IMPACT OF ACTIVITY AND LAB BASED TEACHING ON STUDENT PERFORMANCE AND MOTIVATION

By

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A THESIS

Submitted to
Michigan State University
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE

Mathematics Education

2011

ABSTRACT

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This paper reviews student performance in freshman Biology through a lab and activity based approach. Students used various manipulatives designed by the teacher, conducted several labs, and engaged in other activities designed for this hands on approach to learning. This study took place throughout many units of a yearlong course in Biology in an urban, public school district in a cooperative learning environment. Two classes of 30 and 32 students were involved in this study. The results based on pretest and posttest data suggest that an activity-based approach for teaching science concepts increased student performance and motivation overall. Students surveyed claimed better information retention when practiced and enriched through multiple labs and activities for various subjects. More student engagement was seen by the instructor when compared to previous years. The cooperative learning environment in which activities were conducted in proved to have positive effects.

ACKNOWLEDGEMENTS

I am grateful to all of those with whom I have had the pleasure to work during this and other related projects. I have been blessed with some incredible teachers to work through this program with the last several summers and feel that I have learned a lot from their ideas and teaching styles. Merle Heidemann has given me extensive guidance and taught me many ways to get around spending a lot of money in the classroom but still making laboratories possible.

Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents, whose love and guidance are with me in whatever I pursue. My father Ralph has given me unending help through college, internship, 8 years of teaching various science classes, and now a Master's program. Most importantly, I wish to thank Slade and Tori who have put up with me being busy for the past 4 summers and always supporting me at each step of the way.

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Introduction:

‘If I hear I forget;
If I see I remember;
If I do I understand.’

The research reported here involves new activities developed by the instructor in a ninth grade Biology classroom. The instructor followed an activity based approach to learning by providing activities to give students chances to “learn by doing”. These hands-on activities can provide students with a great learning tool to understand many abstract concepts through visible objects they can put their hands on.

The activity-based approach is involved in both collaborative interaction and providing access to information-rich resources, according to MacDonald and Twining (2002). The goal of activity-based learning is for learners to construct mental models that allow for ‘higher-order’ performance such as applied problem solving and transfer of information and skills (Churchill D., 2003). Mental models assist students by providing quick answers to questions that face them and also the ability to retain that information longer. Churchill (2003) calls this a ‘mental model’. According to Jonassen (1999) mental models are more than just repeating knowledge learned but are allowing learners to move to the next level of advanced knowledge representations. These mental models can be accomplished by non-traditional types of learning activities including group work, hands-on activities and labs. Some students simply think of these activities as “fun” or “lightweight” when compared to other lessons in class. They do tend to look forward to these activities as a break from written work and although they sometimes feel like they are just “playing”, there is a lot of learning going on as well. These activities were used as a tool to teach and motivate at the same time.

Most of these activities and labs were performed as exercises in cooperative learning groups as the unit was implemented. Cooperative learning generally involves groups working together on tasks that are deliberately structured to provide specific assignments and individual contributions from each group member (Lazarowitz, 1994). To be effective, students need to be provided with clear directions as well as an outline of the goals and time line. According to Blumenfeld (1996), the effects of group work depend on how the group is organized, what the tasks are, who participates, and how the group is held accountable. Students learning in a cooperative fashion tend to learn more of the material presented and retain that information longer than if presented in other instructional formats (Gross, 1993). Lord (2001) suggests other benefits for working in a cooperative learning environment include upgrading reading and writing skills, promoting science thinking, providing opportunities for modeling real life situations, and increasing practical as well as social skills. Lord stated that ‘When done correctly, cooperative learning has much more to offer biology students than traditional methods’. When considering the negatives of group work, there are several obvious problems for teachers. The two big issues of cooperative learning are the potential to create more discipline problems in the classroom, and difficulty in grading these projects/activities fairly due to differentiated input to the activities by individual students. It is common that the most motivated, grade conscientious, or brightest student will often take over the group and sometimes even do all the work to assure a favorable outcome. Often the least motivated students will take the easiest route, sometimes even enabling the more able students to take over a project. These problems can be overcome by peer grading in which each student takes a role that has very clearly defined tasks, and students answer a survey on the productivity of their fellow team members at the completion of the activity. They grade their group members as well as themselves as to what they think they deserve for participation. The instructor uses grade given by peers as part of their final grade for the activity. Haines and McKeachie (1967) have shown that cooperative discussion methods encourage even more effective work among students and better morale than any sort of competitive methods. There is a time and place for cooperative learning. Typically this turns out to be in the middle to the end of a unit to enhance understanding at the point where general knowledge of the topic has already been attained. These cooperative learning activities give depth to lessons and allow students to practice some aspect of what they've been learning. Johnson and Johnson and Smith (1991) state that when small teams work together to solve challenges in a student-centered environment, they not only understand the information better, but also retain that information longer than just teacher-led instruction. Students are able to work using their own language to teach each other. Peer teaching happens naturally in cooperative learning and is a great learning tool for both sides.

The general approach of teaching of the author falls under the heading of *Deductive teaching*. *Deductive teaching,* also known as 'direct instruction', is much less "constructivist" than *Inductive teaching* (Felder 1993). Constructivist Teaching is the philosophy of learning based on the premise that we conduct our own understanding of the world we live in by reflecting on our experiences (Brooks 1999). The Constructivist Theory facilitates the creation of mental models that assist in higher order thinking rather than just memorization of the "right" answers (Brook 1999). While Inductive teaching concentrates on students covering things on their own through activities the teacher has chosen, *Deductive teaching* starts with a highly structured introduction in each unit that provides students with all the necessary background knowledge as they move into other activities of the unit. Felder (1993) states that both deductive and inductive teaching should be used in all Biology classes. The instructor using a deductive approach typically presents a general concept by first defining it and then providing examples or illustrations that demonstrate the idea (Felder, 1993). However, Fisher and Waldrip (1999) suggest that lessons that encourage exact modeling by students result in less favorable attitudes towards science and lower inquiry level achievement such as in *Deductive teaching* alone. The model of instruction used in the work repeated here is teacher-led instruction followed by activities and labs to which they had been introduced. The practice of beginning with *direct instruction* is common, especially to those of us teaching young secondary learners (6th-9th graders), and especially in urban schools. Erskine-Cullin (1996) states, “Successful teaching in these low-income, urban, multicultural schools is different from teaching in suburban settings, which have more homogeneous student populations, more parental support and more stable student populations”. These diverse students learn in many different ways including visual, auditory and kinesthetic. Felder (1988) says that most people learn most effectively with one of the three modalities and tend to miss or ignore information presented in either of the other two. Direct instruction does not provide a wide enough range of learning styles for a diverse classroom with the addition of hands on activities students with varied learning styles can be achieved.

Everett High School is an urban institution with approximately 1391 students for the 2010-11 school year. Approximately 52.3% of this population is female and 47.7% male, 46.7% are African American, 27.7% Caucasian, 15.7% Hispanic, 9.1% Asian, and 0.7% Native American. Over 59% of our student population is economically disadvantaged and 13.7% are limited English speakers.

This research was conducted in my ninth grade Biology classes. Ninth graders were the largest class in the school, compromising 34.9% of the Everett population. Everett has 16% of its student population receiving special education support and that describes the ninth grade study population as well. This is a diverse group of students, many disadvantaged in one way or another. The target Biology classes had 30 students in one hour and 32 in the other. The demographics of the students in this study break down as follows: 71% African American, 19.4% Caucasian, and 6.5% Hispanic. High ninth grade failure rates are a nationwide problem but this is an even larger problem in urban schools. Our school district, like many urban schools, has high failure rates, truancy, dropouts, discipline problems, students moving from one school or district to another, and high teacher turnover rates. Pinkney (2000) notes that the "poor health, inadequate motivation, malnutrition, lack of basic learning-skills all are found to a greater extent among children in urban areas than among students in suburbs". As an urban teacher I feel that I have more responsibilities and challenges to teach these students and meet their needs. Freshmen are even more challenging and have even added problems when considering the often troublesome adaptation from middle school to high school. Leonard (2011) states that "hands-on science instruction has a role in urban schools that can never be understated".

There are three major obstacles to learning in my target classrooms; 1) lack of necessary teaching materials, 2) large, varied gaps in previous science knowledge on the part of incoming students, and 3) a wide range in post-secondary aspirations. The lack of materials in the classroom are things such as textbooks, lab materials, demonstration models, and all others that would serve a role in improving the teaching and learning in the science classroom. These curriculum materials play a major role in initiating and sustaining reform in science education because they are concrete, tangible things for embodying the essential ideas of a reform (Powell, 2002). A diverse classroom in terms of ethnicity, background, economic standing, and post-secondary plans makes teaching meaningful science to children in urban classrooms a daunting task for a teacher of any caliber (National Center for Education Statistics, 1996, 1999; U.S. Department of Commerce, 1993).

Students' post-secondary plans also play a huge role in terms of what needs to be addressed. Many freshmen will not graduate but drop out at the first opportunity. Everett only maintains a 70% graduation rate. Others will graduate and move directly into the work force and still others will continue their post-secondary education at colleges or universities. Only 15% of the graduating Everett students will move on to a four year university. It is hard to address multiple levels and provide all of them with what they need without leaving anyone behind. Limited resources force many urban teachers to teach to the test or teach science without any hands-on activities or relevance to student's personal lives. (Oakes, 2000; Tobin, Broscoe, and Holman, 1990). During research by Stahle and VanSickle (1992) it was found that the more immersed the students became in biology, the more difficult it was for troublesome individuals to gain the attention of other students.

I have always felt that students learn more from "doing" and this year I had the opportunity to test that idea. The activities and labs I developed involved students getting up and out of their seats which is often a welcome change on their part, but can also cause increased problems with discipline. Wilson and Corbett (2001) reported that urban classroom environments "should be places in which expectations are clearly stated, no excuses permitted, and inappropriate behaviors are dealt with immediately". Weiner (1999) adds to this by stating that urban teachers need to have more authority to be successful. Both these statements are true in this study. The directions and expectations of the developed activities had to be clear cut in order to be successful.

My hypothesis was that if I could increase the number of laboratories and activities completed in Biology, students' performance on assessments should increase along with their motivation to learn science. With the right mix of an introduction to new concepts with teacher-led direct instruction and completing units with cooperative learning activities and laboratories assessments should show significant improvement. The two things I expected to see in my students were an increased understanding of subject matter and higher learning motivation. The level of understanding is readily documented by increased test scores and a higher performance in other daily assessments.

Implementation:

The activities developed during the research summer were mostly simple labs or activities. Most of them required little class time, sometimes a day, and sometimes only part of an hour. These activities required students to be active so they left their seats. They worked in groups, often moved from station to station and/or had various things to do in different parts of the room. These activities could be easily modified to fit into other teacher's curriculum without restricting content coverage. Most activities came at a point in the unit where the main concepts and vocabulary had already been presented and they were practicing these concepts in some form or taking them to the next level of understanding. The activities served to engage students in content knowledge as well as develop science process skills. Specific descriptions of each activity are provided in this section. The general structure starts with teacher-led instruction, in a *deductive teaching* approach that gave them a base of knowledge for them to move forward onto collaborative activities.

