

USING BRAIN-BASED STRATEGIES TO INCREASE MOTIVATION, COGNITION
AND LONG-TERM MEMORY OF BIOLOGY CONCEPTS

by

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July 2013

DEDICATION

This research paper is dedicated to my colleagues and professors that helped me in the process of completing this action research project. Without their help it may have not come into fruition. My thanks also go to my family for putting up with the long hours spent working on this project and their encouragement. Lastly, I would like to acknowledge my father for instilling in me the importance of hard work and dedication.

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND	1
CONCEPTUAL FRAMEWORK.....	4
METHODOLOGY	8
DATA AND ANALYSIS.....	15
INTERPRETATION AND CONCLUSION	22
VALUE	24
REFERENCES CITED.....	28
APPENDICES	30
APPENDIX A: Birmingham Grid for Learning	31
APPENDIX B: Student Attitude Survey	35
APPENDIX C: Unit Pre-and Post-Tests.....	37
APPENDIX D: Teacher Online Mailbox	61
APPENDIX E: Pre-Treatment Interview.....	63
APPENDIX F: Photosynthesis Skit Cards.....	65
APPENDIX G: Infectious Disease Choice Board	68
APPENDIX H: Post-Treatment Survey.....	70
APPENDIX I: Post-Treatment Interview	72
APPENDIX J: Delayed Constructed Response Questions	74
APPENDIX K: Louisiana Biology End of Course Constructed Response Rubric	78

LIST OF TABLES

1. Triangulation Matrix	14
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LIST OF FIGURES

1. Neuron and Synapse Anatomy.....	5
2. Presence of Student Intelligences	15
3. Intelligence Preferences	16
4. Type of Class Work Preferred by Students.....	17
5. Unit Pretest and Post-Test Scores	18
6. Delayed Assessment Average Student Constructed Response Rubric Scores	19
7. Average Student Responses to the Student Attitude Survey	20
8. Average Student Responses to Post-Treatment Survey Questions Regarding the Teacher Mailbox	22
9. Comparison of Delayed Assessment Scores Between Students of Different Achievement Levels.....	26

ABSTRACT

Brain-based education focuses on how we learn and the effects our emotions play in the learning process. This project looked at the effect of using brain-based strategies in the classroom on understanding, motivation, and long-term retention of biology concepts. This project spanned three units in two biology classes. The first unit was taught using traditional lecture, videos, diagramming activities, and PowerPoint shows. The other two units incorporated brain-based strategies such as team building activities, positive feedback, use of multiple intelligences, and student choice. Pre- and post assessments were used to evaluate student learning and constructed response essays were used to determine long-term retention of concepts. Student attitude surveys along with pre- and post interviews were used to determine whether there was an increase in motivation as a result of treatment. Overall, the use of brain-based strategies had a positive effect on student understanding, motivation and long-term retention of biology concepts as well as had a positive impact on the classroom environment and peer interactions.

INTRODUCTION AND BACKGROUND

For the past three years I have been teaching Biology I, Biology II and environmental science courses to high school students at Delhi Charter School. Delhi Charter School is located in Northeast Louisiana just outside of the small town of Delhi, LA. The school was opened in 2001 due to the consolidation and rapid decline of public schools in the area. The school works on a charter that is renewed every five years contingent upon meeting state standards. The school has 684 students in grades K-12 and renewed its charter last summer. The new charter allowed the school to increase the student population, but required the school to let more students in that were at risk which brought the at risk population to approximately 70%. The student to teacher ratio is 18:1. The school demographics are 71.5% Caucasian, 24% African American, 3.4% Hispanic, .5% Pacific Islander, .3% Native American, .3% Asian (*Demographics for Delhi*, 2012). The student body is about equally divided between males and females. Each grade level is composed of two classes, with the exception of grades K, 3 and 5, which are composed of three classes. Students are randomly selected for classes except in the high school where they are divided by dual enrollment and career track students.

The subject I chose to implement my action research-based classroom project was Biology I. In the state of Louisiana, Biology I is a required course for all high school students. I have two Biology I classes for a total of 48 students. Ninety-six percent of students enrolled in my biology classes are sophomores taking biology for the first time. Four percent of students are juniors and seniors taking biology a second time after failing on their first attempt. Both classes were a mixture of gifted, average, and

students with Individual Educational Plans, or IEP's. Both classes occurred in the early morning.

I chose to implement this study in my Biology I classes because it is imperative for my students to make connections with the science material. When they make connections with the material, they will remember concepts long-term and score well on the EOC test at the end of the year, pass the course, as well as, apply their knowledge and understanding in future courses and real-life situations.

This year we have had an influx of new students from failing public schools in the area. This has led to a more diverse classroom atmosphere and changed the classroom dynamics drastically. I noticed that many of my new students have learning gaps and consistently receive lower test scores than the other students in the class. I also noticed that many of the new students do not look comfortable when working with peers on cooperative projects, and some have expressed that they only did book work in their other schools. It has been a challenge in terms of getting my new students caught up with the other students in class and motivating them to study and learn the class material.

I became interested in brain-based research after attending a professional development day at my school. During the workshop, instead of using the traditional lecture, the speaker used many types of learning activities to engage the teachers in learning. We participated in activities that incorporated multiple intelligences such as movement, interaction with peers, visuals and music. I found the use of multiple strategies engaging because I often lose interest during lectures due to the fact that I am a kinesthetic learner. After the workshop, I began to watch my students more closely

when I was giving lectures paying close attention to my new students and low achieving students. I noticed that many students would pay attention the first 10 minutes, then if not actively engaged would tend to get off track. This led me to do more research on brain-based strategies. While researching, I noticed that many brain-based strategies addressed multiple intelligences as well as making the classroom environment friendly and less stressful.

By incorporating brain-based strategies, I feel that I can increase student motivation by providing a non-stressful, active environment in which students will be able to make connections to the material through using multiple intelligences therefore making neuronal connections. Through review and reflection, students will be able to store information in their long-term memory, which will benefit them this year as well as in the future.

The primary focus question of this study was: What are the effects of incorporating brain-based strategies on student motivation, cognition and long term memory of science concepts? The sub questions for this project are as follows:

1. Will the incorporation of a teacher mailbox and positive feedback motivate students to communicate with the teacher?
2. Will the incorporation of student choice to address multiple intelligences affect student motivation, understanding, and long-term retention of science concepts?
3. How will the incorporation of team building activities affect peer-relations?
4. How will the incorporation of brain-based strategies affect teacher motivation and pedagogy?

CONCEPTUAL FRAMEWORK

According to the National Centers for Educational Statistics, one-third of new teachers leave the profession in their first five years citing student behavior and motivation as top reasons (Provasnik & Dorfman, 2005). Since motivation is the driving force for all actions, students who are not positively motivated in the classroom will exhibit disruptive behavior. Disruptive behavior leads to increased teacher stress and burnout (Haberman, 2004). Students in disruptive classes often have less actively engaged learning time, make poorer grades and receive lower standardized test scores (Oliver, Wehby & Reschly, 2011). Behavior and motivation is linked to student's home lives and personal experiences that can have an impact on their emotions. Emotions have a direct impact on learning (Hinton, Miyamoto & Della-Chiesa, 2008).

The role of the teacher has evolved over the years to include many more responsibilities. Teachers no longer just educate, but also act as counselors to help students deal with emotional problems. The desire to help students grow and mature in a healthy manner led to the development of brain-based education (Lanier, 1997).

Brain-based research came into full swing in the 1980's. Through the research, a picture began to develop on how learning begins, what impedes the learning process, and what educators can do to enhance the learning process (Jensen, 2008a). Some recent discoveries are that the human brain grows new neurons, social conditions influence our brain, the brain can rewire and remap itself because of plasticity, chronic stress can impede learning, gene expression does have an effect on learning, movement is necessary, and environments can have a profound impact on the brain (Jensen, 2008b). This provided educators with the challenge of creating a nonthreatening and conducive

environment for learning along with stimulating lessons that are differentiated according to student needs in order to establish the goal of student motivation and learning (Connell, 2005).

Brain-based learning is defined as the engagement of strategies based on principles derived from an understanding of the brain (Jensen, 2008a). The basic unit of the brain is the neuron, which is made up of a cell body, an outgoing component called an axon, and incoming units called dendrites (Figure 1). In order for information to pass from one neuron to the next, electrochemical signals have to cross the synapse between the axon and dendrite. These electrochemical signals are called neurotransmitters. Two important neurotransmitters have been identified that have a direct impact on learning, cortisol and noradrenaline (Medina, 2008).

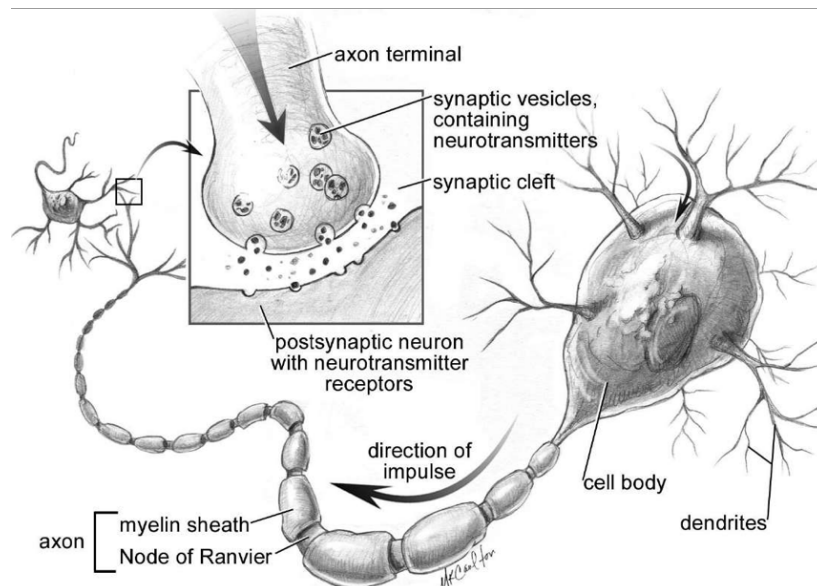


Figure 1. Neuron and Synapse Anatomy (Craig, 2003).

