seeds.

**Hypothesis:** (If...then...because statement) Create your own hypothesis in this space provided

Important Vocabulary that you will need for this lab:

Part of the lab represented by this vocabulary word

Part of experiment	Definition	How will you remember this?
Control		
Independent Variable		
Dependent Variable		
Constants		

**Comment [m69]:**

Students will be given the purpose of the lab and a list of materials and contaminants that will be available to them during the lab.

Students will develop a hypothesis indicating whether the addition of contaminants to seeds will increase or decrease their germination.

This vocabulary is essential to understanding the scientific method. This chart will be revised to reflect the lab. Students will be required to define each term and identify the part of the lab represented by each term. The latter column will guide students as they design their procedure.

Including this chart in the revised lab accommodates Common Core Learning Standards: Shift #6: Academic vocabulary.

**Procedure:**

1. You will need 5 - 10 radish seeds.
2. Obtain your contaminant which is \_\_\_\_\_. In this experiment the contaminant is considered the \_\_\_\_\_ variable.
3. One group will use water instead of a contaminant. This is considered the \_\_\_\_\_.
4. Place your radish seeds in a paper bag. Fold the paper towel in half and then half again. Make sure your seeds do not fall out.
5. Put your paper towel containing the seeds in the plastic baggie.
6. Add drops of your contaminant to the paper towel is wet but NOT SOAKED! There should not be excess water in the baggie.
7. Put your name and contaminant on the baggie and place it in the window for a week.
8. After a week, count the # of seeds that have germinated and measure the length of the root in mm. Write your data in the chart below. This data that you collected is called the \_\_\_\_\_ variable.

Data:

Your Contaminant	Length of root 1 (in mm)	Length of root 2 (in mm)	Length of root 3 (in mm)	Length of root 4 (in mm)	Length of root 5 (in mm)	Average length of roots (in mm)

**Comment [m70]:**

The lab as it is currently written is an expository lab. It will be revised as a guided inquiry lab. When students design an experiment, they can be graded at different levels of depth (Lefkos, Psillos, & Hatzikraniotis, 2011). Students who completed inquiry labs rated a higher confidence in science than when they completed expository labs (Corsi, 2012).

Students will be given a list of available materials and contaminants to use during the development of their procedure.

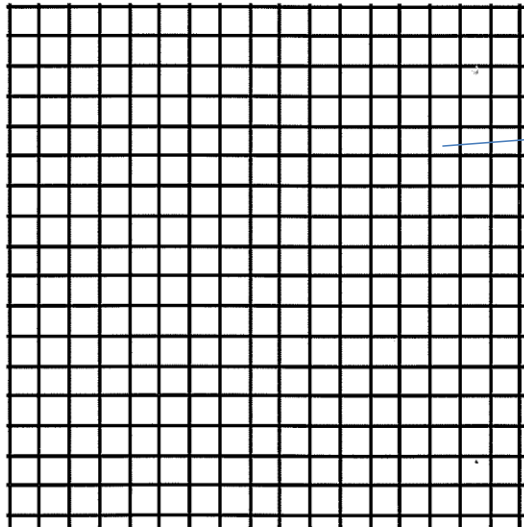
The frequent placement of teacher checks throughout the lab will help students be accountable for their work throughout the process and ensure they are meeting the objective of the lab.

Students will create their own data tables based on the procedure they develop.

Class data: Obtain the results from your classmate and record them in the chart below.

Contaminant	Number of seeds	Average length of the roots (in mm)
water		
Bleach		
Acid		
Fertilizer		
Antifreeze		
Salt		

Graph your results: Make a bar graph of the different contaminants and their average root length.



**Comment [m71]:**

Students will not organize class data in a table such as this because groups will have used different procedures. However, the analysis of their data will include students providing two methods to use that verify their data.

Students will reference class notes about different types of graphs and when to use them based on the data they collect. By not telling the students which graph is appropriate, they must think about the data they collect and understand it. This will also make students more accountable for the class notes they complete.

**Data Analysis:**

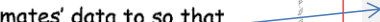
1. Which contaminants had the greatest effect on seed germination and root growth? EXPLAIN your answer.



2. How could the information you developed in this experiment be useful to a local farmer?



3. Using the information you obtained from this lab, describe the optimum (best) conditions for plant germination and growth. Use your classmates' data to so that you include at least 3 different factors.



4. After completing this lab, what have you learned about how humans can affect the environment?



**Comment [m72]:**

Question #1 as it is currently written is ambiguous; it could refer to the greatest positive or negative effect on seed germination. The question will then be reworded more specifically-What contaminant had the greatest positive growth on germination? What contaminant had the greatest negative growth on germination?