Each unit began by defining our main topic. Students would read the chapter or chapter sections and examples were given throughout of what the subject is and examples of what it isn't. This the 'Explanation Phase' and is teacher-directed with textbook reading and note taking done together as a class with discussions and examples throughout. All cooperative learning activities followed the chapter reading and teacher led note taking. These activities provided opportunities for students to expand their current subject knowledge in a variety of activities that they caused students to get out of their seats and physically move around.

OSMOSIS UNIT

Table 1: Osmosis Unit Activities

Activity	Description
Read Book	Covering new vocabulary and everyday examples of how diffusion and osmosis occur
Cell Membrane Drawing	Students color and label a cell membrane
Notes-Cell membrane	Notes cover selectively permeable membrane, examples in everyday life, diffusion and osmosis
Section 4-1 worksheet	Practicing cell membrane questions using class notes and the book.
Vocabulary worksheet	Practicing vocab, definitions, and pictures
Eggsperiment with Osmosis ***NEW ACTIVITY***	Using eggs as representations of cell membranes and syrup and water as models of hypertonic and hypotonic solutions
Cell Membrane Review Sheet	1st day- students independently work through questions similar to those they will see on the test.2nd day-go over answers
Review Game Boards ***NEW ACTIVITY***	Use review game boards and cards for this unit to review for test
TEST	Unit test

Osmosis is typically a difficult concept for some students. This topic follows the Cells unit in which they learn about the different cell organelles and their functions. Students begin this unit with the prior knowledge that the cell membrane is semi permeable as it allows certain things to cross it while preventing other substances from moving across. In 'Egg-speriment with Osmosis' activity students have two eggs that are lacking their shell this provides a model for a cell and cell membrane.

Egg-speriment with Osmosis (Appendix 1a and 1b)

Prior to the lab we have read about osmosis, discussed real life examples and taken notes. We started the lab by going over the directions and discussing our predictions of what we thought would happen to the egg placed in water and the egg placed in a syrup solution. Students write down their hypothesis in a journal, including drawings, which will later be transferred to the lab report. Students wrote down observations and data collected on their lab sheets (1a). After conclusion of the lab students completed a rough draft lab report (3b) by following directions on the Lab Report Instructions (1b). This was checked for accuracy by the instructor and students finished the activity with a typed final draft lab report.

<u>DNA UNIT:</u> Table 2: DNA Unit Activities

Activity	Description
Read Book	Chapter 9 -read together as a class
Notes-DNA	Students follow along with PowerPoint, filling in blanks as they go. Covers DNA basics, early scientists, structure, base pairing rule
Large DNA model- ***NEW ACTIVITY***	is used throughout this unit to provide a visual representation of the structure, shape, and components of a DNA molecule
Colored letters- ***NEW ACTIVITY***	The first time students will use the colored, laminated A's, T's, C's and G's to practice the base pairing rule.
DNA coloring & worksheet	Includes questions and a DNA double helix in which students need to label the phosphate group, the five-carbon sugar molecule, and the four bases.
Paper DNA models- ***NEW ACTIVITY***	Groups composed of 3-4 members and each group cut out and assembled as many as they could in one day. When all groups had finished we put them all together to form one giant color coded paper DNA strand
Super-Secret Decoding worksheet	Students turn a DNA strand into an RNA stand through the process of transcription, then an RNA strand into a protein through the process of translation and then find use the 3 letter codons to find what amino acid it codes for.
Colored letters- ***NEW ACTIVITY***	Students use the colored laminated letters to further practice transcription and translation. This time they use the codon wheel to determine amino acid as well.
DNA review Sheet	Worksheet is done in groups and goes over test questions in several forms. Students use their journals, notes and all other items in their folder to answer questions.
Codon Bingo	Students practice going from DNA to RNA to separating codons and finally finding the amino acid in this faster paced review activity.
TEST	Unit test

The DNA unit is typically a short unit with a concentration on the shape of DNA, base-pairing rules, transcription, and translation. The following activity was developed to be used as a learning tool for these concepts

Colored letters (Appendix 2b)

Several letters representing adenine, thymine, guanine, cytosine, and uracil were prepared. Each set of letters was on its own color of paper so they were easy to tell apart. They were used as an introduction to the four bases of DNA. After learning about the base-pairing rules students made the complementary strand with other letters in their envelopes. The letters were also used to learn about transcription and the differences between RNA and DNA. Finally, they were used as RNA templates for amino acids. Students were checked and graded by the instructor. This activity was simple in that there was little direct instruction needed. Students seemed to like the hands on approach rather than simply writing these examples down in their journal as students had done in previous years

.

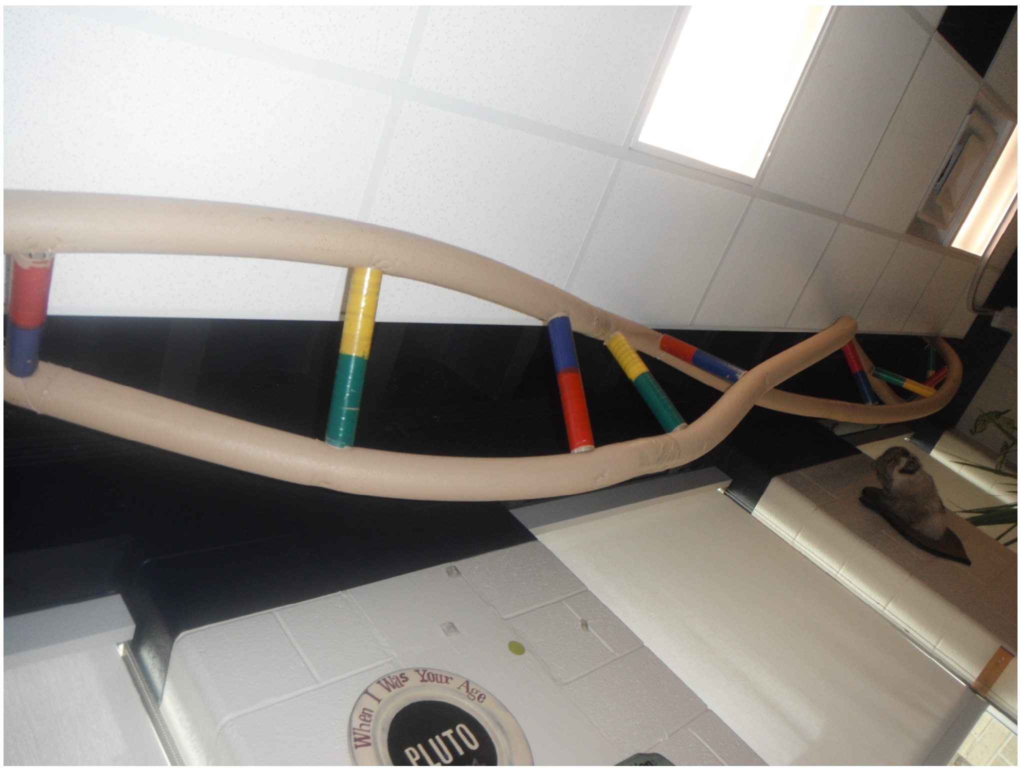
Paper DNA models (Appendix 2c)

Paper DNA models based on four colors of paper to represent the four bases were prepared for student use. Students worked in groups to cut out and assemble their own strand of DNA and all groups parts were combined to form one giant DNA strand. Questions were answered after the activity was completed.

DNA Model (Appendix 2d)

A student and the instructor made a DNA model using pool noodles for the sides of the DNA ladder and paper towel tubes for the rungs. The model was painted and the rungs were given 4 different colors to represent the different nucleotide bases. It hangs in the back of the room and is twisted to form the shape of the double helix. The classes were excited to see it go up and it has served its purpose well of a giant model of DNA.

Figure 1: Classroom DNA model (For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this thesis)



DNA Extraction Lab (Appendix 2c)

Students had learned that all living things have DNA and they were able to actually see that DNA after they extracted it from a strawberry. These lab materials were easy to obtain and the materials were adjusted substituting coffee filters for cheesecloth. After completing the activity students answered a series of questions regarding the lab. We also modified the lab by students mashing/kneading the strawberries in a thick Ziploc baggie which substituted for the blender. After completing the activity students answered a series of questions regarding the lab.

Genetics Unit:

Table 3: Genetics Unit Activities

Activity	Description
Read chapter	Begin reading about Gregor Mendel, chromosomes, and probability
Notes-chromosomes	Notes cover chromosomes, karyotypes, some genetic disorders
Karyotype Activity	Students cut out 46 (or 47) chromosomes and arrange them on a karyotype according to size and banding pattern. They determine the sex of their child and if it has down syndrome
Jeans to Genes - ***NEW ACTVITY (Appendix 3a &3b)***	Activity in which t-shirts and socks demonstrate the differences of phenotype and genotype
Why Pea's Advertisement	Students make a drawing or cartoon with all the reason why Mendel choose to work with peas in his genetic experiments
Simple stuff	Introductory simple punnett squares
Punnett Square Worksheet	More in depth worksheet covering punnett squares
My Baby	Students work in pairs in the role of parents and flip a coin to determine the traits of their child.
Bikini Bottom Genetics	Spongebob Punnett Squares
Notes-pedigrees	Covering the basics of pedigrees including representation symbols, practice in drawing them, and following those with autosomal or sex-linked disorders.
Punnett Square Packet	Worksheet practicing various monohybrid and dihybrid crosses
Punnett Square Quiz	Assessment covering punnett squares
Pedigree Packets	Worksheet covering pedigrees
Lorenzo's Oil	Movie about a boy with a ALD
Genetic Disorder Project	Research project on genetic disorders
Review game boards- ***NEW ACTIVITY***	Genetics cards are used on game boards to begin review
Review Sheet	Review sheet covering questions similar to the test
TEST	GENETICS TEST

Students follow up learning about the structure of DNA into the Genetics unit in which we begin by students learning that a chromosome is single piece of coiled up DNA containing many genes. The following activity serves as a model to represent chromosomes and the genes found on those chromosomes.

Jeans to Genes Activity (Appendix 3a & 3b)

Each ‘chromosome’ is comprised of various pieces of clothing. The whole long string of clothes represents the chromosome and each individual piece of clothing represents one gene on that chromosome. Based on this model we discussed how many chromosomes humans have in their cells and relevant questions such as ‘What about someone with Down Syndrome?’ Why there are two chromosomes. We reviewed the terms homozygous and heterozygous and looked at some different “genes” on the two models to see if we think they are the same (homozygous) or different (heterozygous). These can be represented with two different colored socks for heterozygous or two of the same gloves for homozygous.