Cortisol, a stress hormone, impairs learning and can have negative effects on the immune system when high levels are present in the body. Cortisol kills brain cells by interfering with the brain's supply of glucose, impairing the function of

neurotransmitters, and causing an influx of calcium ions (Khalsa & Stauth, 1997).

Goleman (1995) states, “Cortisol steals energy resources from the working memory.

When cortisol levels are high, people make more errors, are more distracted, and can’t remember as well. Irrelevant thoughts intrude, and processing information becomes more difficult” (p. 76). Noradrenaline is a stress hormone that is linked to alertness and attention. In high levels it enhances learning and memory. It is produced when we react to difficult situations or challenges and strengthens our ability to deal with further challenges provided it is not released continuously (Caine & Caine, 1991).

In order to make the classroom environment conducive to learning, the teacher needs to first understand that all students can learn and that they are emotional beings. Student emotions drive their actions (Connell, 2005). The limbic system, which is composed of the amygdala, hippocampus, thalamus and hypothalamus, deals with emotion, memory, and control the body’s physiological response to stress. When information enters the brain the thalamus and hypothalamus determine whether it needs immediate attention or can be processed normally. If information is perceived as negative, the fight or flight response can kick in, and memory can be impaired by the release of stress hormones. In order to prevent the release of stress hormones, the teacher can create a positive environment by interacting with the students in a pleasant, respectful, nonthreatening manner (Caine & Caine, 1991). The teacher needs to encourage students, find positive ways to make each student feel special, provide clear expectations, and keep sensitive information confidential. Students should also speak and act respectfully towards all members of the class (Erlauer, 2003). When students feel safe and respected, neurons begin to fire, forging connections telling their limbic

system, the emotional brain, that the environment is nonthreatening and opens the door for learning (Connell, 2005).

Along with emotion, a student has to find relevance in learning material. If material does not seem relevant to their lives, they will quickly lose interest and stop listening. On average, short-term memory holds information for roughly 5-20 seconds. Information that is deemed unimportant is quickly dumped and important information is stored (Caine & Caine, 1991). When a teacher can establish relevance in learning, students will become more engaged, thereby strengthening neural systems that already exist, as well as making new neural connections. In order to make material relevant to students, teachers can accommodate ability levels and learning styles by offering students choices in learning activities that are differentiated for multiple intelligences (Erlauer, 2003).

Finally, students should be encouraged to be active participants in the learning process so that they can take ownership of their learning. The teacher should provide opportunities for students to experience learning by using as many senses as possible. In a typical classroom, students display a variety of intelligences and learning styles. Sousa (1998) stated that 46% of students are visual learners, 35% are kinesthetic learners, and 19% are auditory learners. All lessons should present information using at least two modalities. Time should be allocated for exploration and group discussion. Not only will this be stimulating to students of different learning styles it will also stimulate neurons in different centers of the brain, resulting in the formation of neural networks. At the end of a learning activity, students should also be given down time in order to reflect on

information they learned. This gives the brain time to make the proper links and create new synapses for long-term memories (Connell, 2005).

Through the understanding of the brain and its implications for learning, teachers can create positive environments for their students that have a positive effect on their emotional well-being. By doing this, teachers will stimulate students' brains to be receptive to new learning experiences. When combined with relevance and student centered learning activities, new neuronal networks can be created that will last long-term (Jensen, 2008a).

METHODOLOGY

This project was designed to determine whether using brain-based strategies would increase student motivation, understanding and long-term retention of biology concepts. This project spanned three nonconsecutive units, due to teacher medical leave. Data collection began in January 2013 and culminated in March 2013. The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained.

Students chosen for the sample for this project were students in two Biology I classes at Delhi Charter School. The Biology I classes are sophomore level and divided into two sections, for a total of 46 students. Thirty-nine students were chosen to be in the sample for this project. Biology is a required course for all high school students and is representative of the whole school demographic. Students range in achievement ability from gifted students to those with IEP's. The demographics of the Biology I

sample are 15 males and 24 females. Seventy-seven percent of students are Caucasian, 20.5% African American, and 2.5% Hispanic. Three percent of Biology I students have IEP's and 5% are in Gifted Education.

This project included one non-treatment unit on Earth's Cycles and two treatment units. Treatment unit one was on photosynthesis and cellular respiration, while treatment unit two covered health and disease. Prior to the non-treatment unit students took the Birmingham Grid for Learning (BGfL, n.d.) online to assess multiple intelligences and provide data on what types of learning styles should be incorporated into the treatment units (Appendix A). Students also completed the Student Attitude Survey prior to the non-treatment unit to provide baseline data on student attitudes (Appendix B). The Student Attitude Survey consisted of three sections and was designed to determine how students felt about the classroom environment, the teacher and their own abilities. Students responded to questions in each category ranking them from 1-5 with 1 representing *never* and 5 representing *always*. The survey was re-administered at the conclusion of the second treatment unit. Student data for each category was averaged, both pre-treatment and post-treatment, then compared to determine whether student attitudes changed as a result of treatment.

Identical Pre-and Post-tests were used for each unit to evaluate student knowledge and comprehension of concepts (Appendix C). All tests were created using the test maker from Pearson Biology, Louisiana Edition. The non-treatment and treatment unit one tests consisted of multiple choice, modified true false, short answer, science skills, and essay questions. The test for treatment unit two consisted of only multiple choice and short answer items. Students were required to record answers on

teacher-made scantron sheets. The pretests were used to provide baseline data on student understanding of biology concepts for each unit. At the conclusion of each unit students took the post-test. Pre-test and post-test scores were averaged and compared in order to measure whether student learning and understanding of concepts improved as a result of learning experiences used during each unit.

The non-treatment unit, Earth Cycles, addressed concepts relating to the water, carbon, nitrogen and phosphorus cycles. This unit included regular use of PowerPoints, lectures, videos, exit tickets and diagramming activities. Students worked on all activities associated with this unit independently.

Prior to the first treatment unit, photosynthesis and cellular respiration, a teacher mailbox was set up online as a means of communication between the students and teacher (Appendix D). The mailbox was used for students to express concerns that they did not feel comfortable talking about in class and to address questions they had after school hours. Students were instructed on how to access the online teacher mailbox. Students were also told that if they could not remember their passwords to access the teacher mailbox they could send their questions to the teacher through email. Also, eight students, representative of the sample demographic, were selected to participate in Student Pre-Treatment Interviews (Appendix E). Pre-treatment interviews were conducted with each student in private and responses were recorded manually. Each interview consisted of ten questions that included topics such as communication with teacher, instruction, classroom environment, multiple intelligences/learning styles, group work and student choice. Student responses were used to understand their background and to determine what learning experiences would meet their needs.

The first treatment unit, photosynthesis and cellular respiration, focused on the processes and molecules involved in photosynthesis and cellular respiration, location within the cell, reactants involved and products of the processes, and the organisms in which they occur. Lessons during this unit were differentiated for multiple intelligences. Concepts were introduced using PowerPoint shows, interactive diagrams and music videos. After concepts were introduced students were assigned to groups for team building activities. Student groups remained the same throughout the unit. Team building activities were used to build positive peer relations and reduce student stress. Activities included creating skits on photosynthesis and lessons on cellular respiration. During the first activity, photosynthesis skits, students were given molecule and cycle cards and were challenged to create a skit to demonstrate the process of photosynthesis (Appendix F). Students were given time to research the steps of photosynthesis and the molecules involved, and create their skit. Students then performed skits for the class while being filmed by the teacher. Student filmed skits were then shown to the class in order to allow students to view their own skits so they could reflect on it later and as means of review. After viewing filmed skits student groups participated in discussions addressing positive experiences gained through the activity then, shared experiences with the whole class. At the conclusion of the activity students were given time to reflect on what they learned and posted comments about what they learned to the class blog.

The second teambuilding activity consisted of students creating lessons to teach the class about the process of cellular respiration. Students within each group appointed team leaders, researchers, and artists. The teacher listed important concepts on the board that were to be included in their lessons and students were given time to conduct

research and create lessons. Student groups were given two class days for this activity. Student groups presented their lessons, and then were asked to reflect on the process of cellular respiration. Students were asked to explain what they learned on a large Post-It notes and to stick it on the door in the class parking lot on their way out. The teacher read all reflections after students left the room and corrected any student misconceptions at the beginning of the next class period. The final day of the unit was used for review. During the review student groups used a Venn diagram to compare the processes of photosynthesis and respiration and participated in an interactive review game.

The second treatment unit, health and disease, was presented using multiple intelligences and student choice activities were incorporated. Concepts covered during this unit were causes of disease, transmission of disease, non-specific and specific defenses of the body, immunity and autoimmune diseases.

Prior to the first lesson, students were given the Infectious Disease Choice Board (Appendix G). The choice board included all intelligences. Each lesson that was presented had corresponding activities on the choice board for the students to choose from. Symbols on the choice board were used to designate activities for each concept. Students were to complete two activities on the board after the concepts of disease transmission and humoral immunity were taught. All students were required to complete the center activity *Make a Movie on an Infectious Disease*, in which students chose the disease they wanted to research.

Concepts covered during this unit were taught using PowerPoint shows, lecture, videos, images, and music videos. While working on lessons from this unit students were able to choose whether they wanted to work in groups or alone on activities. If

students chose to work in groups they were able to create their own groups. The only activity that students had to work on individually was the movie activity. At the end of the student choice activity that covered humoral immunity, students presented their work to class. After all presentations were complete, students were given time to reflect on their work and post comments to the class blog. Prior to the unit test we had two movie days in which students introduced their infectious disease as well as showed their movie. During movie day students were required to write positive comments for each movie shown. All positive comments were given to students.

At the conclusion of treatment students were re-administered the Student Attitude Survey and completed the Post-Treatment Survey (Appendix H). Each survey was completed online on the class website. Student Post-Treatment Interviews were also conducted (Appendix I). Observations and reflections were made throughout the project. Responses from the surveys and interviews, along with teacher observations and reflections were used to determine change in student attitudes and motivation as well as change in teacher motivation and pedagogy as a result of treatment.