The following questions will request students to provide data from their data tables to support their answers.

This question asks students to think about a real-life application they may not have experience with. Rather than answer this question, students will be asked to identify someone who may benefit from knowing what the students learned in this lab. Because the revised question is more open-ended, students can answer it based on the experiences they have had. Doing so also results in less cultural bias.

This question will be eliminated because students did not complete the class set of data.

Although it won't be included in the revision of this lab, students could do an extension of this lab by researching the effect each contaminant has on the environment.



Revised Lab #13

The Effect of Contaminants on Radish Seed Growth Lab

The Effect of Contaminants on Radish Seed Growth

Pre-lab

1. Read the following paragraph from the website "Biology of Plants" and answer the questions that follow.
2. Underline or highlight where in the text you found that answer.

Plants come from seeds. Each seed contains a tiny plant waiting for the right conditions to germinate, or start to grow.

What does germinate mean?

Seeds wait to germinate until three needs are met: water, correct temperature (warmth), and a good location (such as in soil). During its early stages of growth, the seedling relies upon the food supplies stored with it in the seed until it is large enough for its own leaves to begin making food through photosynthesis. The seedling's roots push down into the soil to anchor the new plant and to absorb water and minerals from the soil. And its stem with new leaves pushes up toward the light.

1. What 3 needs must be met in order for seeds to germinate?

- 
- 
- 

2. What 2 materials does the plant absorb from the soil?

- 
- 

Teacher Check



Purpose

You will design and carry out an experiment to determine how different contaminants in the water affect the germination of radish seeds.

You will have the following materials and liquids available to you. ☺

Materials

Radish seeds  
Ziploc bags  
Paper towels

Liquids

Water  
Salt water  
Lemon juice  
Fertilizer  
Bleach

Hypothesis

---

---

Procedure

Fill in the chart below to help you get started with the procedure.

Vocabulary term	Definition	Part of the experiment represented by this vocabulary word
Control		
Independent variable		
Dependent variable		
Constants (choose 3!)		

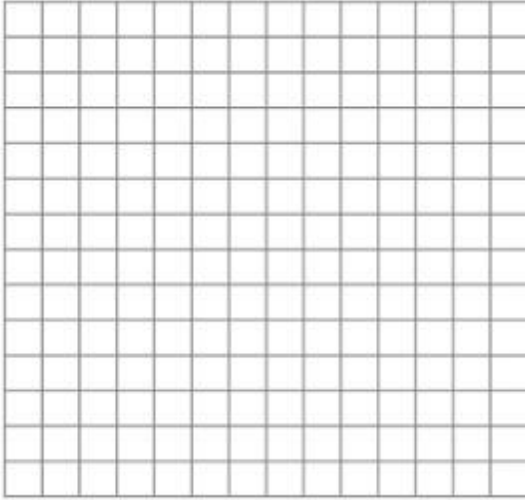
Teacher Check

You are now ready to begin writing your procedure! Use the space below. 😊

Teacher Check

Data

Graph



Analysis

1. What contaminant had the greatest **positive** effect on the growth and germination of the radish seed?
2. What data (numbers) from your data table supports your answer to question 1?
3. What contaminant had the greatest **negative** effect on the growth and germination of the radish seed?
4. What data (numbers) from your data table supports your answer to question 3?
5. List 2 ways you can verify if your results are accurate.
  - 1.
  - 2.

Teacher Check

Conclusion

**Claim:** Circle the statement below that is true.

Contaminants affect radish seed germination.

Contaminants do not affect radish seed germination.

**Support:** What data (numbers) from your data table supports the statement you circled?  
Answer in complete sentences.

**Analysis:** Who could benefit from knowing what you learned in this experiment? Why? Answer in complete sentences.

Comment [m74]:

The title will be changed to "Homeostasis in Blood Lab" to reinforce the important role blood has in maintenance of homeostasis. It will also expose students to academic vocabulary thus supporting Common Core Learning Standards Shift #6: Academic Vocabulary.

This is the essential question and will be the focus of the lab.

The background information will include text-based questions to support Common Core Learning Standards Shift #4: Text-based answers and Shift #6: Academic Vocabulary. The terms "erythrocytes" and "leukocytes" will be eliminated in the revised lab because they are not required for the Living Environment curriculum. They could, however, remain in the lab to support high achieving students as an extension of the content.

This background information will also prepare students for the graphic organizer they will create in Part 2 of the revised lab.

The three purposes as they are currently written will be eliminated because they are addressed in the essential question.