Classification Unit:

Table 4: Classification Unit Activities

Activity	Description
Read Book	Covers basic facts about taxonomy, early scientists involved, dichotomous keys and cladograms.
Notes-Classification	Notes cover taxonomy and the seven levels of classification.
Sharks dichotomous key	Students have previously practiced using a dichotomous key in journals and will now determine the genus and species name for 12 different varieties of sharks.
Chapter 15 vocabulary	This worksheet practices new vocabulary for the chapter as well as several tables in which different animal and plants have all 7 names listed for each of their levels of classification.
Salamander dichotomous key	More practice with naming organism's scientific names by using a dichotomous key.
Chapter 15 questions	Students use classification notes and chapter 15 in their textbook to answer worksheet questions.
Leaf Classification Guide Activity- ***NEW ACTIVITY***	Students travel in groups to 12 stations around the room in which different leaves are available to identify. Students have their own leaf classification guide they take with them to find the genus and species name of each.
Review Sheet	covers all topics, vocabulary and activities to prepare for the unit test
TEST	UNIT TEST

Dichotomous keys and cladograms are concentrated on in the Classification Unit to discuss how and why scientists classify organisms. Throughout the unit, students practice with finding scientific names of organisms with different dichotomous keys and ended with the ‘Leaf Classification guide. This provided a hands on activity in which students could practice this skill.

Leaf Classification Guide

Producing the *Leaf Classification Activity* was something needed that the research summer provided the opportunity to complete. In the past, several different dichotomous keys were used to give students an understanding of how to use keys to identify animal/plant scientific names. The Michigan State University Field Ecology course provided the author with a greater knowledge of Michigan trees to be used in this activity. Based on the Michigan Trees Identification Guide an activity guide book and worksheet was developed for use in the classroom. Students moved around stations in the room in which they used their tree identification book to identify 12 different sets of Michigan leaves. In each of these stations students worked with different leaves that had been laminated and numbered. By using the dichotomous key in the leaf guide as well as some pictures of leaves, cones, and fruit students could find the common name and scientific name of the twelve species. The leaf specimens were collected from around Michigan State University campus and sealed with numbers in clear contact paper. A field guide (Cooperative Extension Service, Michigan State University) was used to prepare guides for students. The lab assignment also included questions that they could answer at their seats.

Review game boards

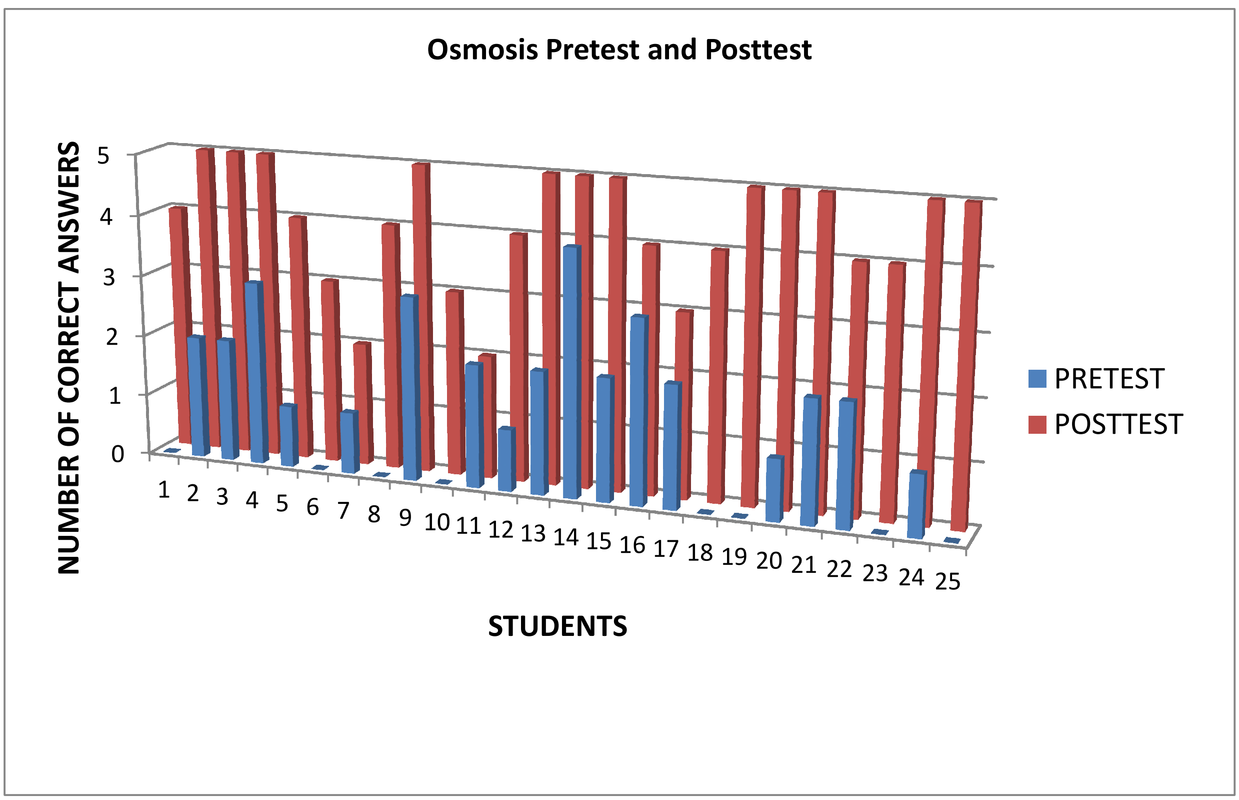
The Review game boards were used in multiple units and required a great deal of thought and preparation. Once a board was assembled, color copies were made and pasted onto old game boards and laminated. Various objects were used for the pieces (old game pieces mostly) that were moved around the board and cards for each unit review were developed. The board was used during Cells, DNA, Genetics, History of Life and Evolution units. The students enjoyed using these in groups as an alternate way to review. Students were asked a test question, or one very similar to a test question, and needed to supply the correct answer to the table. One student was deemed the 'teacher' who would use their review sheet to verify if the other students had answered correctly. If they did they would move forward on the board, the first to the finish being the winner. The winner then switched spots with the 'teacher' who jumped into their spot so the game could go on a little longer. A prize was given to the group that completed the game first; the whole process went surprisingly fast.

Results/Data:

The pretests and posttests (appendices 5a-5d) covered the four units of Osmosis, DNA, Genetics, and Classification that incorporated the newly developed activities. Each test consisted of 5 multiple choice questions and was given at the beginning and the end of the four units. Results for each are given below in Figures 1-4. The highest score possible in each case is a 5.

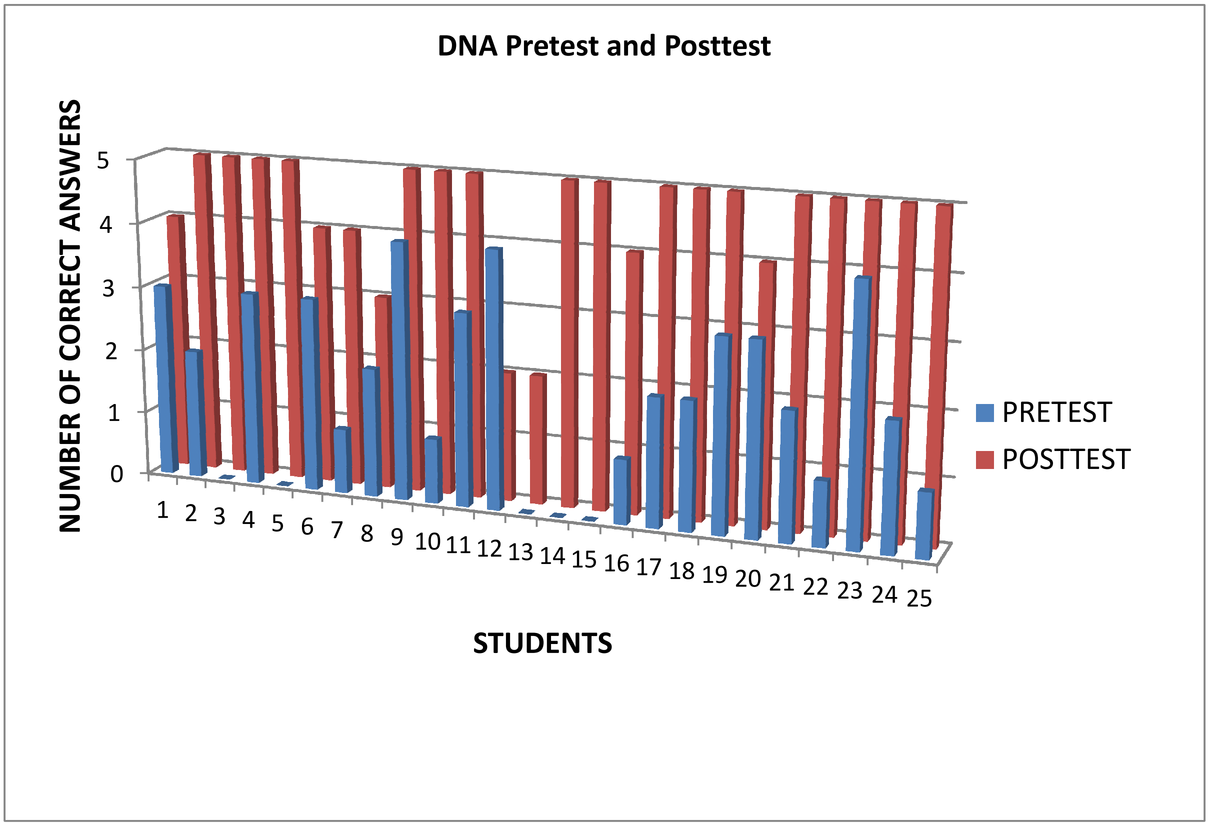
A paired t-Test was conducted on each set of data comparing pretest score percentages to post test score percentages for that unit. By conventional criteria, this difference for each was considered to be statistically significant with $p = 0.05$.