In order to measure long-term knowledge and understanding of concepts students completed Delayed Constructed Response Essays (Appendix J). Essays were assigned and completed two weeks after conclusion of each unit. Student essays were graded using the Louisiana Biology End of Course Test Constructed Response Rubric (Appendix K). The rubric measures understanding on a scale of 0-2, with 0 indicating the student responded incorrectly, or did not respond and 2 representing a completely correct answer. Data from each unit essay were averaged and compared to determine which unit the students retained the most knowledge and understanding from (Table 1).

Table 1
Triangulation Matrix

<i>Primary Focus Question: What are the effects of incorporating brain-based strategies on student motivation, cognition and long-term memory of science concepts?</i>			
Research Questions	Data Source		
	1	2	3
1. Will the incorporation of a teacher mailbox and positive feedback motivate students to communicate with the teacher?	Student Interviews	Artifacts	Teacher Observation
2. Will the incorporation of student choice addressing multiple intelligences affect student motivation, understanding, and long-term retention of science concepts?	Multiple Intelligence Survey Student Interviews	Student Essays Teacher Observation	Pre-/Post-Tests
3. How will the incorporation of team building activities affect peer relations?	Pre-Post Student Attitude Survey	Post Treatment Interviews	Teacher Observation
4. How will the incorporation of brain based strategies affect teacher motivation and pedagogy?	Teacher Reflections	Student Interviews	Pre-Post Student Attitude Survey

DATA AND ANALYSIS

Data from the BGfL online survey, Student Attitude Survey, teacher generated tests, student essays, student interviews, artifacts, and teacher observation journal were examined. The patterns of results from these sources were used to answer the fundamental research questions posed.

The BGfL established a baseline for student intelligences. Eighty-two percent of students had one dominant intelligence; of those, 31.25% were interpersonal, 21.8% were musical, , 15.6% intrapersonal, 12.5% kinesthetic, 6.25% linguistic, 6.25% naturalistic, 6.25% visual, and 0% logical. The remaining 18% of students showed a preference for more than one intelligence; of those, all had interpersonal intelligence (Figure 2).

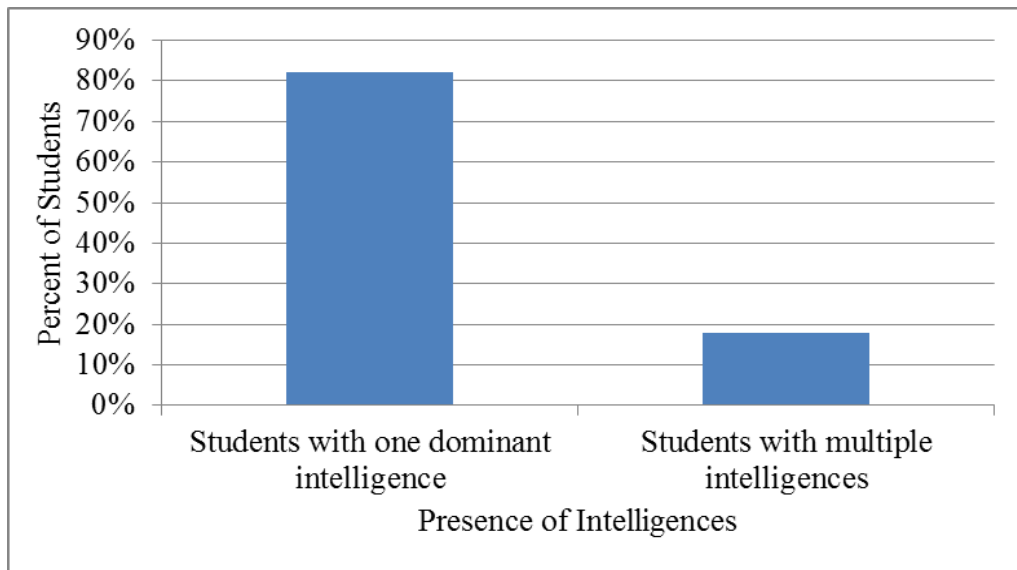


Figure 2. Presence of student intelligences, (N = 39).

When all students, both students having one dominant intelligence and those having evidence of multiple intelligences were represented by their intelligences the interpersonal learning was represented the most, followed by musical, intrapersonal and

kinesthetic. Intelligences represented the least were naturalistic, visual, logical and linguistic. Student intelligences are shown in the data below, students with multiple intelligences were represented by each of their intelligences (Figure 3).

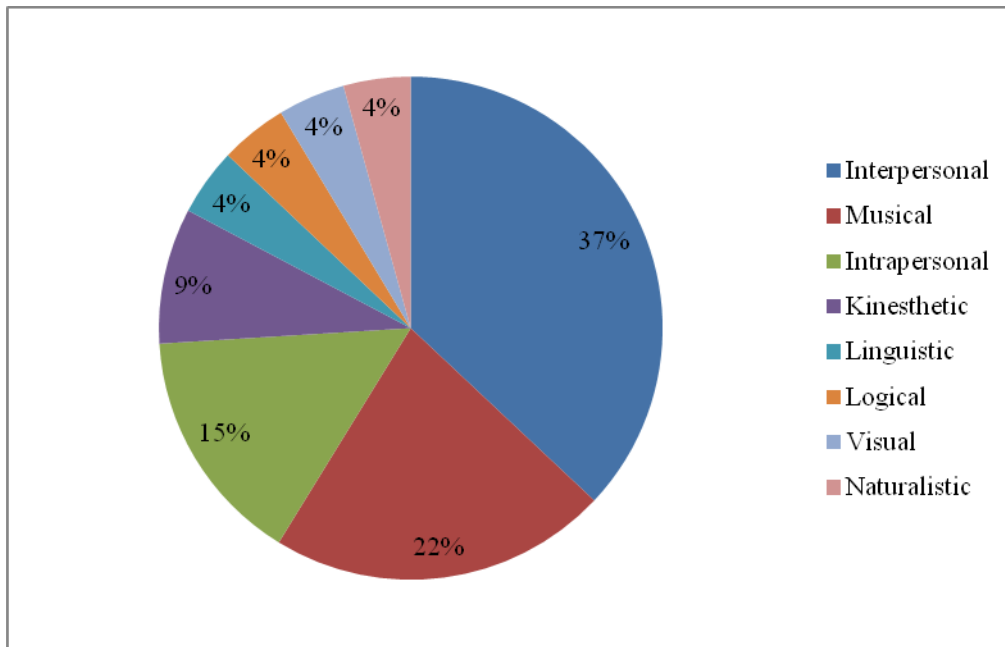


Figure 3. Intelligence preferences, (N = 39).

Exit tickets that contained two open-ended response questions that reflected on the results of the BGfL Survey were also analyzed. Students were asked whether they preferred to work in groups or alone. Fifty-six percent of students responded that they would rather work in groups. One student stated, “I get more work done when in a group because we have more heads working together and thinking.” Another student explained, “When I’m in groups I can build off of everybody’s ideas.” The data further indicated that 41% of students in preferred working alone. One student responded, “I get more work done alone because I don’t have to worry about other people.” Another student stated, “I don’t have the distractions of other people when I work alone.” Two

percent of students responded that it didn't matter whether they worked in groups or alone (Figure 4).

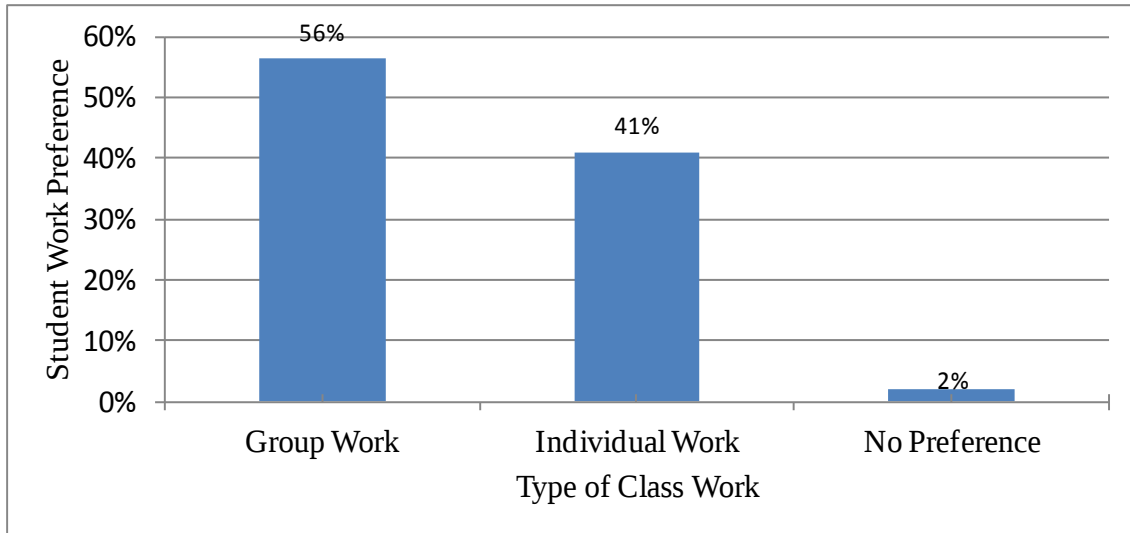


Figure 4. Type of class work preferred by students, ($N = 39$).

The final question asked students what the teacher could do in class to help them learn better. Fifty-four percent of students indicated that the teacher could let them do more hands on projects in groups. Student responses included, “you can use more songs” and “you already do a good job, don’t change anything.”

Unit pre- and post-tests were used to determine student understanding and comprehension. For each successive unit pretest scores followed an increasing trend. There was an increase by 12% from the non-treatment unit to treatment unit one and a 92% increase from the non-treatment unit to treatment unit 2. When post-test scores were compared, students scored highest on treatment unit one with an average of 83%. In comparing pretest and posttest scores, the non-treatment unit showed a 196% increase

in scores as compared to treatment unit one with a 196.4% increase, and treatment unit two with an increase of 56.25% (Figure 5).