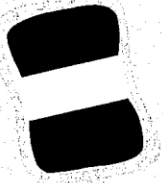
Students will not complete the lab as stations. Rather, the lab will be divided into four parts so students can work at their own pace. This will accommodate learners of different abilities.

Part 1 of the revised lab will require students to focus a slide of blood under the microscope and draw the field of view. Students will identify and count the number of red blood cells, white blood cells, and platelets present in the blood. Additionally, students will be asked to identify the relationship between structure and function of each cell to help them understand this overarching theme in science.

Students will not be asked to label the organelles because this information should be review and is a task that requires only a low level of thinking.

Name:

Homeostasis in Blood Lab



# The Blood Lab



How does the blood function to help the body maintain homeostasis?

**Background:** Blood is a tissue made up of two different components, living cells and nonliving liquid. The cellular part has three different cell types, each having a unique form and function. These three cell types are red blood cells (~~erythrocytes~~), white blood cells (~~leukocytes~~), and platelets. The liquid part is called plasma.

**Purpose:**

- To understand how the blood maintain homeostasis
- To compare and contrast normal blood
- To see how abnormalities in blood lead to a failure of homeostasis

**Station 1. - Living Cells of the Blood**

1. Examine the picture of human blood. Locate the red blood cells. Diagram 1 or 2 of these cells in the table below. Label the cell membrane and cytoplasm.
2. Count the number of cells you see in your field of view. Record your answers.
3. Repeat procedure 1 with the white blood cells. Label the cell membrane, cytoplasm, and nucleus.
4. Repeat procedure 1 for platelets.

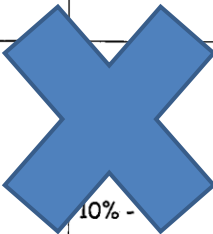
Students will use a microscope to view images of the blood. Conducting authentic laboratory work increased student learning of science concepts (Thomas, 2012).

Data Table:

Cell Type	Diagram and labels	Number of cell in field of view
Red Blood Cells		
White Blood Cells		
Platelets		

**Station 2: - Non-Living Liquid of the Blood**

**Plasma**

Look at the diagram of blood in test tubes. Draw those two test tubes; before and after it is centrifuged.	List the components of plasma
	
	<p>10% -</p> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>

**Comment [m75]:**

Students will sketch the field of view for the blood slide under high power rather than sketch the cells individually. This will help students understand the components of blood as a whole system. Additionally, students will be able to better see the difference in frequency among each of these cells to make the connection between the cell characteristics and their functions.

Students will read a section of text from the Glencoe textbook titled, "Biology." This text has a lot of information condensed into a small reading. Students will read the text describing the components of blood and then create a graphic organizer to illustrate the text. This activity represents a close reading, one of the skills students learn in their English Language Arts class through the Common Core Learning Standards.

**Station3: - Physical Characteristics of Blood Diseases**

You are going to be given either prepared slides or pictures of sickle cell anemia and leukemia. Look for the distinguishing characteristics of each blood disease. That is, look for the characteristics that a specialist might use to diagnosis the disease. As you draw the blood, remember to emphasize those characteristics.

	Sickle Cell Anemia	Leukemia
Drawing of Blood		
Distinguishing Characteristics		

**Station 4: - Diseases of the Blood and failure of Homeostasis.**

You will be provided with background information for three diseases of the blood, Sickle Cell Anemia, Leukemia, and Hemophilia. Using this information complete the chart on the next page summarizing the information and describing how the disease affects homeostasis. Remember the relationship blood, which is part of the circulatory system, has with other systems and the entire body.

**Comment [m76]:**

The statement at the beginning of station three could give students the impression that the lab is not organized. The revised directions for Part 3 will contain specific directions to ensure students the lab is well-planned. Lab efficacy had one of the greatest impacts on students' attitudes towards that particular lab (Baseya & Francis, 2011).

The task of "Look for the characteristics that a specialist might use to diagnose the disease" is not a realistic one because students do not have the same experience as a specialist. Rather, students will be asked to view slides of each disorder under a microscope, sketch their observations, and compare it to the normal blood structures they drew in Part 1 of the revised lab. Comparing and contrasting accesses a high level of thinking skills.

As students describe the differences between the normal cells and the abnormal cells, they will be asked to hypothesize what affect this could have on a person's body. This requires evaluating and creating tasks according to Bloom's taxonomy.

The Common Core Learning Standards identify research as an integral part of education. Students will read excerpts from two sources-WebMD and the National Institute of Health. Both articles have been modified to benefit students for this lab. Students will read each excerpt, answer text-based questions, and identify where in the text they found each answer. This activity supports Common Core Learning Standards Shift #4: Text-based answers.