Figure 2: Osmosis Unit Data



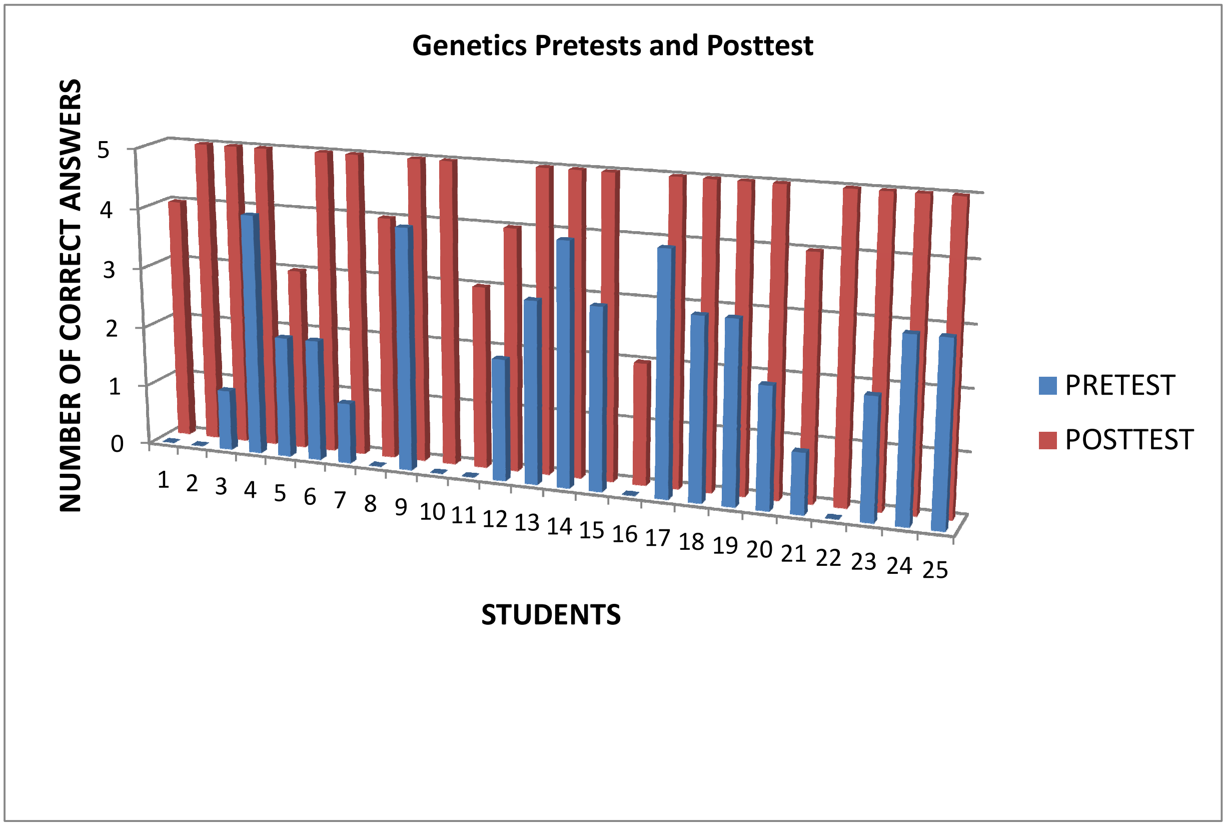
The two-tailed P value for this data equals 0.0389 and is considered to be statistically significant. The data displayed here indicates that 32% of these students received a score of 0 out of 5 for the pretest and 20% received a score of 1 out of 5 for the pretest. This indicates that many students started with little to no knowledge regarding this unit. Many of these students scored a 4 or 5 on the posttest indicating a significant increase in content knowledge.

Figure 3: DNA Unit Data



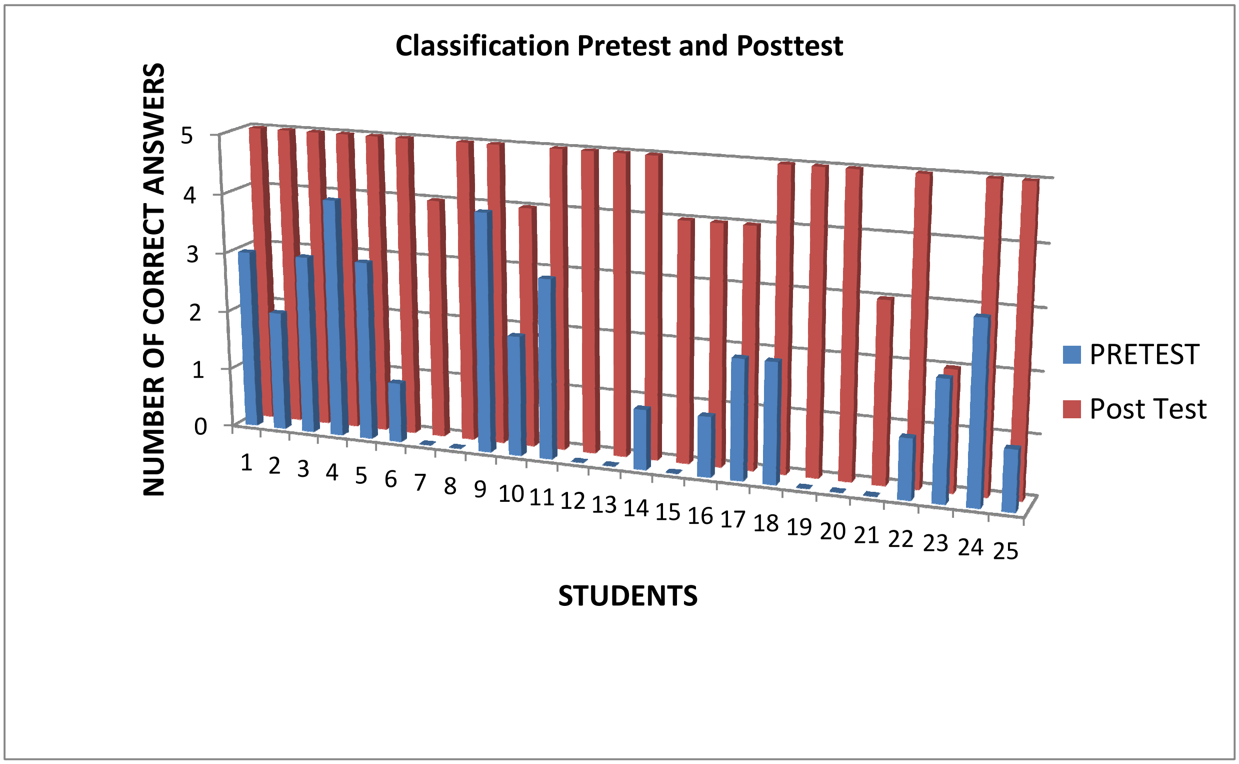
The two-tailed P value for the DNA data was less than 0.0001 which is considered to be statistically significant with p=0.05. Many students scored a 0-3 on the pretest indicating students had some previous knowledge coming into the DNA unit. Almost all of these students increased there score to a 4 or 5.

Figure 4: Genetics Unit Data



The two-tailed P value for the Genetics data was less than 0.0001 which is considered to be statistically significant. There was a wide range of pretest scores for this set of data. Students that scored a 4 out of 5 at the start of the unit compromised 28%, while 16% of students started out the unit with a score of 0 out of 5. It was obvious that there was a wide range of previous knowledge. Altogether 72% of students received a 100% on the post test.

Figure 5: Classification Unit Data



The two-tailed P value for the Classification data equals less than 0.00010 which is considered to be statistically significant. There was not as much previous knowledge at the start of this unit but still 72% received 100% on the post test.

The pre and post test score comparison of all four unit graphs shows evidence of significant improvement in learning throughout the unit as measured by the key 5 questions for each unit.

Discussion:

The goal of this project was to increase students understanding of the content, not to just increase their ability to memorize. This was to be obtained by increasing engagement and motivation through hands-on activities. In the context of this study the activities I developed had three requirements: materials for activities that can be used year after year, labs that can be done using everyday items and/or inexpensive materials, and models that can be stored in the classroom for quick visuals.

I have observed this in my own my own classes and noticed that the higher the interest level in the activity, by at least most of the students, the fewer discipline problems I have. When considering the pros and cons of cooperative learning through research and previous experience it was decided that these activities would work well in a cooperative learning environment.

The instructional year as a whole was covered with new activities rather than just one unit. I've always believed the science classroom should have a very different look and feel compared to a Math, English and Social Studies classroom. There should be more activity and there should be more "doing" going on. As in previous years I started each unit with teacher led instruction or *deductive teaching*, but this time finished up with more activities than previous years. The research reported here involved finding and/or developing activities and labs that can be used in my classroom, based on inexpensive and easy to obtain items. Students were provided several different types of activities and laboratories throughout the many units of the curriculum in an activity-based learning style. Students were able to have enhanced laboratory experience and learn from many different types of activities while learning the necessary content.

This activity based learning was conducted mostly in a cooperative learning environment with students' working with different groups throughout the year.

Starting with deductive teaching styles and ending with cooperative activities can be the best of both worlds. Although I like to incorporate as much hands on learning as possible I feel that in my school and my classroom teacher-led instruction is needed at the beginning to cover necessary content. Ample time was given at the introduction of each unit so that students could grasp the new concepts and vocabulary. These were then practiced throughout the unit with new activities. Students were given guidance and feedback throughout with the goal being mastery of the subject matter

During the Osmosis Unit the students completed a new lab I called ‘Egg-speriment with Osmosis’. Students enjoyed this lab tremendously and it was referred back to as the ‘egg lab’. Overall, this lab had incredible results as measured by lab report grades as well as final assessment test scores. Other benefits were that materials were easy to obtain, and I observed the students gaining a much greater understanding of the diffusion of water through this activity. Although students took data (weights and circumference before and after of the eggs), the results were so obvious that they could visually see the differences before taking those measurements. The egg in syrup shrunk in size considerably and looked dented in. The egg put in the hypotonic solution grew noticeably larger in the water and even had stretch marks on the membranes. Almost all the eggs in the study showed these drastic results. For more dramatic results the eggs should be left in vinegar for two nights instead of just one, thereby giving the vinegar time to disintegrate the shells completely. Groups whose egg didn’t change size used the data of the team next to them to write their report with. I used this as an opportunity for discussion as to what went wrong with those eggs. This laboratory will be used again in the future.

Several of the newly developed activities were employed in the unit on DNA. The colored letters were used as students practiced base pairing, transcription and translation; the letters were also used to review before the test. In the past I have had students write all this down in journals at the beginning of the hour and this proved a much more engaging way to teach and learn. The primary problem with this activity was that a couple of students couldn't catch up with the rest of the class as they worked on the letters. The cause of this seemed to be that the letters were all mixed up and some students felt the need to sort the letters by color before beginning.

The *Paper DNA model* activity was a little time consuming and took some preparation. In previous years students made a very simple model of DNA with Twizzlers, marshmallows, and toothpicks. When comparing the two models, the *paper DNA model* has many advantages. Students gained a greater understanding of the structure as well as it being much more inexpensive activity. Another benefit of this activity was that we were able to take their separate models and put them together to form one very long strand of DNA that could be displayed in the room. Even from a distance students were reminded of the base pairing rule with the coordinating colors of the nitrogen bases. The only negative aspect to this project was getting the colored paper as requests need to be made early in the year.

We finished the DNA Unit with our *DNA extraction lab*. Students were able to extract strawberry DNA by using diluted dish soap and alcohol resulting in beautiful, spoolable result. There was a lot of excitement with this lab and many students told me the next day they went home and told their families that they "took the DNA out of a strawberry today". During research with the DNA extraction lab I experimented with other fruits and decided that strawberries were the best. If more time is available in the future classes will repeat the experiment with other fruits to reinforce the process and the steps involved.

Finally a giant model of DNA was made and put up in the classroom. This was made by a student in the Forensics Science class as extra credit. However, the Biology students were very excited to see it go up when it was completed and it was referred to often when we reviewed the double helix shape of a DNA strand. The model was made with easily attainable materials, and although it took some time to build it serves as a permanent giant representation of the molecular structure of DNA.

The 'Jeans to Genes' activity went smoothly and we referred back to it often. This new model incorporated into the Genetics unit and reinforced the concepts early in the unit. Students were engaged and asked several questions. Once the "chromosome" was assembled we looked at the two sets of "genes" together. If both socks were the same color we said that it was homozygous for that trait. If they were different colors then it was heterozygous. This activity will be used in the future, I would also like to make a permanent 'clothes chromosomes' that can be pulled out and used more quickly.