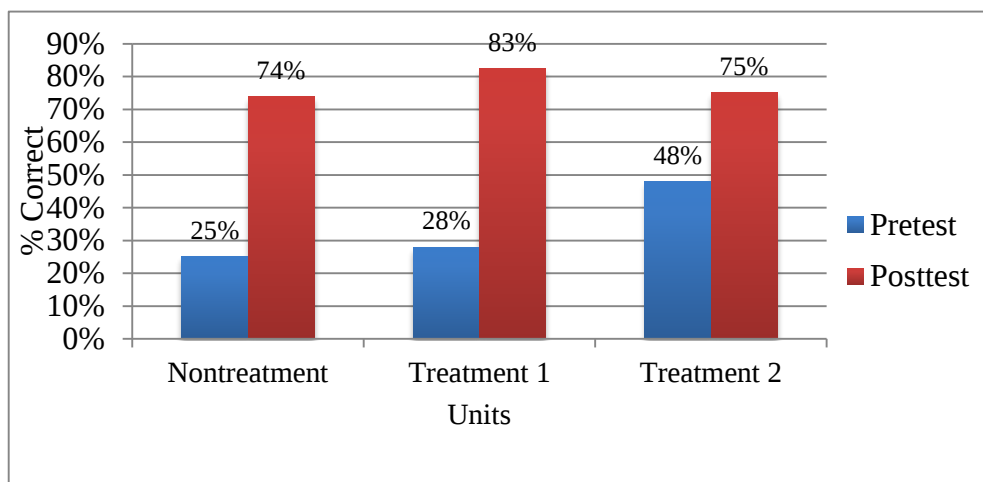


Figure 5. Unit pretest and post-test scores, ($N = 39$).

Interestingly, even though there was less gain in treatment unit two, 65% of students felt that this unit matched their learning style, and 46.5% felt that they learned the most during this unit. Seventy-five percent of students ($n=8$) interviewed indicated that having a choice in learning activities helped them learn the material better during treatment unit two. One student stated, “When I get to choose the activity, I can choose what matches my learning style, also I won’t be bored when I do something I like.” An inconsistency noted between the data was that even though treatment unit two was indicated as matching students’ learning styles better, 63% of students indicated that role play activities that were done in treatment unit one was the activity that helped them learn best. One student stated, “I find that doing activities that involve teamwork, fun, and an easy way to learn, makes kids my age want to learn about the activity. So, to me, stuff like creating skits with friends is by far the best activity to learn.”

Student constructed responses for long term retention of conceptual understanding indicated that students retained the least amount of conceptual understanding from the non-treatment unit followed by treatment unit one, and retained the most conceptual understanding from treatment unit two. Gains in concept retention from the non-treatment unit to unit one were 15.6%, and from the non-treatment unit to unit two was 73.4% (Figure 6).

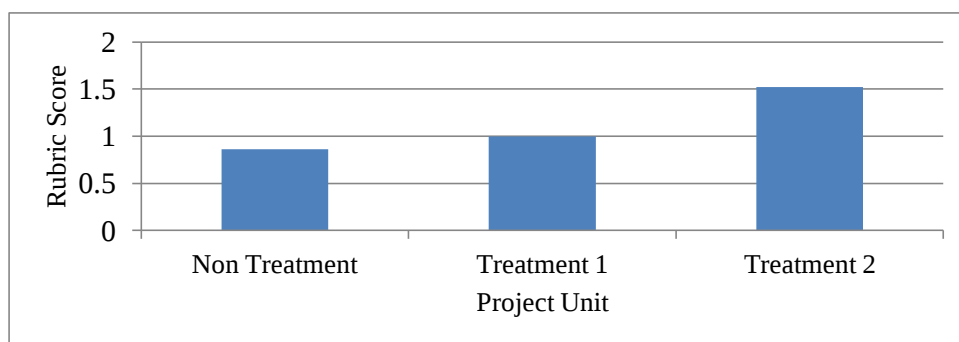


Figure 6. Delayed assessment average student constructed response rubric scores, (N = 39). Scoring Key: 2=correct and complete answer, 1=partially correct answer, 0=incorrect answer or too brief to evaluate.

Student attitude and motivation data were gathered through quantitative and qualitative sources such as the Student Pre and Post Attitude Surveys, Post Treatment Surveys, student interviews and the teacher observation journal. Results from the Student Attitude Survey showed that student attitudes regarding the classroom being a safe and positive environment averaged 4.2 on a 5 point scale which was an increase of 17.3%. In the Post Treatment Survey, 92% percent of students indicated that team building activities had a positive effect on the classroom environment. One student responded, “working in groups makes me feel more comfortable with my class and

makes me feel better about asking questions in class.” A note in the teacher observation journal stated, “Students really seem to be working nicely with each other, they are not asking me so many questions. They are relying more on one another to get the work done.” Student feelings about their teacher being enthusiastic, helpful, and differentiating for their learning needs also saw an increase. Student attitudes regarding their teacher averaged 4.19 which was an increase of 5.8%. A score of 3.56 was observed in student attitudes regarding their ability to learn and confidence levels which was a decrease of 3.8%. The decrease was due to a shift of students choosing *always* to *almost always* categories to *almost always* to *sometimes* (Figure 7).

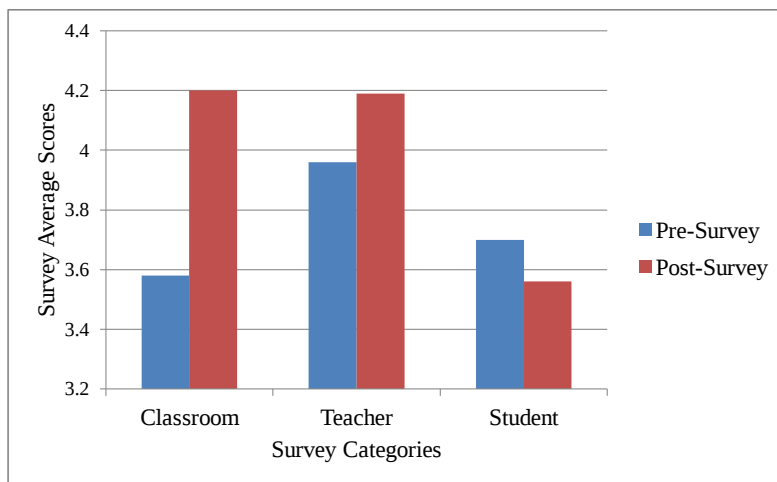


Figure 7. Average student responses to the student attitude survey, (N = 39). Scoring Key: 1=never, 2= almost never, 3=sometimes, 4= almost always, 5= always.

Teacher attitude was measured qualitatively through use of student interviews and the teacher observation journal. Comments throughout treatment units reflect a positive teacher attitude such as, “I love that students are working so well together, the class is so much more productive” and “I do not have to discipline as much since everyone is on task.” Student interviews also showed a positive change in teacher attitude and motivation. One student stated, “you are always positive and encouraging to us.” Another responded, “you always help us when we need it.” Other students responded that the teacher made lectures more interesting during treatment by drawing diagrams and giving real life examples while teaching.

Quantitative data showed that the incorporation of an online teacher mailbox had a minimal affect on student communication with the teacher. Fourteen percent of students used the online mailbox to ask questions throughout the treatment period. Eighty six percent of students preferred to ask the teacher questions directly in class or after class. According to the Student Post-Treatment Survey, 40.5% were undecided whether they felt the mailbox was helpful. Thirty five percent of students responded that the online teacher mailbox made them feel more comfortable about asking questions in class compared to 24.3% that responded that it did not make them feel more comfortable about asking questions (Figure 8). An entry in the teacher observation journal stated “I guess the mailbox is not as useful as I thought, students keep staying after class to discuss any problems” and “the only time the mailbox has been used is after school hours.”

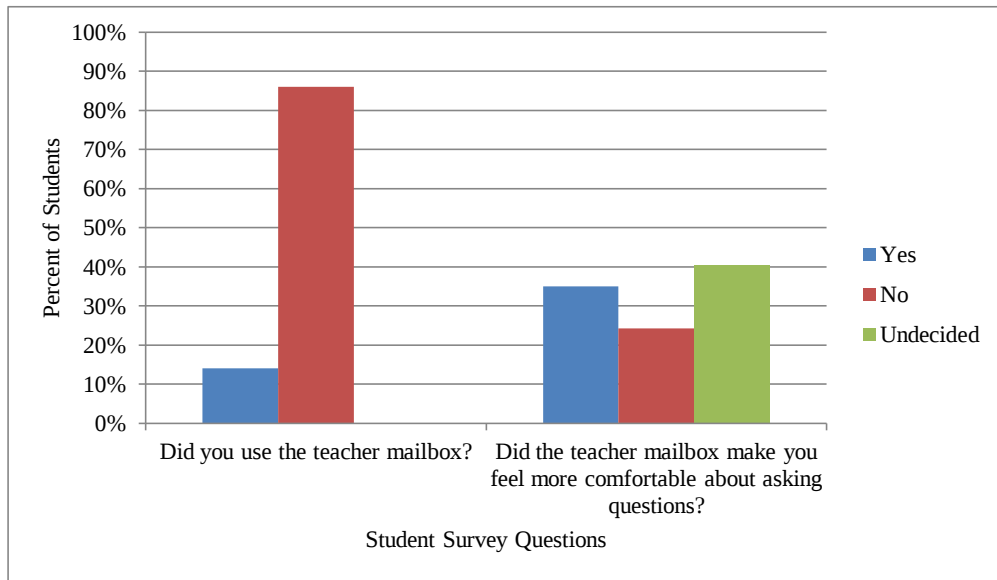


Figure 8. Average student responses to post-treatment survey questions regarding the teacher mailbox, ($N = 39$).