Students will not be required to research hemophilia. Eliminating this disorder will maintain consistency among the lab therefore helping students develop deeper connections between each part of the lab.

**Comment [m77]:**

The revised lab will not require students to know how the disease is acquired. Students will be accountable for the description of the disease and its effect on homeostasis. The relationship between structure and function is significant in science and will be emphasized in the revised lab.

Disorder	How do you get it?	Description of Disease	What is its effect on homeostasis?
Sickle Cell Anemia			
Leukemia			
Homophilia			



**Conclusion:**

**Claim** - Blood is essential to maintaining homeostasis in the body. The inability of blood to function properly, because of a disease, can lead to a failure in homeostasis.

**Evidence -**

**Interpretation -**

**Comment [m78]:**

Students will be given the claim. They will support this claim with evidence from each of the four parts of the labs. These parts will be scaffolded to ensure students complete multiple pieces of evidence. The analysis will require students to analyze the relationship between structure and function to help them understand that the blood itself is a system.

Revised Lab #14  
Homeostasis in Blood Lab

Homeostasis in Blood Lab

As you complete this lab, keep the following question in mind...

*How does blood function to help the body maintain homeostasis?*

**Pre-lab**

Directions

1. Read the text below.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found each answer.

Blood is a tissue made up of two different components, living cells and nonliving liquid. The cellular part has three different cell types, each having a unique form and function. These three cell types are red blood cells, white blood cells, and platelets. The nonliving liquid is called plasma.

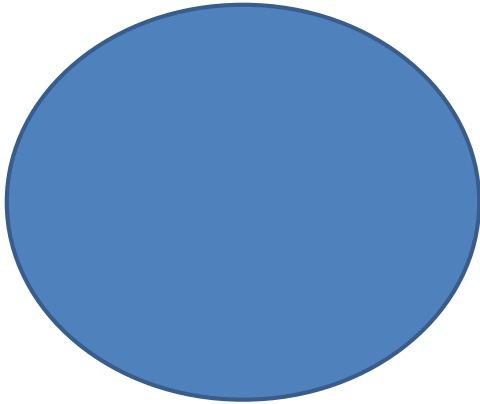
1. What is blood?
2. What are the three cells found in blood?
  - 
  - 
  -
3. What is the nonliving liquid in blood called?

PART 1: Blood Slide Observations

1. Focus a slide of blood under high power.

Teacher Check

2. Sketch the field of view **exactly as you see it** in the space below.



3. Color each cell the following color.

Red blood cells = red

Platelets = purple

White blood cells = white (just outline in black)

Check here when finished \_\_\_\_\_

4. Count the number of each type of cell:

Red blood cells = \_\_\_\_\_

Platelets = \_\_\_\_\_

White blood cells = \_\_\_\_\_

5. Fill out the chart below.

Cell	Structure	Function
Red blood cell		
Platelet		
White blood cell		

6. Use the information you collected in Part 1 to explain how the structure of each cell is related to its function.

Red blood cell:

Platelet:

White blood cell:

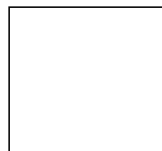
PART 2: Components of Blood Analysis

1. Read the following text from the "Biology" textbook.

Blood is made up of many different parts. The liquid part of blood is called plasma. Plasma makes up about 55% of the total volume of blood. Ninety percent of the plasma is water. The remaining 10% is made of a variety of substances that are dissolved in the water. These dissolved substances include salts, glucose, amino acids, fatty acids, vitamins, enzymes, hormones, cellular wastes, and proteins. The other 45% of the blood is made up of red blood cells, white blood cells, and platelets.

2. Create a graphic organizer in the space below to represent the components and their percentages in the space below.

Teacher Check

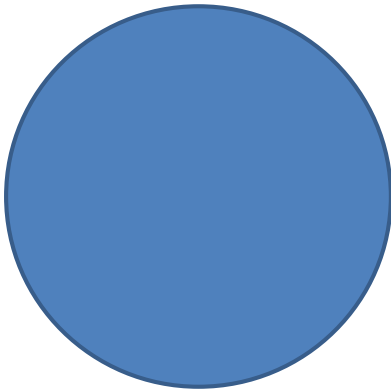


PART 3: Failures of Homeostasis in Blood

1. Focus the slide of sickle cell anemia.

Teacher Check

2. Sketch the field of view under high power in the space below.



3. How are the red blood cells from someone with sickle cell disease different from normal red blood cells?

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4. What problem do you think this difference can cause in a person affected with sickle cell anemia?