When introducing the *'Leaf Classification activity'* to students I realized that most students had no background knowledge in identifying trees. Although the knowledge of trees was not the objective of the exercise, it served as a good enrichment activity for a Biology class. Overall, the '*Leaf Classification Activity'* went smoothly and students had few problems with it. There were some leaves that were hard to differentiate between two species, such as Sugar Maple and Red Maple, and students were told to make their best guess based on visible characteristics. Although some of them lost their color, they were easy to handle, store, and will be useful in coming years

Developing the review boards was the project that required the most time but was also used the most this past year. Students were instructed how to play the game during the first unit on Cells and they caught on easily. Playing the games went a little faster than expected but provided the opportunity for several winners. The boards were used as a review tool for the Cells, Osmosis, DNA/mitosis/meiosis, Genetics, and History of Life units. The majority of the time involved with making the boards was tracking down old board games to cover and making the one template that was copied for each of the boards. Boards were easy to store and pull out on review days. Instructor and students alike enjoyed using these boards as a unique form of review.

The biggest problem observed with these increased activities done in a cooperative learning environment was the increase in disciplinary problems. Students often think that this is strictly "playtime" and that the task at hand is not a valuable activity. Secondly, the work accomplished is not always fairly distributed among the group members. Rubrics were given to students to show them the basis of final grades, with participation taking a large role in that grade. Specific information was given on the nature of inappropriate behavior (wandering around the room, talking to other groups, having other materials out, etc.) and clear instructions were given on the penalties. Constant observation by the instructor was needed during activities to gauge progress. There were problems, but they were manageable. Overall the hardest thing about introducing more "doing" was work and time needed from the teacher. Constant observation was needed as well as supplies to gather ahead of time, materials to set up the day before and between class periods. For this reason these activities don't always fit in exactly where the teacher might want them but lend themselves to being very flexible as to where they are implemented in a unit.

An addition in the aspect of teaching these units was the re-writing of several of my tests to reflect the new activities. Some of the new activities had taken enough time that I felt that they needed to somehow be represented on the end of the unit assessment and therefore had to add in questions to some tests regarding those activities.

The benefits of increasing lab and activity time were obvious in the scores. Data taken and assessed over these four units was in the form of pretest and posttest responses. Great improvements in these scores, including significant evidence from paired t-tests, made it obvious content knowledge went up consistently. From daily comments and conversation I observed that they were more interested than I have seen in previous years classes. “Doing” is a big part of learning science and the excitement of the activities was obvious in the students’ behavior. Between the preexisting labs and activities that were in place and the newly developed ones, we were “doing” things quite a bit. It became a habit of many students to walk in and promptly ask if we were doing a lab that day. Increased engagement in the Biology curriculum by the students was obvious when compared to previous years.

An additional benefit of this project was sharing these activities with other science teachers in the building. Additionally, the students asked more questions and were more engaged throughout these activities. Possibly the most positive things I heard often was “feeling like a scientist” while doing labs was undeniably a positive thing. Even if the lab is harder than what a typical assignment might be, they had the drive to participate and complete it. When reflecting on test score improvements as well as overall attitudes towards the class and motivation to learn, the increased laboratory time was a positive experience for everyone.

Appendices

Appendix 1a: Eggsperiment with Osmosis

Name________________________

Egg-speriment with Osmosis

Purpose: During this activity students investigate the concepts of osmosis and diffusion using eggs as a model of the cell membrane.

Materials Needed:
2 Eggs
Vinegar
Corn Syrup
Water
String
Scale
Ruler

Day 1: Carefully put your 2 eggs in 2 different cups and label them with your group name and then label them A and B. Pour vinegar in each cup just enough to cover the egg. Place both cups on trays in the back of the room

Day 2: Retrieve cups from back of the room and write several observations in the space below. Remove eggs (carefully, they have no shell now!) and weigh each of them on the scale. Write these measurements down (in grams) on your lab sheet. Next, carefully take the circumference of each egg by wrapping the string around the egg and then measuring the length of string on the ruler. Write these measurements down (in cm) on your lab sheet. After pouring out the vinegar in each cup, put egg A back in its cup and carefully cover it with water. Put egg B back in its cup and carefully cover it with corn syrup. Put both eggs back on the trays in the back of the room and clean up your area.

Day 2
Observations:____
____
____
____
____
____
____

Appendix 1a: Eggsperiment with Osmosis (cont'd)

Day 3: Retrieve cups and make observations again below. Carefully remove both eggs and weigh and measure their circumference as you yesterday. Bring any broken eggs to me and I will give you someone else's data to use. Record all data on your lab sheet. Dump water in the sink and dispose of your eggs in the trash. Finish cleaning up your area.

Day 3
Observations:____
____
____
____
____
____
____

Data Table:

	Day 2 weight (g)	Day 2 circumference (cm)	Day 3 weight (g)	Day 3 circumference
Egg A				
Egg B				

Appendix 1b: Lab Report Instructions

<u>Lab Report Instructions</u>

DIRECTIONS: Writing the final draft of your osmosis lab report is not hard but is worth MANY POINTS! You will be using the information we obtained in the experiment which has been written on your 'Osmosis Lab' data sheet and in the lab report rough draft that we worked on together in class. Title each section with the title written below and double check these directions to make sure you have included all the necessary information.

FINAL DRAFT LAB REPORT MUST BE TYPED!!! Leave room in your hypothesis section to draw the sketches of our predictions (in rough draft).

Title: <u>Eggsperiment with Osmosis</u>

Problem/Question: ____

Hypothesis: Include a written explanation as to what we predict will happen to Egg A and Egg B. Also include the drawings of the two eggs in each solution (we did these together in your journal).

Materials: Listed on 'Egg-speriment with Osmosis' directions and data sheet.

Procedure: In this section you must explain what we did on each day IN DETAIL! Separate each section by Day 1, Day 2, etc.

Results/Data: In this section you should include all your observations you made for each day. All measurements (mass before and after, width before and after) that are in your 'Egg-speriment with Osmosis' data sheet should be included in this section. You may staple the data table to the

Appendix 1b: Lab Report Instructions (cont'd)

back of your lab report or cut and paste it into this section. Your graph of egg size can be stapled to the back of your report but MUST be included! Remember to include all the parts of a good graph for full credit!!!

Conclusions: In this section you should accept or reject the hypothesis we made together. EXPLAIN why you accepted or rejected your hypothesis using the data to support you.

Appendix 1c: Lab Report Rough Draft

Rough Draft

Title: ___________________________________

Problem/Question:

____

____

H**ypothesis:**

____

____

____

(Draw pictures from journal hypothesis here)

Materials:____

____

____

Procedure:

Appendix 1c: Lab Report Rough Draft (cont'd)

(Day 1)

___

___

(Day 2)

___

___

(Day 3)

___

___

Results/Data:___

___

___

___

___

___

Conclusions:___

___

___

___

Figure Appendix 2a: Colored letters

C	C	C	C	C
C	C	C	C	C
C	C	C	C	C
C	C	C	C	C
C	C	C	C	C
C	C	C	C	C

Figure Appendix 2a: Colored letters (cont'd)

G	G	G	G	G
G	G	G	G	G
G	G	G	G	G
G	G	G	G	G
G	G	G	G	G
G	G	G	G	G

Figure Appendix 2a: Colored letters (cont'd)

A	A	A	A	A
A	A	A	A	A
A	A	A	A	A
A	A	A	A	A
A	A	A	A	A
A	A	A	A	A

Figure Appendix 2a: Colored letters (cont'd)

T	T	T	T	T
T	T	T	T	T
T	T	T	T	T
T	T	T	T	T
T	T	T	T	T
T	T	T	T	T

Appendix 2b: DNA extraction lab

Name_________________________

DNA extraction lab

Background: The long, thick fibers of DNA store the information for the functioning of the chemistry of life. DNA is present in every cell of plants and animals. The DNA found in strawberry cells can be extracted using common, everyday materials. We will use an extraction buffer containing salt to break up protein chains that bind around the nucleic acids, and dish soap to dissolve the lipid (fat) part of the strawberry cell wall and nuclear membrane. This extraction buffer will help provide us access to the DNA inside the cells.

Pre-lab questions:

1) What do you think the DNA will look like?
2) Where is the DNA found?

Materials:

Heavy duty Ziploc bag
1 strawberry
10ml DNA extraction buffer (made with 20 ml dish soap, 20 g salt, and 180 ml distilled water)
Cheesecloth
Funnel
50 ml vial/test tube
Glass rod, inoculating loop or popsicle stick
20 ml ethanol

Procedure:

1. Place one strawberry in a Ziploc bag.
2. Smash/grind up the strawberry using your fist and fingers for 2 minutes. Careful not to break the bag!
3. Add the provided 10ml of extraction buffer (salt and soap solution) to the bag.
4. Kneed/mush the strawberry in the bag again for 1 minute.
5. Assemble your filtration apparatus as shown to the right.
6. Pour the strawberry slurry into the filtration apparatus and let it drip directly into your test tube.
7. Slowly pour cold ethanol into the tube being careful not to mix the layers. Do this by pouring the ethanol VERY slowly down the side of the test tube.

Appendix 2b: DNA extraction lab (cont'd)

8. Dip the loop or glass rod into the tube where the strawberry extract and ethanol layers come into contact with each other. Swirl DNA around rod to spool up DNA. OBSERVE!

Conclusions:

1) Describe what the DNA looked like:

2) Explain what happened in the final step when you added ethanol to your strawberry extract (Hint: DNA is soluble in water but not in ethanol)

3) Why is it important for scientists to be able to remove DNA from an organism?

4) Is there DNA in your food? How do you know?

5) Name one thing that DNA is NOT in? How do you know this?

Appendix 3a: From Jeans to Genes Activity

From Jeans To Genes

Overview and Purpose:
Students are introduced to the structure of chromosomes and genes as these concepts are illustrated utilizing articles of clothing as a model of a chromosome.

General Goals:
Students will understand concepts such as homozygous and heterozygous, genotype and phenotype, and dominant and recessive genes.
Specific Goals:
1. Students will describe and differentiate chromosomes and genes.
2. Students will identify the relationship between genotype and resulting phenotype.
3. Students will differentiate dominant and recessive genes.
4. Students will predict the possible genotypes and phenotypes produced from various genetic crossings.

Teaching Strategies:
1. Students will view chromosome model and brainstorm observations about the structure of a single chromosome and homologous chromosomes.
2. Students will discuss dominant and recessive genes and their relationship to phenotypes.
3. Students will predict the possible genotypes and phenotypes produced from various genetic crossings through independent practice.