INTERPRETATION AND CONCLUSION

As an educator I found it critically important to determine the type of intelligences and learning styles of my students so that I could meet their learning needs. I was not surprised to find out that the vast majority of my students were of the interpersonal intelligence, which will benefit them in the future if they learn how to work as team and encourage one another. Positive experiences boost self-confidence and motivation. I was surprised to see a decrease in student confidence as noted in student attitude surveys. The decrease in student self-confidence was slight and can be attributed to the fact that student surveys were administered just before spring break when students were stressed out about completing a research paper they had due in their English class. The stress that they were feeling, even though not attributed to biology class, had an

impact on their entire attitude. However, even though their self-confidence was lacking, they were highly motivated to complete their classwork. Students often stayed in my classroom at recess and came in during their PE time to make sure their assignments were complete and to their liking.

Teacher motivation and pedagogy increased throughout treatment because the role of lecturer and disciplinarian changed to as less stressful role of facilitator of learning as noted in teacher reflections. One reflection stated, “It is nice to see students wanting to learn, they really seem to be getting along. They only need my technical assistance. I’m glad I have not had to fuss. This is much less stressful!” A less stressful environment had a positive impact on the teacher’s attitude, which made the classroom a more inviting environment.

The results of this study demonstrated moderate improvement in overall student knowledge and understanding of biology concepts and great improvement in long-term retention of biology concept knowledge and understanding as result of using brain-based strategies. However, some of the data were a bit confusing. For example, students made great gains in understanding and knowledge of concepts during the first treatment unit that covered photosynthesis and cellular respiration and less gain during the second treatment unit on health and disease as shown in the comparison of pre- and post-test scores. This could be attributed to the fact that student pretest scores were twenty points higher on the pre-test for unit two, therefore less gain was probable. Also, the end of the second treatment unit was rushed due to spring break holiday.

The most noteworthy improvement that was seen was the students’ ability to apply the information they learned to answer the delayed constructed response

questions. I believe this can be attributed to the fact that students were allowed to choose the activities they would complete. Since students chose the activities they would complete they were more likely to complete the activity and gain knowledge and understanding in a way that best matched their type of intelligence and learning style. This had a great impact on their motivation and confidence.

As a result of team building activities in the form of challenges, I saw a great deal of positive peer interaction and my newer and more introverted students seemed to open up and ask more questions, which had a tremendous impact on their learning. Positive notes during the movie viewing also made students feel good about their work. One student stated, “Mrs. Gray, I really like that you had us write reviews, it made me feel good about what I did.”

The addition of a teacher mailbox did not have much impact on student teacher communication. Students preferred to ask the teacher questions directly during class or after class. The only time students accessed the mailbox was after school hours, and still very few students did. Over half of the students in the study said they liked the idea of the mailbox, but they were not sure whether they would use it.

VALUE

Brain-based education not only attempts to match student learning experiences to their types of intelligences and learning styles, but also focuses on student emotions that can be reflected in their attitudes and motivation levels. Student emotional stability is vital to their ability to listen and learn new material. Through interaction with material in

ways that match their type of intelligence and learning style students are able to understand and retain more information.

Through this project I learned a great deal about my students and myself, foremost being the importance of students feeling emotionally safe in the classroom environment. When students are preoccupied with negative emotions they cannot pay attention to what is being taught, therefore will not connect to the material being taught. Students who are emotionally preoccupied will tend to disrupt the classroom more or simply not pay attention to what is being taught and will result in lower achievement. The lower achievement will impact their self-confidence and make them more likely to detach further or act out to gain peer attention, which will have a negative impact on all students. By incorporating team building activities students learn to work together and through encouragement of their peers they feel like they are a part of the class rather than just an observer. When students feel like they are part of the class they feel emotionally safe will become active learners and begin asking questions. This will have positive consequences on their retention of concepts and therefore achievement.

Secondly, I have learned the importance of assessing student intelligences and learning styles. When not assessing types of intelligences and learning styles of students, we as educators do not know how to begin teaching our students so that they actually learn and retain the information we are trying to teach. It is vital to know how your students learn because they are all unique and what work for one may not work for another, which results in a loss of valuable teaching and learning time. By teaching a student in the learning style that is not compatible with their own, fewer connections within the brain will form and it is less likely that students will retain the information

that they are taught. This will result in lower achievement and impact their self-confidence in a negative manner. When allowing students a choice in learning activities, they will choose what is compatible with their type of intelligence and learning style which will allow them to make more connections to the material resulting in long-term retention. This was especially true of my lower achieving students. Even though the low achieving students post test scores did not reach the level of the average or high achieving students, they showed gains throughout each sequential unit, whereas the other groups did not. The positive effects of using brain-based strategies on my lower achieving students was evident in their ability to comprehend and remember information long -term which was demonstrated in their ability to answer constructed response questions on the delayed assessment. Their achievement on the delayed assessment was very close to the average and high achieving students, therefore closing the learning gap. I found this to be a major success as a result of this study (Figure 9).

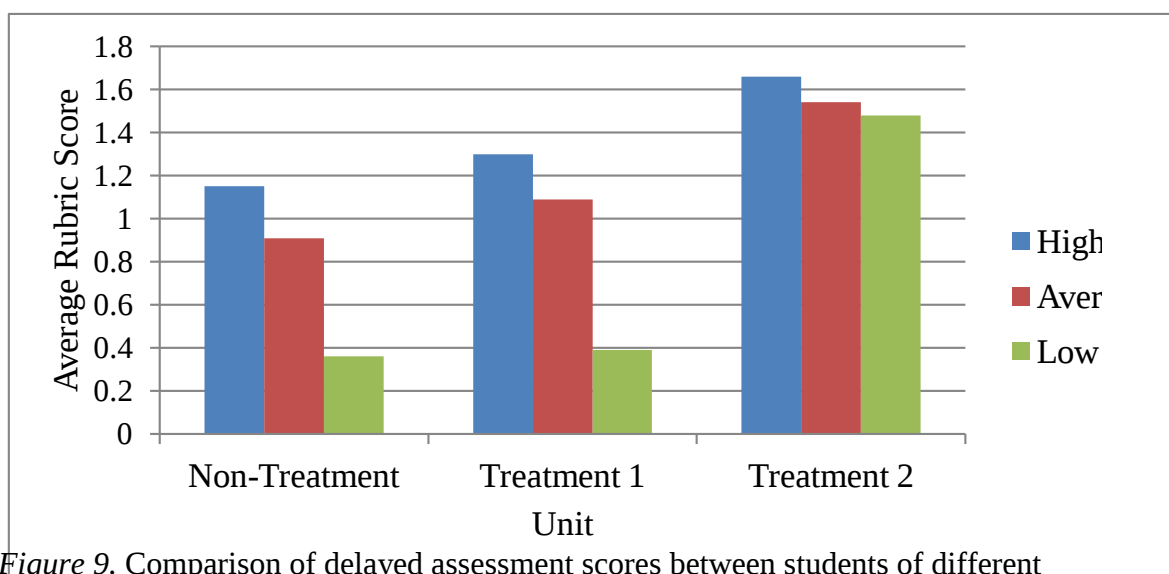


Figure 9. Comparison of delayed assessment scores between students of different achievement levels, (N = 39). Scoring Key: 2=correct and complete answer, 1=partially correct answer, 0=incorrect answer or too brief to evaluate.

Throughout this project, I have come to look at my students in a new light. I have learned that I need to avoid having preconceived notions about students just because other teachers label them as troubled students or low ability. In reality those students may be very intelligent and well behaved. It could be the teachers themselves that have had a negative impact on their students by not meeting their individual needs in the classroom as well as not communicating with them in a positive manner. Since we are not with our students at all times, we don't know everything that is going on in our students lives, which has a definite impact on their learning. As a result of this project I will make sure that I listen and observe my students better to determine whether there is anything in the way of learning and address those things with the students, administrators and parents if warranted. I believe it is my job not just to teach material, but to teach students to communicate in order to determine what their specific needs are so that they can achieve success.

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APPENDICES

APPENDIX A

BIRMINGHAM GRID FOR LEARNING

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Section 1: Tell us a little bit about yourself

[What are Multiple Intelligences?](#) | [Take a Test](#) | [Results](#) | [Notes](#)

Are you male or female? ☐ Male ☐ Female

What is your age? ☐ 11 or under ☐ 12 - 14 ☐ 15 - 16 ☐ 17 - 18 ☐ 19 or over

Where do you live?

	This is not like me at all	I am very rarely like this	This is a bit like me	This is sometimes like me	I am like this more often than not	I am always like this
I am interested in why people do the things they do.	☐	☐	☐	☐	☐	☐
I like to work with a team.	☐	☐	☐	☐	☐	☐
I learn best when I have to get up and do it for myself.	☐	☐	☐	☐	☐	☐
I need to see something in it for me before I want to learn something.	☐	☐	☐	☐	☐	☐
I have a good sense of balance and like to move around a lot.	☐	☐	☐	☐	☐	☐
I can picture scenes in my head when I remember things.	☐	☐	☐	☐	☐	☐
I am good at mathematical problems and using numbers.	☐	☐	☐	☐	☐	☐
I like to make lists.	☐	☐	☐	☐	☐	☐
Pollution makes me angry.	☐	☐	☐	☐	☐	☐
I like to think through problems while I walk or run.	☐	☐	☐	☐	☐	☐

Next

Top

	This is not like me at all	I am very rarely like this	This is a bit like me	This is sometimes like me	I am like this more often than not	I am always like this
I can recognise and name different types of birds, trees and plants.	☐	☐	☐	☒	☐	☐
My mood changes when I listen to music.	☐	☐	☐	☒	☐	☐
I enjoy making music.	☐	☐	☐	☒	☐	☐
I like working and thinking on my own and quietly.	☐	☐	☐	☒	☐	☐
I enjoy logic problems and puzzles.	☐	☐	☐	☒	☐	☐
I have a good sense of direction.	☐	☐	☐	☒	☐	☐
I like to work with my hands.	☐	☐	☐	☒	☐	☐
I enjoy working on my own.	☐	☐	☐	☒	☐	☐
I am sensitive to the moods and feelings of others.	☐	☐	☐	☒	☐	☐
I can remember pieces of music easily.	☐	☐	☐	☒	☐	☐
I remember things like telephone numbers by repeating them to a rhythm.	☐	☐	☐	☒	☐	☐
I can link things together and pick out patterns easily.	☐	☐	☐	☒	☐	☐
I find it easy to explain to others.	☐	☐	☐	☒	☐	☐
I enjoy writing things down.	☐	☐	☐	☒	☐	☐
I can take things apart and put them back together easily.	☐	☐	☐	☒	☐	☐

APPENDIX B

STUDENT ATTITUDE SURVEY

STUDENT ATTITUDE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way. This survey was given on the school echalk website <http://www.delhicharterschool.org/intranet>.