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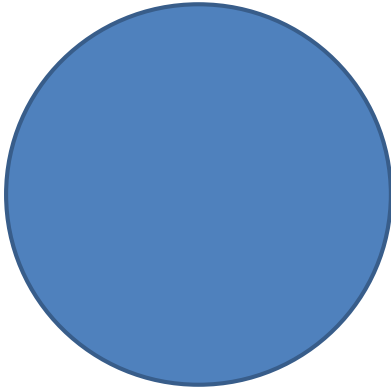
5. Explain your response to question #4.

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6. Focus the slide of leukemia.

Teacher Check

7. Sketch the field of view under high power in the space below.



8. What is different about the white blood cells in a person with leukemia compared to normal white blood cells?

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9. What problems do you think this difference could cause in a person with leukemia?

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10. Explain your response to question #9.

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PART 4: Research

Leukemia

1. Read the following excerpt from the article titled, "Leukemia-Topic Overview," from WebMD.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found each answer.

Leukemia is cancer of the blood cells. When you have leukemia, the bone marrow starts to make a lot of abnormal white blood cells, called leukemia cells. Over time, leukemia cells can crowd out the normal blood cells.

1. What causes leukemia?
2. How does leukemia affect other cells in the body?

Crowding out normal blood cells can lead to serious problems such as anemia, bleeding, and infections. Leukemia can also spread to the lymph nodes or other organs and cause swelling or pain.

What is 1 problem that can be caused by leukemia?

Sickle Cell Anemia

1. Read the following excerpt from the article titled, "Sickle Cell Anemia," from the National Institute of Health.
2. Answer the questions that follow.
3. Highlight or underline where in the text you found each answer.

Sickle cell anemia is a serious disease in which the body makes sickle-shaped red blood cells. "Sickle-shaped" means that the red blood cells are shaped like the letter "C."

What do sickle cells look like?

Sickle-shaped cells don't move easily through your blood vessels. They tend to form clumps and get stuck in the blood vessels. Blocked blood vessels can cause pain, serious infection, and organ damage.

What is 1 problem caused by sickle cells?

**Conclusion**

**CLAIM:** Blood maintains homeostasis in the body.

**SUPPORT:** Describe evidence from each part of the lab that supports the claim.

Part 1 Evidence:

Part 2 Evidence:

Part 3 Evidence:

Part 4 Evidence:

**ANALYSIS:** How is the structure of blood related to its function?



Name \_\_\_\_\_ Date \_\_\_\_\_  
Lab # \_\_\_\_\_ Populations of Peppered Moths Lab Simulation \_\_\_\_\_  
\_\_\_\_\_

**Peppered Moths**

**Introduction:**  
Industrial melanism is the term used to describe the adaptation of an organism in response to a type of industrial pollution. An example of rapid industrial melanism occurred in the peppered moth, *Biston betularia*, in the area of Manchester, England from 1845 to 1890.  
Before the Industrial Revolution, the trees in the forest around Manchester were light grayish-green due to the presence of lichens on their trunks. Peppered moths, which lived in the area, were colored light with dark spots. Their coloring served as protective camouflage against predators, especially birds. As the Industrial Revolution progressed, the trees became covered with soot, turning the trunks dark. Over a period of 45 years, a change in the peppered moths took place.  
In this investigation, you will observe the effects of industrial melanism in the peppered moths over the course of 10 years. You will then determine the relationship between the environmental changes and the color variation of the peppered moth by using research data to graph the effects of an environmental adaptation.

**Purpose:**

**Hypothesis:** How will the changing environment affect the survival rate of the two different varieties of moths?

**What you need to know**

- Individual organisms and populations change over time
- Human decisions and actions have a profound impact on the physical and living environment

Spring, 2005, Olympia

The title of the lab will be changed to "Populations of Peppered Moths Lab Simulation" to reinforce the concept of the lab.

The information found in the introduction supports the Social Studies curriculum and helps students make a connection between two different content areas.

The text in the introduction will be chunked to help students focus on a smaller amount of information at one time. Chunking the text will also accommodate students who require this on their IEP or 504 plan. Text-based questions will follow each section of chunked text to support Common Core Learning Standards Shift #4: Text-based answers.

Students will complete a computer simulation that models the change in population of light colored moths and dark colored moths based on their environment. Students will collect and record their own data. Students who complete Web-based learning programs demonstrate an increase in learning and academic achievement (Wang, et. al, 2010).

Students will draw graphs to predict the change in population sizes in different environments. Drawing a graph to represent a hypothesis is one strategy to help students visualize the outcomes of the lab (Lefkos, Psillos, & Hatzikraniotis, 2011).

Students learned this information in previous units so it will be eliminated in the revised lab. It will, however, be reviewed in a warm up activity prior to the lab.