Materials Needed:
Phase One - Chromosome Model
2 blue jeans - identical colors 2 socks - identical colors
2 shirts - different colors 2 boxer underwear - different colors
2 gloves - identical colors 10 large safety pins
Phase Two - Phenotype and Genotype and Genetic Crossings
4 blue socks, 3 white T-shirts
4 white socks, 3 blue T-shirts

Activities (step by step procedure) and Teaching Strategies:

Phase One - Chromosome Model
1. A model of a chromosome will be made prior to the lesson by attaching one of each of the clothing items (sock, glove, jean, boxer underwear, and shirt) together with safety pins. The entire string of clothing will represent a chromosome. The individual garments will represent gene segments along the chromosome. A second chromosome will be constructed containing the same types of clothing placed in the same order.
2. Hand out "Jeans To Genes" Observation Sheet

Appendix 3a: From Jeans to Genes Activity (cont'd)

3. Call on two student volunteers to display the first chromosome model to the class.

4. Ask students to record their observations of the single chromosome. Is the chromosome the same throughout? Call on volunteers to share their observation.
Explain that the entire chain of clothes represents a chromosome and that the individual garments represent genes. Although we cannot see an individual's genes, we can see the traits that they control (phenotype). For instance, the "glove" gene may control the shape of our fingers and the "Jean" gene the hair on our legs.
6. Call on two more student volunteers to hold up the second chromosome. Explain that two chromosomes are modeled because our chromosomes are paired. One we receive from our mother and the other from our father.
7. Ask students to brainstorm and record similarities and differences between the two chromosomes.
8. Students will then be asked to make observations about the chromosome models by answering directed questions. Students should note that the two chromosomes are similar because each contains the same number and types of genes. In addition, the genes are in the same order and located in the same place on each chromosome. Students should note that some genes are identical, while others, although they control the same trait, are different.
9. Introduce the terms homozygous and heterozygous. Explain that genes that are identical are called homozygous. Genes that control the same trait but are different are called heterozygous.
10. Check for comprehension by asking students to list all homozygous and heterozygous genes illustrated by the models on their observation sheet.

Phase Two - Phenotype and Genotype
1. Tell students that we will now focus on only one gene located on the chromosome model; the sock gene. Students will be given a hypothetical scenario. Tell students to imagine that these genes belong to a certain type of blackbird. Some blackbirds have white chests and some have blue chests. The sock gene will control chest color.
2. Demonstrate genotype and phenotype by selecting a student volunteer. Ask the student to hold two white sock genes in each hand and drape a white T-shirt over his/her shoulders.
3. Explain that the socks represent the bird's genes. These two genes are located in the DNA of the bird and are referred to as the bird's genotype.
4. Explain that although we cannot see the actual genes inside a cell, we can see the expression of the genes which is the white chest (illustrated by the white T-shirt). Tell students that this physical expression of the genes is referred to as the phenotype.
5. Select two additional student volunteers. The second student will be handed two blue socks and wear a blue T-shirt to illustrate a blue phenotype.
6. Issue the last student volunteer one blue and one white sock and a white T-shirt. Explain that some genes are stronger than others. These genes called dominant genes mask the weaker genes called recessive genes. In this case, white is dominant.
Genetic Crossings (This lesson provides an introduction and transition to the study of heredity and punnett squares.)
1. Call on three student volunteers. Inform the class that the first volunteer will represent the mother blackbird. Have this student hold two white socks, one in each hand. Check for

Appendix 3a: From Jeans to Genes Activity (cont'd)

comprehension of parts one and two by asking students if this represents a homozygous or heterozygous genotype. Also, ask students what phenotype this bird would have. After students have responded, drape a white T-shirt over the student volunteer representing the mother bird.
2. The second volunteer will represent the father blackbird. Issue this bird two blue socks and a blue shirt.
3. Explain to students that although all of our body cells have two genes for every trait, only one gene is donated in the creation of the sperm and egg cells. This can be illustrated by placing one sock from the mother bird into a poster board with a picture of an egg cell and one sock from the father bird into a poster board with a picture of a sperm.
4. Explain that the donation of the gene from the gene pair by the parents is random. However, since both parents are heterozygous, mother will always donate a white and father will always donate a blue.
5. Have the third student represent the baby bird. Using the sock model and student volunteers, the class will predict possible offspring gene pairs (genotypes) and resulting phenotypes.
6. Repeat this procedure for the various genetic crossings indicated on observation sheet. Have student's record possible phenotypes and genotypes of offspring from these crossings on observation sheet.

Appendix 3b: From Jeans to Genes Student Sheet

FROM JEANS TO GENES
STUDENT OBSERVATIONS

1. Describe only one chromosome. What are the segments called? What do these segments control?

1. Compare the two chromosomes. Why are they called homologous chromosomes?

2. How are homologous chromosomes alike?

3. How are homologous chromosomes different?

5. What does homozygous or pure bread mean? Give an example from the chromosome model.

6. What does heterozygous or hybrid mean? Give an example from the chromosome model.

7. Imagine that sock genes control the chest color of a blackbird. Define the following terms as students demonstrate the concepts with blue and white socks and blue and white t-shirts.
genotype:
phenotype:
dominant genes:
recessive genes:

APPLICATION OF TERMS
Imagine that sock genes control the color of a blackbird's chest. Blue socks are dominant and white socks are recessive.

1. Cross homozygous white with homozygous blue. What fraction of offspring will be white? blue?

2. Cross homozygous blue with heterozygous. What fraction of offspring will be white? blue?

Appendix 3b: From Jeans to Genes Student Sheet (cont'd)

3. Cross homozygous white with heterozygous. What fraction of offspring will be white? blue?

4. Cross two heterozygous. What fraction of offspring will be white? blue?

Appendix 4a: Leaf Classification Activity

Name_________________________

Leaf Classification Activity

Go to the 12 stations around the room (in any order) and identify the leaves using your 'Leaf Classification Guide'.

1. ____________________ common name; _______________________ scientific name
2. ____________________ common name; _______________________ scientific name
3. ____________________ common name; _______________________ scientific name
4. ____________________ common name; _______________________ scientific name
5. ____________________ common name; _______________________ scientific name
6. ____________________ common name; _______________________ scientific name
7. ____________________ common name; _______________________ scientific name
8. ____________________ common name; _______________________ scientific name
9. ____________________ common name; _______________________ scientific name
10. ____________________ common name; _______________________ scientific name
11. ____________________ common name; _______________________ scientific name
12. ____________________ common name; _______________________ scientific name

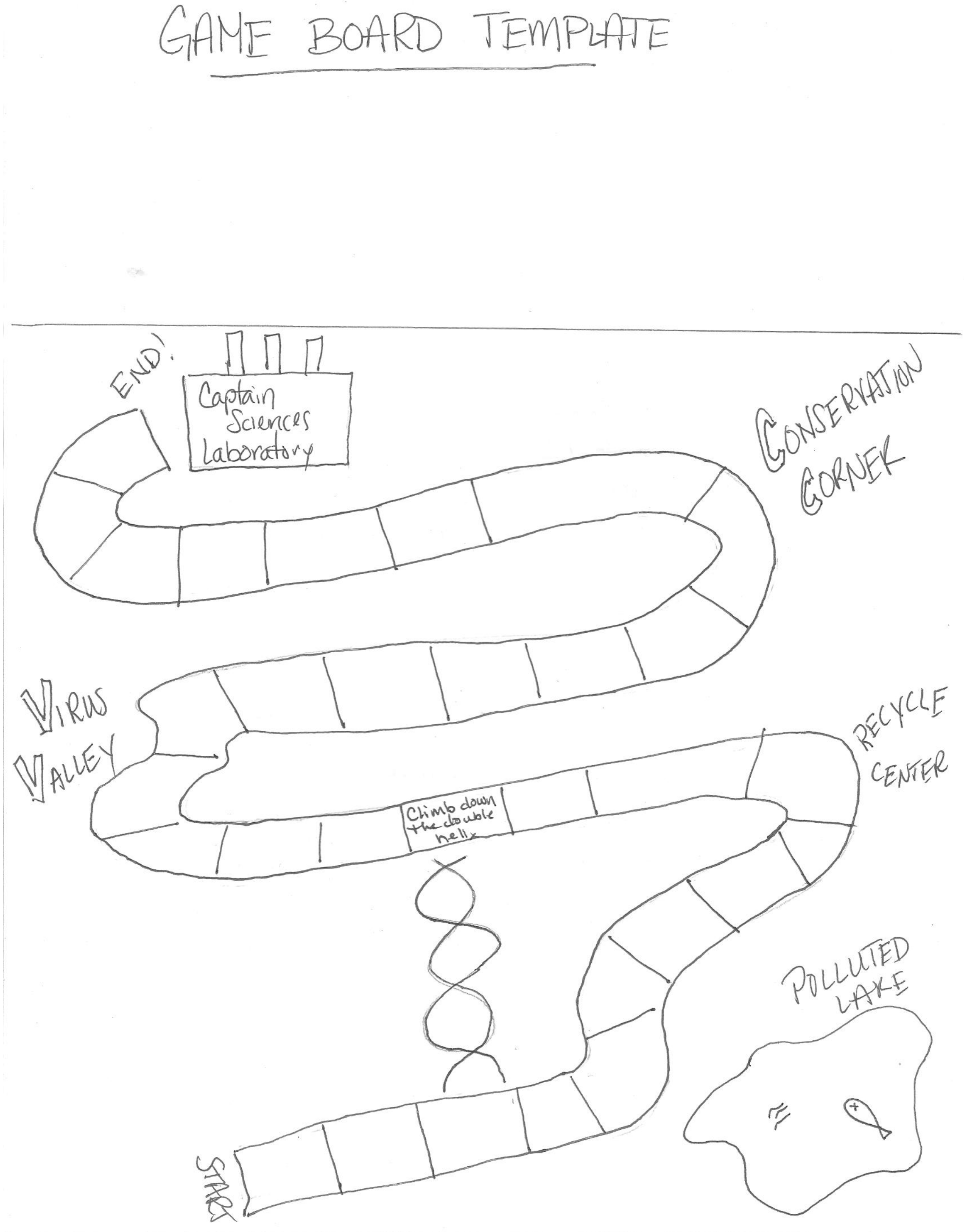
13. Using the diagrams in the front of your guide, draw a finely serrated leaf below:

14. Draw a lobed leaf:

15. Draw needle-like leaves:

15. What type of tree are helicopters from and what are they actually called?____
16. Using the dichotomous key in the front, what type of tree has opposite leaves that are pinnately compound and a double samara? _______________________________
17. Even before leaves are out in the spring you can still tell the difference between trees by their bark and buds. Draw the difference between the buds of an Elm tree and a White Ash below. (Using 'types of buds' in front of guide)

Appendix 5a: Review game board template drawn by author



Appendix 5b: Review game cards for Cells Unit

Review Game Cards-
Cells

The cards on the following pages were printed with images of animal and plant cells on the tops of them to place on game board for review of this unit

Figure Appendix 5b: Review Cards for Cells Unit (Cont'd)

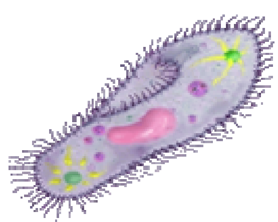
What is the shape of an animal cell?	What is the shape of a plant cell?
What types of structure and support do plant cells have?	What does the nucleus contain?
What is the main difference between a eukaryotic and a prokaryotic cell?	What is the name for a modern prokaryote?
What is the main difference between a prokaryote and a eukaryote?	This is the way a cell can move. What is it called? 