	Always	Almost Always	Sometimes	Almost Never	Never
Classroom					
1. I feel safe in the classroom.					
2. I feel comfortable about asking questions in class.					
3. I find the classroom to be a positive environment.					
4. I don't worry about being harassed in class.					
Teacher					
5. My teacher is enthusiastic about teaching.					
6. My teacher enforces classroom rules.					
7. I feel that my teacher cares about me.					
8. My teacher treats students equally.					
9. My teacher encourages me to do well.					
10. My teacher offers extra help when I need it.					
11. My teacher presents class material in a variety of ways.					
12. My teacher knows a lot about science.					
13. When teaching, my teacher gives real-life examples.					
Student					
14. I find science challenging.					
15. I am good at science.					
16. I feel confident in my learning abilities.					

APPENDIX C

UNIT PRE-AND POST-TESTS

Earth's Cycles Test

Multiple Choice

Identify the choice that best completes the statement or answers the question.

- _____ 1. Matter can recycle through the biosphere because
- a. matter does not change into new compounds.
 - b. matter is assembled into chemical compounds.
 - c. biological systems do not use up matter, they transform it.
 - d. biological systems use only carbon, oxygen, hydrogen, and nitrogen.
- _____ 2. The repeated movement of water between Earth's surface and the atmosphere is called
- a. the water cycle.
 - b. the condensation cycle.
 - c. precipitation.
 - d. evaporation.

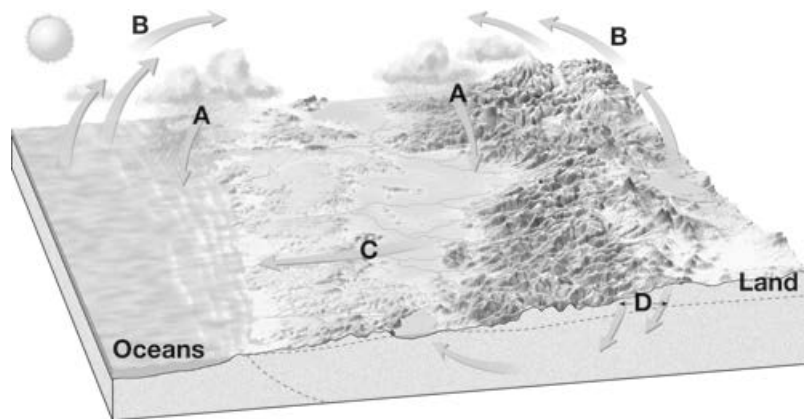


Figure 3-3

- _____ 3. What is happening to water at D in Figure 3-3?
- a. Water is falling to the ground as precipitation.
 - b. Water is evaporating from the ocean.
 - c. Water is being taken up by plants through transpiration.
 - d. Water is seeping into the ground to become groundwater.
- _____ 4. Which part of Figure 3-3 shows transpiration?
- a. A on the left
 - b. B on the left
 - c. A on the right
 - d. B on the right
- _____ 5. Carbon cycles through the biosphere in all of the following processes EXCEPT
- a. photosynthesis.
 - b. transpiration.
 - c. burning of fossil fuels.
 - d. decomposition of plants and animals.
- _____ 6. Which part of the water cycle is a biological process?
- a. transpiration
 - b. runoff
 - c. precipitation
 - d. condensation

- ____ 7. Nitrogen fixation is carried out primarily by
- a. humans.
 - b. plants.
 - c. bacteria.
 - d. consumers.
- ____ 8. Animals get the most of the nitrogen they need
- a. by consuming plants or other animals.
 - b. by breathing in atmospheric nitrogen.
 - c. directly from bacteria in the soil.
 - d. from the process of denitrification.
- ____ 9. Organisms need nutrients in order to
- a. utilize hydrogen and oxygen.
 - b. carry out essential life functions.
 - c. recycle chemical compounds.
 - d. carry out nitrogen fixation.
- ____ 10. Because of biogeochemical cycling,
- a. human activity has no effect on elements, chemical compounds, and other forms of matter.
 - b. living organisms are not limited by any one nutrient.
 - c. nutrients are circulated throughout the biosphere.
 - d. many nutrients do not reach toxic concentrations in the biosphere.

- ____ 11. Phosphorus is very important for living things because living organisms need phosphorus to
- a. make carbohydrates.
 - b. form DNA and RNA.
 - c. perform transpiration.
 - d. cycle energy.

Modified True/False

Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.

- ____ 1. Scientists classify the nitrogen, carbon, phosphorus, and water cycles as biogeochemical cycles.

- ____ 2. The burning of fossil fuels and photosynthesis are part of the phosphorus cycle.

Short Answer

1. Explain how the biogeochemical cycling of oxygen, carbon, nitrogen, and hydrogen are important to living systems.

Science Skills

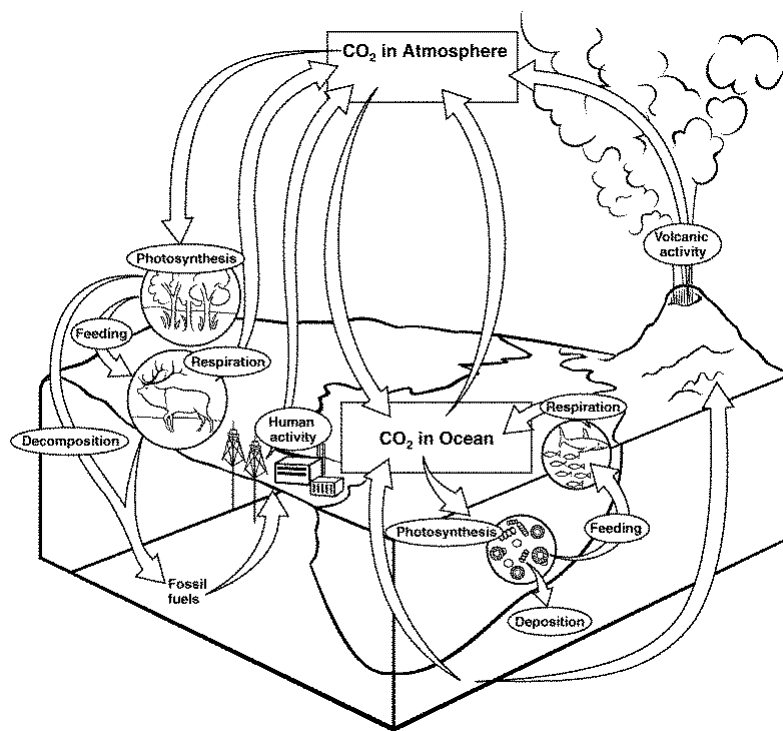


Figure 3–9

1. **Interpret Visuals** Explain the roles of photosynthesis and respiration in the carbon cycle.

Essay

1. Describe the roles of bacteria in the nitrogen cycle.
2. Why is nitrogen fixation important for the survival of producers in an ecosystem?

Cellular Respiration and Photosynthesis Test

Multiple Choice

Identify the choice that best completes the statement or answers the question.

- ____ 1. What are the three parts of an ATP molecule?
- a. adenine, thylakoid, and a phosphate group
 - b. stroma, grana, and chlorophyll
 - c. adenine, ribose, and three phosphate groups
 - d. NADH, NADPH, and FADH₂
- ____ 2. Energy is released from ATP when
- a. a phosphate group is added.
 - b. adenine bonds to ribose.
 - c. ATP is exposed to sunlight.
 - d. a phosphate group is removed.

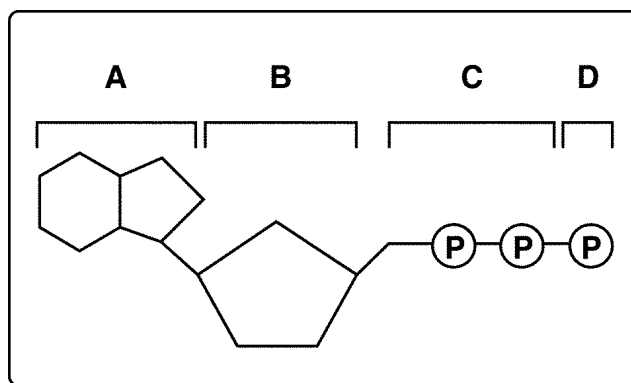


Figure 8-1

- _____ 3. Look at Figure 8–1. All of the following are parts of an ADP molecule EXCEPT
- a. structure A.
 - b. structure B.
 - c. structure C.
 - d. structure D.
- _____ 4. Organisms, such as plants, that make their own food are called
- a. autotrophs.
 - b. heterotrophs.
 - c. thylakoids.
 - d. pigments.
- _____ 5. Organisms that cannot make their own food and must obtain energy from external sources are called
- a. autotrophs.
 - b. heterotrophs.
 - c. thylakoids.
 - d. plants.
- _____ 6. What happens during photosynthesis?
- a. Heterotrophs consume ATP.
 - b. Heterotrophs produce ATP.
 - c. Autotrophs consume carbohydrates.
 - d. Autotrophs produce carbohydrates.

- ____ 7. Plants get the energy they need for photosynthesis by absorbing
- a. high-energy sugars.
 - b. chlorophyll *a*.
 - c. chlorophyll *b*.
 - d. sunlight.