**Comment [m80]:**

This information will also be eliminated from the revised lab but reviewed before students begin the lab.

Students will complete a simulation on the computer in which they manipulate environmental conditions and record population growth of light colored peppered moths and dark colored peppered moths. Simulations allow students to change the parameters of the lab and observe several consequences in a short period of time (Lefkos, Psillos, & Hatzikraniotis, 2011).

- Some characteristics give individuals an advantage over others in surviving and reproducing. The advantageous offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.
- The variation of organisms in a population increases the likelihood that at least some members of the species will survive under changed environmental conditions.

**Procedure:**

1. You are a scientist who has been hired to recreate the peppered moth experiment. You have a large warehouse in which you can set several "forest like" rooms. Develop a procedure as if you were in Manchester, England and investigating the effects of industrial melanism and the survival rates of the different color varieties of peppered moth.
2. What is your independent variable?  
  
What is your dependent variable?  
  
How will you collect your data?
3. To increase the validity of the experiment, you should develop a control that will serve as the basis for comparison. What will your control be?
4. Once you have a procedure, have it verified by your teacher.
5. You will graph data from other scientists.

**Procedure:**

- 1.
- 2.
- 3.

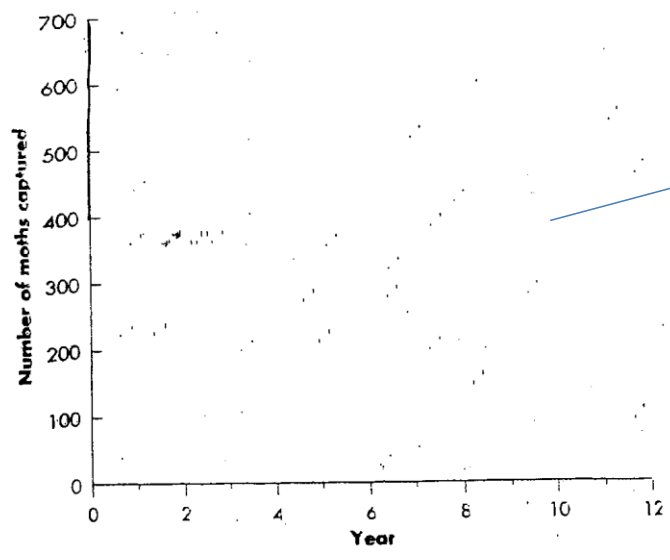
Spring, 2005, Olympia

- 4.
- 5.



Data:

Year	# of light colored moths	# of dark colored moths
2	537	112
3	484	198
4	392	210
5	246	281
6	225	357
7	193	412
8	147	503
9	84	594
10	56	638



**Comment [m81]:**

The current lab consists of one set of data for students to graph. While this is good graphing practice for students, it does not demonstrate how the population of peppered moths changes in different conditions. Students will run simulation of light colored moths and dark colored moths in a forest with dark tree trunks and a forest with light tree trunks.

Students will be able to create multiple graphs as a result of the revised computer lab simulation.

**Comment [m82]:**


This question is a review from the genetics unit. It will not be included in the revised lab.

These two questions access a high level of cognition and will remain in the revised lab.

This question will be eliminated because the major points were removed in the revised lab.

The conclusion as currently written is a template and does not provide specific instruction. The conclusion in the revised lab will be scaffolded.

**Data Analysis:**

1. What could have caused the  few moths to change from a light variety to a dark variety?
2. Explain the reason for the increase in the number of dark colored moths after the Industrial Revolution.
3. Predict what effect cleaning up the environment would have on the different color varieties of moths.
4. Take one of the four major points you "need to know from this lab". Discuss how this lab demonstrates that important point.

**Conclusion:**

Formulate a minimum of one paragraph that provides a summary of this investigation use the CEI format. The CEI must include the following:

- **Claim**-A specific statement based on the lab that is linked back to the purpose of the lab.
- **Evidence**-Specific examples from the data that support the claim.
- **Interpretation**-Explanation of what the claim and evidence reveal and how this connects to the real world and/or future investigations.

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Revised Lab #15

Populations of Peppered Moth Lab Simulation

Populations of Peppered Moths Lab Simulation

**Pre-lab**

Directions

1. Read the text.
2. Answer the questions that follow each section of text.
3. Highlight or underline where in the text you found each answer.

Industrial melanism is the term used to describe the adaptation of an organism in response to a type of industrial pollution. One example of rapid industrial melanism occurred in the peppered moth in the area of Manchester, England from 1845 to 1890.