Figure Appendix 5b: Review Cards for Cells Unit (Cont'd)

What is the job of the Golgi apparatus?	What is the difference between the smooth and the rough ER?
How did cells get their name?	What is the job of the ribosomes?
What is the largest organelle in the plant cell?	What organelle supplies energy to a plant cell?
What organelle supplies energy to an animal cell?	What is the nickname for the nucleus?

Figure Appendix 5b: Review Cards for Cells Unit (Cont'd)

What is the job of the cell membrane?	What 3 things does a plant cell have that an animal cell doesn't?
Name one kind of eukaryotic cell.	The tail like structure used for movement is called:
The hair like structure used for movement is called:	The interior of the cell is called the :
What structure in a plant cell is responsible for photosynthesis?	Which type of cell came first?(prokaryote or eukaryote)

Figure Appendix 5b: Review Cards for Cells Unit (Cont'd)

The structure labeled A is the:	The structure labeled B is the:
The structure labeled C is the:	The structure labeled D is the:
The structure labeled E is the:	What type of cell is figure 2?
What type of cell is figure 3?	Substances enter or leave the cell through the:

Figure Appendix 5b: Review Cards for Cells Unit (Cont'd)

What cells have a cell wall?	This is the name given for mini organs:

Appendix 5c: Review cards for Osmosis Unit

Review Game Cards-
Osmosis

The cards on the following pages were printed with images of a slug with a salt shaker (class example) on the tops of them to place on game board for review of this unit.

Figure Appendix 5c: Review cards for Osmosis Unit (cont'd)

The cell membrane is made up of phospholipids. The tails of these are ______ and therefore repel water	Because a cell membrane allows only certain substances to cross it, it is said to be _________
(true or false) The diffusion of water does not take energy from the cell	(true or false) The cell membrane includes a triple layer of phospholipids
The excretion of materials to the outside of the cell by discharging them through vesicles is called (exiting)_____	Larger materials can ENTER the cell through vesicles, this is called ________
(true or false) A cell placed in a hypertonic solution could burst	If the concentration of water is lower outside the cell than inside the cell, which way will the water move?

Figure Appendix 5c: Review cards for Osmosis Unit (cont'd)

In diffusion, a substance tends to move from _____ concentration to _____ concentration	It takes energy from the cell to move _____ its concentration gradient
Plant cells don't burst because of their ____ _____	Active transport requires the cell to use ______
_______ is the simplest type of passive transport	Osmosis is the diffusion of ________ molecules
(true or false?) A cell placed in a hypotonic solution would burst	______ transport is like floating downstream in a raft (takes no energy)

Figure Appendix 5c: Review cards for Osmosis Unit (cont'd)

______ transport is like having to paddle upstream (takes energy)	In our experiment, the egg in the corn syrup solution was in a _______ solution
One way to maintain homeostasis is by controlling the movement of substances across the _________	(true or false?) Chlorine would dissolve faster in a pool at **room temperature** than a **hot** tub.
The job/nickname of the cell membrane is the ______________	When red blood cells are placed in an isotonic solution they will: **swell/shrink/stay the same (pick one)**
Red blood cells placed in water would: **swell/shrink/stay the same** (pick one)	Drinking salt water is an example of putting your cells in a hypertonic solution and they will ________

Appendix 5d: Review cards for DNA/Mitosis Unit

Review Game Cards-
DNA/MITOSIS/
MEIOSIS

The cards on the following pages were printed with images of a double helix on the tops of them to place on game board for review of this unit.

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

During which phase of mitosis do the centromeres separate?	The sex of a human offspring is determined by ___________
As a cell prepares to divide, DNA coils up to form a ____________________	The condition in which chromosome 21 has an extra chromosome is called __________ (both names please)
Phases G1, S, and G2 are collectively called ____________	Bacteria reproduce asexually by______________ _________________
The fertilized egg, the first cell of the new individual is called a ___________________	The process by which the nucleus of a cell is divided into two nuclei is called ______________

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

A cell spends 90% of its life in this stage of the cell cycle	In this stage of the cell cycle, the DNA coils up and the chromosomes first become visible
The uncontrolled division of cells is called	The cytoplasm is divided in this stage
How many chromosomes do humans have in their REGULAR (somatic) cells?	How many chromosomes do humans have in their SEX cells (gametes)?
What happens in the S phase of the cell cycle?	During which phase of mitosis do the chromosomes move to the middle of the cell?

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

What is the cell doing during the G stage?	During what stage of mitosis does the nuclear envelope dissolve?
During what stage of mitosis does the nuclear envelope reform?	Name the stucture that moves the chromosomes during mitosis.
The shape of DNA is referred to as the ___________ ____________	DNA is composed of 4 nitrogen bases. Their letters are ___, ___, ___, _____
A males sex chromosomes are represented with these two letters	A females chromosomes are represented with these two letters

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

One chromosome has ____ chromatids	Name the stages of mitosis in order
Name the stage of meiosis in order	What is the rule that states that adenine (A) will always pair with thymine (T) and cytosine C with guanine (G)?
DNA contains the sugar deoxyribose, RNA contains the sugar_______	Are sex cells (gametes) haploid or diploid?
Are somatic cells haploid or diploid?	There is no thymine (T) in RNA, what letter is then complementary to adenine (A)?

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

A codon consists of _____ letters or nucleotide sequences	DNA is a double strand while RNA is a _________ strand
The stage of mitosis in which the chromosomes move away to opposite poles is	in this stage of the cell cycle, the DNA coils up and the chromosomes first become visible
Increased age of the mother is a factor in the chances of having a baby with _______	Is a benign or malignant tumor better news (the kind that doesn't spread)?
Does mitosis or meiosis make clone cells?	One cell dividing by mitosis makes ____ cells, One cell dividing by meiosis produces ____ cells

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

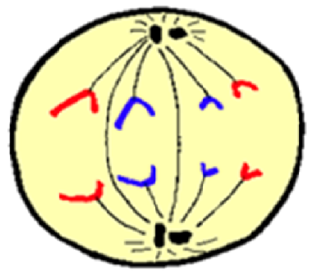
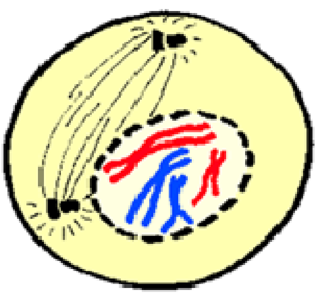
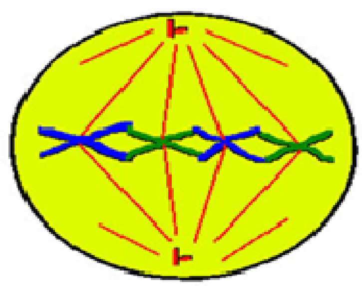
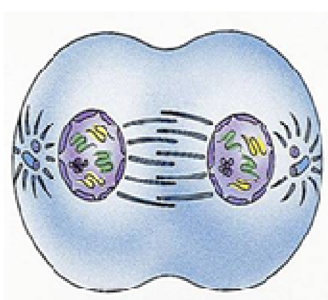
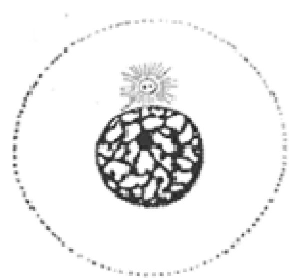
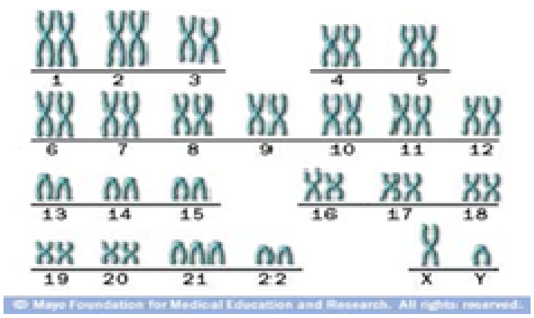
Does meiosis make somatic (regular) or sex cells (gametes)?	A picture of a person's chromosomes is called a _______
What is chemotherapy?	Name that phase: 
Name that phase: 	Name that phase: 
Name that phase: 	Name that phase: 

Figure Appendix 5d: Review cards for DNA/Mitosis Unit (cont'd)

Why is it necessary that egg and sperm cells have half the # of chromosomes as regular cells?	Two chromatids are attached by a ________________
Male of female? 	What is the main difference in the number of stages between mitosis and meiosis?

Appendix 5e: Review cards for Genetics Unit

Review Game Cards-
Genetics

The cards on the following pages were printed with images of an image of Gregor Mendel on the tops of them to place on game board for review of this unit.

Figure Appendix 5e: Review cards for Genetics Unit (cont’d)

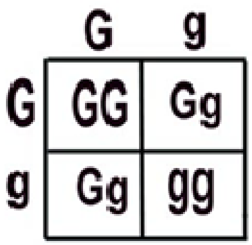
When 2 different alleles occur together, the one that is expressed is called ____	An organism that has inherited two of the same alleles of a gene from its parents is ____ for that trait
What is this? 	(True or false) The P generation comes before the F generation.
Hh (homozygous or heterozygous?	**HH** (homozygous or heterozygous)?
Different versions of a gene are called __________ ___________	The color of a dogs coat is its _________ (phenoytype or genotype)

Figure Appendix 5e: Review cards for Genetics Unit (cont'd)

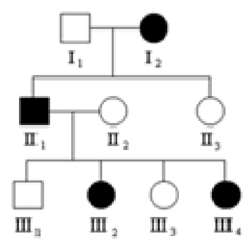
Before there was a cure for ALD, girls couldn't get it, why not?	What letter is a sex linked disorder carried on?
Why can't a male be a carrier for a sex linked disorder?	What is this called? 
How many marriages are in the pedigree on the board?	(Punnett Square on board) What color is the fur in both of the parents in the cross?
(Punnett Square on board) What is the phenotype of box 3?	(Punnett Square on board) What is the genotypic ratio?

Figure Appendix 5e: Review cards for Genetics Unit (cont'd)

Who is called the 'father of genetics'?	Cross a wrinkled worm with a homozygous smooth worm. The genotypic ratio is: __:___:__
Cross a clear worm with a heterozygous green worm. The phenotypic ratio is ___:___	How many generations are on the pedigree on the board?
(pedigree on board) If I am inidvidual #8, who is #10 to me?	(pedigree on board) If I am individual #8, who is #12 to me?
(pedigree on board) If I am individual #8, who is #4 to me?	(pedigree on board) If I am individual #8, who is #7 to me?

Appendix 5f: Review cards for History of Life Unit

Review Game Cards-
History of life

The cards on the following pages were printed with images of a double helix on the tops of them to place on game board for review of this unit.