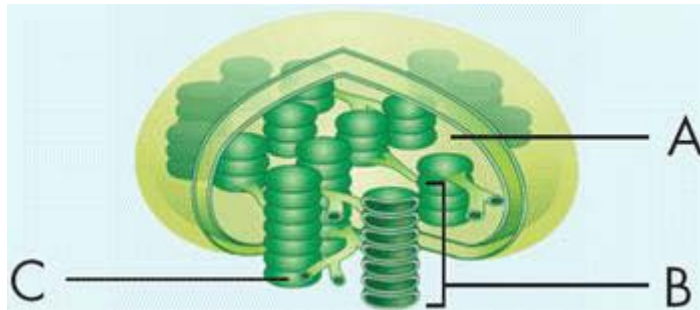


Figure 8–2

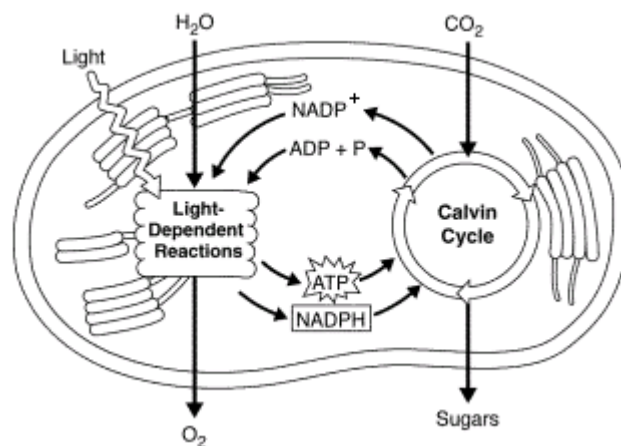
- ____ 8. Which structure in Figure 8–2 represents a single thylakoid?
- a. structure A
 - b. structure B
 - c. structure C
 - d. structure D
- ____ 9. Where in the chloroplast is chlorophyll found?
- a. in the ATP
 - b. in the stroma
 - c. in the thylakoid membrane
 - d. in the thylakoid space

- ____ 10. Why are electron carriers needed for transporting electrons from one part of the chloroplast to another?
- a. High-energy electrons would be destroyed.
 - b. High-energy electrons are highly reactive.
 - c. High-energy electrons are not soluble in cytoplasm.
 - d. High-energy electrons get their energy from electron carriers.
- ____ 11. Photosynthesis uses sunlight to convert water and carbon dioxide into
- a. oxygen and carbon.
 - b. high-energy sugars and proteins.
 - c. ATP and oxygen.
 - d. oxygen and high-energy sugars.
- ____ 12. What are the products of the light-dependent reactions?
- a. oxygen gas and glucose
 - b. ATP, NADPH, and oxygen gas
 - c. ATP, carbon dioxide gas, and NADPH
 - d. carbon dioxide gas, oxygen gas, and NADPH
- ____ 13. Which of the following activities happens within the stroma?
- a. Photosystem I absorbs light.
 - b. ATP synthase produces ATP.
 - c. The Calvin cycle produces sugars.
 - d. Electrons move through the electron transport chain.

- ____ 14. Which of the following is the correct sequence of events in cellular respiration?
- a. glycolysis → fermentation → Krebs cycle
 - b. Krebs cycle → electron transport → glycolysis
 - c. glycolysis → Krebs cycle → electron transport
 - d. Krebs cycle → glycolysis → electron transport
- ____ 15. What is the correct equation for cellular respiration?
- a. $6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Energy}$
 - b. $6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 + \text{Energy} \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
 - c. $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow 6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6 + \text{Energy}$
 - d. $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Energy} \rightarrow 6\text{O}_2 + \text{C}_6\text{H}_{12}\text{O}_6$
- ____ 16. Cellular respiration is called an aerobic process because it requires
- a. light.
 - b. exercise.
 - c. oxygen.
 - d. glucose.
- ____ 17. Which of the following is one of the ways that cellular respiration and photosynthesis are opposite processes?
- a. Photosynthesis releases energy, and cellular respiration stores energy.
 - b. Photosynthesis removes carbon dioxide from the atmosphere, and cellular respiration puts it back.
 - c. Photosynthesis removes oxygen from the atmosphere, and cellular respiration puts it back.
 - d. Photosynthesis consumes glucose, and cellular respiration produces glucose.

- ____ 18. Unlike photosynthesis, cellular respiration occurs in
- a. animal cells only.
 - b. plant cells only.
 - c. prokaryotic cells only.
 - d. all eukaryotic cells.
- ____ 19. Glycolysis provides a cell with a net gain of
- a. 2 ATP molecules.
 - b. 4 ATP molecules.
 - c. 18 ATP molecules.
 - d. 36 ATP molecules.
- ____ 20. The starting molecule for glycolysis is
- a. ADP.
 - b. pyruvic acid.
 - c. citric acid.
 - d. glucose.
- ____ 21. Which of the following is an electron carrier that plays a role in cellular respiration?
- a. NAD^+
 - b. pyruvic acid
 - c. NADP^+
 - d. ATP

- ____ 22. The starting molecule for the Krebs cycle is
- a. glucose.
 - b. NADH.
 - c. pyruvic acid.
 - d. coenzyme A.
- ____ 23. The Krebs cycle produces
- a. oxygen.
 - b. lactic acid.
 - c. carbon dioxide.
 - d. glucose.
- ____ 24. Cellular respiration uses 1 molecule of glucose to produce approximately
- a. 2 ATP molecules.
 - b. 4 ATP molecules.
 - c. 32 ATP molecules.
 - d. 36 ATP molecules.

Science Skills**Figure 8–12**

1. **Interpret Visuals** Look at Figure 8–12. What are the products of the light-dependent reactions?

Modified True/False

Indicate whether the statement is true or false. If false, change the identified word or phrase to make the statement true.

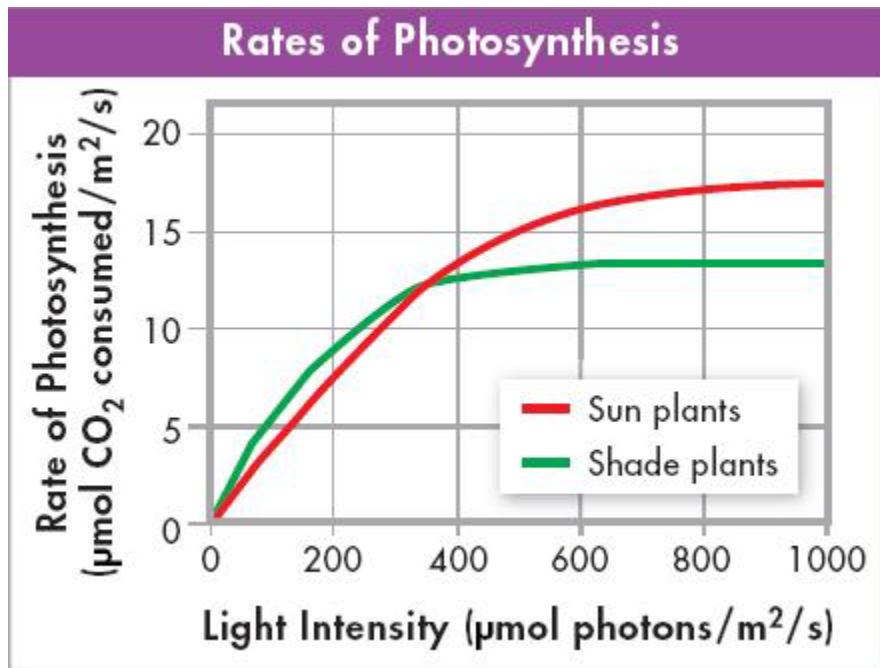


Figure 8–8

- ____ 1. According to the graph in Figure 8–8, the rate of photosynthesis in shade and sun plants decreases and then levels off as light intensity increases. _____

Short Answer

1. How is a molecule of ADP like a rechargeable battery?

Essay

1. List the main events of glycolysis. Then, explain how many ATP molecules are produced and consumed by glycolysis?

Health and Disease Test

Multiple Choice

Identify the choice that best completes the statement or answers the question.

- _____ 1. The germ theory of disease states that infectious diseases are caused by
- a. toxins.
 - b. microorganisms.
 - c. heredity.
 - d. pollutants in the environment.
- _____ 2. Read the following statements that describe the steps that lead one to identify the microorganism that causes a specific disease. What is the correct order in which they occur?
- 1) The purified pathogens should cause the same disease in a new host.
 - 2) The pathogen must be found in the body of a sick organism and not a healthy one.
 - 3) The pathogen should be isolated and grown in a pure culture.
 - 4) The pathogen should be isolated from the second host.
- a. 1,2,3,4
 - b. 3,1,4,2
 - c. 4,2,3,1
 - d. 2,3,1,4

- _____ 3. How are infectious diseases spread?
- a. through coughing, sneezing, or physical contact
 - b. through contaminated water and food
 - c. by infected animals
 - d. all of the above
- _____ 4. Which of the following is an example of a vector and the disease it spreads?
- a. tall grass and Lyme disease
 - b. the deer tick and Lyme disease
 - c. the Nile river and West Nile disease
 - d. insecticides and malaria
- _____ 5. The body's nonspecific defenses against invading pathogens include
- a. antibiotics.
 - b. mucus, sweat, and tears.
 - c. antibodies.
 - d. cytotoxic T cells.
- _____ 6. The inflammatory response can cause
- a. permanent immunity.
 - b. pain, swelling, and a local rise in temperature.
 - c. antibodies to bind to antigens.
 - d. cytotoxic T cells to attack infected cells.

- _____ 7. The body's most important nonspecific defense is
- the skin.
 - cell-mediated immunity.
 - the inflammatory response.
 - permanent immunity.