1. What is industrial melanism?
2. What country experienced industrial melanism between 1845 and 1890?

Before the Industrial Revolution, the trees in the forest around Manchester were light grayish-green due to the presences of lichens (combination of a plant and fungus) on their trunks. Peppered moths, which lived in the area, were colored light with dark spots. Their coloring served as protective camouflage against predators, especially birds.

1. What color were the trees **before** the Industrial Revolution?
2. What color were the peppered moths?
3. Why was the color of the moth beneficial to the moth?

As the Industrial Revolution progressed, the trees became covered with soot, turning the trunks dark. Over a period of 45 years, a change in the peppered moth took place.

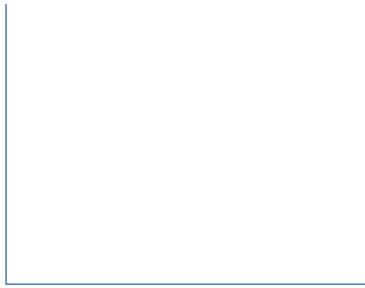
What color did the trunks of the tree turn as the Industrial Revolution progressed?

## Purpose

The purpose of this lab is to simulate how a population of peppered moths changes when they are located in different environments.

## Part 1

1. Go to the website [peppermoths.weebly.com](http://peppermoths.weebly.com)
2. Choose the "Lichen Forest."
3. Describe the lichen forest \_\_\_\_\_
4. Draw a graph to predict how the population of the light colored moths and dark colored moths will change throughout the simulation. MAKE A KEY!



5. Explain the graph you drew for question #4.

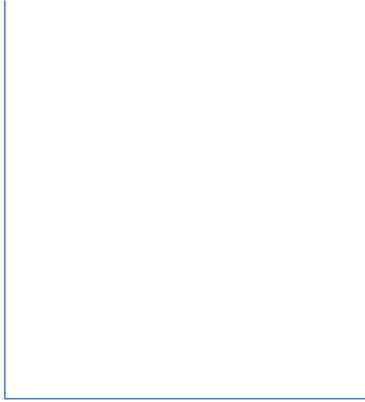
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6. Run the simulation for 1 minute.
7. Record the data in the space below. YOU WILL NEED TO MAKE YOUR OWN DATA TABLE.  
☺

Data

8. Graph the data you recorded in step #7.



9. How does the graph you drew in step #8 compare to the graph you drew for your prediction?

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10. Explain your results from the simulation.

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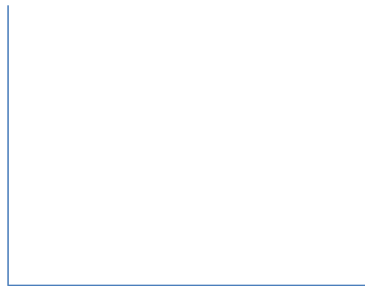
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Part 2

1. Choose the "Sooty Forest."

2. Describe the sooty forest \_\_\_\_\_

3. Draw a graph to predict how the population of the light colored moths and dark colored moths will change throughout the simulation. MAKE A KEY!



4. Explain the graph you drew for question #3.

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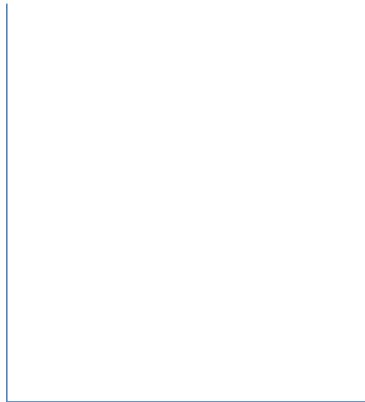
5. Run the simulation for 1 minute.

6. Record the data in the space below. YOU WILL NEED TO MAKE YOUR OWN DATA TABLE.



Data

7. Graph the data you recorded in step #6.



8. How does the graph you drew in step #7 compare to the graph you drew for your prediction?

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9. Explain your results from the simulation.

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### Analysis Questions

1. Summarize how the population of moths changed in each of the forests:

- Light colored moths in light forest:
- Light colored moths in dark forest:
- Dark colored moths in light forest:
- Dark colored moths in dark forest:

2. If 500 light colored moths and 500 dark colored moths were released into a polluted forest, what do you think would happen to the population of each if they were recaptured several days later?

### Conclusion

CLAIM: Circle the statement below that is true.

The environment **has** an effect on the population of species that survive.

The environment **does not** have an effect on the population of species that survive.

SUPPORT: Write 2-3 sentences **from your data tables** that support the claim you circled.

ANALYSIS: How would decreasing the pollution during the Industrial Revolution have affected the population of light colored moths and dark colored moths?