Figure Appendix 5f: Review cards for History of Life Unit (cont'd)

If Carbon-14 decays into Nitrogen-14 than the Carbon-14 is the ________ material.	How many years have humans been around (approximately)?
The bog men died violent deaths. It has been suggested they may have been ________ or ________	The Cretaceous, Jurassic, and Triassic period make up which era?
How many eras are there?	The name of the theory that continents have moved slowly to their present position is called _______
Reptiles evolved from __________	What needs to happen for an organism to be fossilized?

Figure Appendix 5f: Review cards for History of Life Unit (cont'd)

Sketch the shape of a half life graph.	What animals were the first vertebrates?
Give an example of a trace fossil.	What kind of rock are you most likely to find a fossil in?
What is the best environment to become fossilized?	How many periods are there?
During what period did fish evolve?	How many millions of years ago was the greatest extinction on Earth?

Figure Appendix 5f: Review cards for History of Life Unit (cont'd)

How long ago did the dinosaurs go extinct?	Why does one Era end and another begin?
The first living thing on Earth was ________	During what period did the dinosaurs go extinct?
Where did life begin?	(true or false) People and dinosaurs once shared the Earth.
What animal did birds evolve from?	The giant landmass that existed 200 million years ago was called ____________

Figure Appendix 5f: Review cards for History of Life Unit (Cont'd)

Geology is the study of ______	A scientist that studies fossils is called a __________
If the history of the Earth was compared to 24 hrs, how long ago did humans appear?	What is a vertebrate?
What are arthropods and why are they so successful?	What is an invertebrate?
Name at least one piece of evidence that supports continental drift.	How do we determine the age of rocks and fossils?

Figure Appendix 5f: Review cards for History of Life Unit (Cont'd)

A dog is more likely to become fossilized than a worm because a dog has a __________	If the early Earth had no oxygen, where did it all come from?
amphibians evolved from ___________	What is the difference between amphibian and reptile eggs?
Why was the formation of the ozone so important (what does it do)?	What is the half life of carbon?
When a species permanently disappears the species is said to be __________	

Appendix 5g: Review cards for Viruses & Bacteria Unit

Review Game Cards-
Viruses & bacteria

The cards on the following pages were printed with images of a microbe on the tops of them to place on game board for review of this unit.

Figure Appendix 5g: Review cards for Viruses & Bacteria Unit (cont'd)

Viruses do not ______ or ___________ and are therefore not living.	Are viruses alive?
Are bacteria alive?	How is HIV transmitted?
What 2 things are causing the current problem with antibiotics?	What shape is a coccus bacteria?
What shape is a spirillum bacteria?	What shape is a bacillus bacteria?

Figure Appendix 5g: Review cards for Viruses & Bacteria Unit (cont'd)

Tooth decay is the result of __________ (virus or bacteria)	Name one food item made from bacteria.
Which do you take an antibiotic for (virus or bacteria)?	2 parts of a virus are a capsid and an __________
How is smallpox transmitted?	Which (lytic or lysogenic) cycle causes immediate harm?
Name one biological weapon we are currently worried about.	The shape of streptococcus would be _______

Figure Appendix 5g: Review cards for Viruses & Bacteria Unit (cont'd)

(true or false) All bacteria are bad.	How is polio transmitted?
What group of people did polio affect more than any other?	What is a sign of a bacterial infection?
The word 'virus' is latin for ___________________	How was the Bubonic plague (Black Death) spread?
Why is smallpox considered the most dangerous biological weapon?	(true or false) I have been prescribed a 10 day antibiotic but I'm feeling better on day 4 and should stop taking the antibiotic.

Figure Appendix 5g: Review cards for Viruses & Bacteria Unit (cont'd)

Where can you find bacteria?	Bacteria are causing disease by secreting __________

Appendix 6a: Osmosis Pre and Post test

<u>Osmosis Pre and Post Test</u>

1. Osmosis is a specific type of diffusion. What type of molecules does osmosis involve?

   a. sugars   c. water

   b. salt   d. all molecules

2. If osmosis takes no energy from the cell it is considered

   a. active transport

   b. passive transport

   c. osmosis is not considered either of these

3. A cell (or a model of a cell such as an egg) is placed in a beaker of water. This solution is:

   a. hypertonic   c. isotonic

   b. hypotonic   d. none of the above

4. (true or false) The diffusion of water does not take energy from the cell

   a. true

   b. false

5. A cell that is hypertonic…

   a. will have equal net movement of water from both sides and not change in size

   b. will shrink in size

   c. will enlarge

   d. more information is needed

Appendix 6b: DNA Pre and Post Test

DNA Pre and Post Test

1. In DNA, Guanine always pairs with
    - a. alanine
    - b. thymine
    - c. cytosine
    - d. uracil

2. DNA is kept inside all the cells of your body. As a cell prepares to divide, DNA coils up to form a ____________.
    - a. chromosome
    - b. trivet
    - c. spindle
    - d. meiosis

3. Which of the 4 letters below are those that make up DNA?
    - a. U, T, A, C
    - b. R, A, N, C
    - c. A, T, C, G
    - d. A, N, D, C

4. What is the complementary DNA strand for GCTATAC?
    - a. CTCGAAC
    - b. GCTATAC
    - c. CGATATG
    - d. CGAUAUG

5. Each unit consisting of a phosphate group, a five-carbon sugar molecule, and a nitrogen containing base is called a
    - a. nucleotide
    - b. histone
    - c. nucleolus
    - d. gentisome

Appendix 6c: Genetics Pre and Post Test

<u>Genetics Pre and Post Test</u>

1. An organism that has inherited two of the same alleles of a gene from its parents is ________ for that trait.

    a. hereditary   c. homozygous
    b. heterozygous   d. mutated

2. The physical appearance of a trait is called its

    a. genotype   c. phenotype
    b. offspring   d. alleles

3. The color of a dog's coat is the dogs

    a. dominance   c. phenotype
    b. pedigree   d. genotype

4. If smooth peas are dominant over wrinkled peas, the allele for smooth peas should be represented as

    a. W   c. w
    b. S   d. s

5. The scientist whose studies formed the basis of modern genetics is

    a. T.A. Knight   c. Louis Pasteur
    c. Gregor Mendel   d. Robert Hooke

Appendix 6d: Classification Pre and Post Test

<u>Classification Pre and Post Tests</u>

1. Which of the 2 levels of classification are used in our scientific name?
   a. Kingdom and order   c. genus and order
   b. genus and species   d. class and family

2. Using the chart on the board, what is the scientific name for the mountain lion?
   a. Felis concolor   c. Canis familaris
   b. Rana Grylio   d. Quercus rubra

3. For grasshoppers and locusts to be in the same family, they must also be in the same
   a. Order   c. genus
   b. Group   d. species

4. What is binomial nomenclature?
   a. Classifying organisms into seven levels
   b. The naming system developed by Aristotle
   c. grouping animals based on how they move
   d. the naming system in which each organism is given a two-part Latin name

5. What is the broadest classification level?
   a. Species
   b. Phylum
   c. Kingdom
   d. Family

Appendix 7a: Parent Consent Form

INCREASING STUDENT COMPREHENSION IN BIOLOGY WITH THROUGH HANDS ON ACTIVITIES AND LABS PARENTAL CONSENT AND STUDENT ASSENT FORM

Dear Students and Parents/Guardians:

I am currently enrolled as a graduate student in Michigan State University's Department of Science and Mathematics Education (DSME). My thesis research is on improving student comprehension of all Biology units through the use of multiple hands on activities and labs. My reason for doing this research is to learn more about improving the quality of science instruction.

Data for the study will be collected from standard student work generated in the course of teaching units throughout the year, such as pre and post-tests, lab activities, and activities. I am asking for your permission to include your child's data in my thesis. Your child's confidentiality is a foremost concern. During the study, I will collect and copy student work. These assignments will have the students' names removed prior to use in the study. All of the work being collected will be stored and locked in the high school office until completion of my thesis research, and will be shredded after that time. In addition, your child's identity will not be attached to any data in my thesis paper or in any images used in the thesis presentation. Instead, the data will consist of class averages and samples of student work that do not include names. Confidentiality of records will be maintained throughout the course of my study and beyond. MSU requires that research records must be maintained for a minimum of three years following completion of the study. During this time, only myself, my advisor, and the Institutional Review Board will have access to these records. Your child's confidentiality will be protected to the maximum extent allowable by law.

Participation in the study is completely voluntary, and you may change your mind at any time and withdraw. If either the student or the parent requests to withdraw, the student's information will not be used in this study. All students will be required to complete all of the given class assignments and activities. There are no unique research activities – participation in this study will not increase or decrease the amount of work that students do. I will simply make copies of students' work for my research purposes. Students who do not participate in the study will not be penalized in any way. In fact, I will not know who is or is not included in the study until the end of the school year, after grades have been submitted.

There are no known risks associated with participating in this study. In fact, completing course work should be very beneficial to students. I will minimize any risk that may exist by having another person collect and store the consent forms (where you say "yes" or "no") in a locked file cabinet that will not be opened until after the end of the school year. That way I will not know who agrees to participate in the research until after grades are issued. In the meantime, I will

Appendix 7a: Parent Consent Form (cont'd)

save all written work for this unit. Later I will analyze the written work only for students who have agreed to participate in the study and whose parents/guardians have consented.

If you are willing to allow your child to participate in the study, please complete the attached form and return it to Thornburg in Room 2. Please seal it in the provided envelope with your child's name on the outside of the envelope. The envelopes will be stored in a locked cabinet and opened after the completion of the school year.

If you have any concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact me by email at heatheralonge@yahoo.com or by phone at (517) 755-4491. Questions about the study may also be directed to Dr. Merle Heidemann at the DSME by email at heidema2@msu.edu, by phone at (517) 432-2152, or by mail at 118 North Kedzie, East Lansing, Michigan 48824. If you have any questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – the Michigan State University's Human Research Protection Program at (517) 355-2180, Fax (517) 432-4503, e-mail irb@msu.edu, or regular mail at 207 Olds Hall, MSU, East Lansing, Michigan 48824.

Thank you,

Heather Alonge
Lansing Everett High School Biology

Parents/guardians should complete this following consent information:

I voluntarily agree to allow ____ to participate in this study. *(print student name)*

Please check all that apply:

Data:

___________ I give Ms. Alonge permission to use data generated from my child's work in this class for her thesis project. All data from my child shall remain confidential.

___________ I do not wish to have my child's work used in this thesis project. I acknowledge that my child's work will be graded in the same manner regardless of their participation in the study.

Appendix 7a: Parent Consent Form (cont'd)

<u>Photography and Videotaping:</u>

____________ I give Ms. Alonge permission to use pictures or videos of my child participating in various activities while in biology class. I understand that my child will not be identified by name in either photos or videos.

____________ I do not wish to have my child's images used at any time during this thesis project.

<u>Signatures:</u>

_______________________________________ _________

(Parent/Guardian Signature) (Date)

I voluntarily agree to participate in this thesis project.

_______________________________________ ___________

(Student Signature) (Date)

*****Important*****

Return this form to Mrs. Thornburg in Room 2.

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