### *Personal Reflection*

After completing my student teaching placement, I knew I wanted to teach for one year so I could become familiar with the Living Environment curriculum and then begin working on my Master's degree. My first experiences teaching in the classroom made realize the disconnect between many of the lessons I was planning and how students learn science. It was important to me that the work I complete in a graduate program be meaningful and relevant to my students and the instructional opportunities I provide. It became a personal, and albeit selfish, goal of mine to enter into a graduate program that would allow me to accomplish both simultaneously. For this reason, I chose to complete one or two classes at a time and truly incorporate what I was learning into my classroom instruction. Although it took almost four years to complete the requirements for the science education graduate program and required an extension of my initial teaching certification, I know that I have gained the most valuable knowledge and experiences I possibly could have during my studies at Brockport. I truly feel my capstone project is a reflection and embodiment of everything I have learned over these past several years.

Laboratory work is an essential component in any science classroom. During the past five years I have worked in the Greece Central School District, I have taught in five different buildings. There are a common set of labs utilized by the Living Environment teachers. I found it interesting that students across buildings struggled with the same content and components of the same labs. While I had every intention of revising these labs before students completed them, I have not been able to do so as often as I would prefer. Choosing to make this my capstone project has fulfilled a professional and personal goal of completing work that reflects what I have learned throughout the science education program and can be immediately applied to my classroom to benefit students.

I initially planned to revise each lab before students completed them to ensure the optimum laboratory experience. I was disappointed that I was not able to do so for every lab. Interestingly enough, I learned that the labs I did revise improved student understanding of science concepts in several ways but also created new challenges. It became apparent that students struggled with some of the vocabulary and connections between

different parts of the lab. This experience gave me the opportunity to revise these labs once again and incorporate feedback from the students with research in science education.

### *Discussion of Summary and Process*

The product of the capstone project, “Factors That Greatly Influence Student Learning in Science Laboratories: Remediation and Inclusive Strategies to Create a Positive, Lasting Impact,” consists of the modification of fifteen labs currently used by Living Environment teachers in the Greece Central School District to reflect current research in science education. Once completed and approved, the modified labs can be uploaded to the district website and accessed by other teachers.

A copy of each of the fifteen original labs was scanned into a Word document and annotated with commentary identifying revisions to occur in the modified lab based on current research in science education. The modified version immediately follows the original lab to allow the reader to see the “before” and “after” of the modification process. The annotations on the original lab are supported by current research in science education and are often followed by citations in a color besides black. Some of the rationale is also based on my personal experience with the lab and feedback from students after completing the lab.

A majority of the research cited and incorporated into the modifications of these fifteen labs includes the Common Core Learning Standards, Web-based learning, computational modeling, scaffolding, cognitively appropriate material based on the curriculum map for Greece Central School District, engagement based on current events and trends, modification of expository labs to guided inquiry labs, and extrapolation of higher level thinking skills. Designing a lab that helps students identify and understand the relationship between the course content, the lab itself, and the world in which they live is a challenging one. The goal of this capstone project was to accomplish just this.

Each lab emphasizes the implementation of the Common Core Learning Standards for English Language Arts, in particular Shift #4: Text-based Answers and Shift #6: Academic Vocabulary. The Common Core Learning Standards are mostly addressed in the pre-lab readings but are found at various parts throughout the procedures as well. In addition, all pre-lab readings have been chunked to help students comprehend the reading better. This chunking of text especially benefits students who struggle with reading and accommodates students who have classroom modifications requiring chunked text on their Individualized Education Plans. Each section of chunked text is followed by questions based on that particular section of text. Students are

required to highlight or underline where in the text they found the answer for each question. The act of annotating helps students to interact with the text more. Because this is such an important skill, students are graded on their annotation. If they do not underline the relevant text or underline additional text that is not relevant, they lose points. There is a direct correlation between students answering the question incorrectly and not underlining the answer in the text.

When appropriate, computational modeling is incorporated into the lab to allow students the opportunity to manipulate a number of variables in a system and observe the consequences of these manipulations. Several events in science occur over an extended period of time and cannot be observed in their entirety. Computational modeling has the advantage of “fast forwarding” these events.

Many of the revised labs also have scenarios to engage students in the lab. These scenarios typically describe a part of the real world they are familiar with as teenagers. For example, a scenario in one particular lab describes a new app the student downloaded for his iPhone. In the app, he and his friend play a game where they need to determine which two species are most closely related by completing several analyses. A second lab scenario incorporates a video of a court case in which someone is accused of a crime. Many of the analyses for the lab conclusions also require students to do additional research to find an example of the lab content in current events.

One of the greatest characteristics of science labs is their application to the real world. It is my hope that students appreciate this and learn science at the same time through the completion of these fifteen modified labs.

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