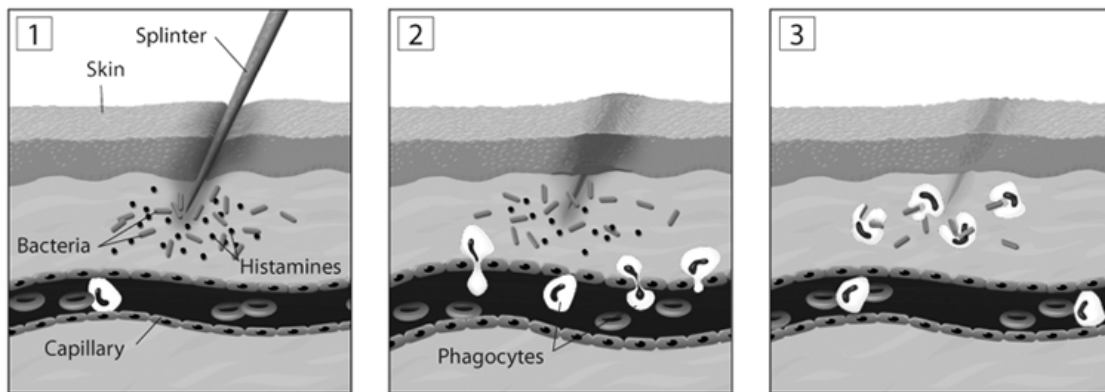


Figure 35-1

- _____ 8. Which type of immune response is being shown in Figure 35-1?
- cell-mediated response
 - humoral response
 - inflammatory response
 - autoimmune response
- _____ 9. Which of the following describes your immune system's specific defenses?
- They respond to a general threat of infection.
 - They respond to a particular pathogen.
 - They include fever and inflammation of the infection site.
 - all of the above

- ____ 10. During the winter you become sick with the flu. Shortly after that, you become sick with strep throat. Will the same type of B-cells that fought the pathogen that caused the flu fight the pathogen that causes strep throat?
- a. Yes. Every B cell is capable of fighting every pathogen with which it comes in contact.
 - b. Yes. B cells recognize similar antigens such as bacterial and viral pathogens.
 - c. No. B cells fight viruses while T cells fight bacteria.
 - d. No. Each B cell is capable of recognizing one specific antigen.
- ____ 11. Proteins that tag pathogens for destruction by immune cells are called
- a. antibodies.
 - b. antigens.
 - c. histamines.
 - d. interferons.
- ____ 12. Which of these are the main working cells of the specific immune response?
- a. self and nonself cells
 - b. B cells and T cells
 - c. antigens and antibodies
 - d. histamines and interferons

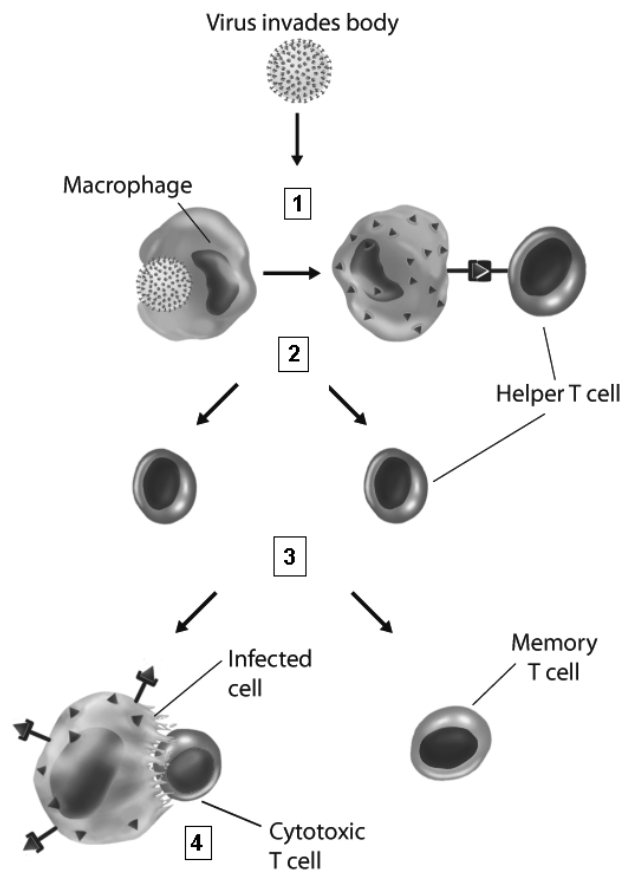


Figure 35-2

- ____ 13. What type of immune response is shown in Figure 35-2?
- a. nonspecific response
 - b. humoral response
 - c. cell-mediated response
 - d. inflammatory response

- ____ 14. Which step in Figure 35–2 shows the destruction of an infected cell?
- a. 1
 - b. 2
 - c. 3
 - d. 4
- ____ 15. In Figure 35–2, which structure will respond quickly if the same virus invades the body again?
- a. macrophage
 - b. memory T cell
 - c. cytotoxic T cell
 - d. helper T cell
- ____ 16. Which of these is an example of active immunity?
- a. a pregnant woman passing antibodies to the fetus across the placenta
 - b. a pregnant woman giving antibodies to an infant through breast milk
 - c. a person developing antibodies against the measles vaccine
 - d. a person receiving antibody shots after being bitten by a rabid animal
- ____ 17. A person who has received a vaccine for human papillomavirus (HPV), which causes genital warts and can cause cervical cancer,
- a. is able to produce antibodies against HPV.
 - b. is more susceptible to HPV than someone who has not had the vaccine.
 - c. has passive immunity against HPV.
 - d. must already have been infected with HPV.

- ____ 18. Which of these is an example of passive immunity?
- a. a person develops antibodies to fight off an ear infection
 - b. antibodies are passed from a pregnant woman to an infant through breast milk
 - c. a person develops antibodies against the measles vaccine
 - d. a person is vaccinated for hepatitis B
- ____ 19. Which of the following are public health measures that have helped fight disease?
- a. regulating food supplies
 - b. monitoring water supplies
 - c. promoting vaccinations
 - d. all of the above
- ____ 20. Antibiotics are effective at treating
- a. a common cold, but not genital warts.
 - b. a tapeworm infection, but not botulism.
 - c. strep throat, but not the flu.
 - d. athlete's foot, but not an ear infection.
- ____ 21. Vaccinations and other public health measures had eliminated which disease globally by 1980?
- a. AIDS
 - b. tuberculosis
 - c. smallpox
 - d. Ebola

- _____ 22. The infectious disease SARS is thought to have been started
- a. by the misuse of medication.
 - b. due to an increase in the exotic animal trade.
 - c. by people failing to follow vaccination recommendations.
 - d. in contaminated water supplies.
- _____ 23. The misuse of antibiotics has led to the re-emergence of which disease?
- a. tuberculosis
 - b. measles
 - c. smallpox
 - d. "bird flu"
- _____ 24. The sneezing, runny nose, and itchy eyes associated with allergies are caused when
- a. smooth muscles reduce the size of air passageways in the lungs.
 - b. the immune system attacks the body's own cells.
 - c. mast cells release histamines.
 - d. infected cells produce interferon.
- _____ 25. Autoimmune diseases result when the immune system
- a. fails to distinguish self from nonself.
 - b. overreacts to certain antigens.
 - c. is weakened by asthma.
 - d. all of the above

- _____ 26. What causes asthma?
- a. Bacteria that are resistant to antibiotics infect the body.
 - b. Particular antigens trigger muscle contractions that make it difficult to breathe.
 - c. Antibodies and cytotoxic T cells attack cells in the tissues of the lungs.
 - d. Antibodies and cytotoxic T cells attack cells in the lining of the heart.
- _____ 27. Doctors first suspected that AIDS was weakening the immune system of infected patients when their patients developed
- a. asthma.
 - b. allergies.
 - c. rare infections.
 - d. strep throat.
- _____ 28. HIV weakens the immune system by killing
- a. antibodies.
 - b. B cells.
 - c. helper T cells.
 - d. cytotoxic T cells.

Short Answer

29. What are four ways you can help avoid contracting and spreading infectious diseases?

30. Measles (rubeola) and German measles (rubella) are caused by different viruses. If you have recovered from rubeola, are you protected against infection with rubella? Why or why not?

APPENDIX D

TEACHER ONLINE MAILBOX

The screenshot displays the Delhi Charter School intranet. The browser address bar shows www.delhicharterschool.org/intranet. The user is logged in as Rachel L. Gray. The left sidebar contains a navigation menu with the following items: My Email, My Account, My Classes, Homepage, Calendar, Settings, Members, My Groups, My School, and Logout. A yellow arrow points to the Logout link. The main content area is titled "BIOLOGY (235-235)". It features an "Events" section with a table of upcoming events and a "Discussions" section with a list of discussion topics. The Windows taskbar at the bottom shows icons for Internet Explorer, Google Chrome, and several application windows.

Delhi Charter School Rachel L. Gray Help

My Email My Account My Classes Homepage Calendar Settings Members My Groups My School Logout

BIOLOGY (235-235)

BIOLOGY (235-235)

Events + Archive HW Drop Box

Monday 04/08/13	Behavior Collage	
Tuesday 04/09/13	Behavior Collage	

Discussions +

Assignment Jan. 16-18

Author: Rachel L. Gray - Last Post: Tuesday, January 15, 2013 at 6:30 PM ET.

Teacher Mailbox

Author: Rachel L. Gray - Last Post: Sunday, February 10, 2013 at 3:59 PM ET.

eChalk
Think Beyond the Building

APPENDIX E

PRE-TREATMENT INTERVIEW

PRE-TREATMENT INTERVIEW QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Do you feel that you can talk to your teacher about problems you may be experiencing in class? Why or Why not?
2. Do you feel that your teacher encourages you in class? Why or Why not?
(If the student answers no, proceed to question 3. If the student answers yes, proceed to question 4.)
3. How could the teacher encourage you more in class?
4. Explain the type of environment in which you learn best.
5. Do you feel that students should have a choice in selecting group members for group activities? Explain.
6. If given a choice, how do you select members for your group?
7. What type of learning activities help you learn best? Explain.
8. Do you feel that having a choice in learning activities will help you learn better? Explain.
9. What could the teacher do to make lectures more interesting?
10. Is there anything else that you would like to add?

APPENDIX F

PHOTOSYNTHESIS SKIT CARDS

Photosynthesis Skit Cards	
H_2O	$NADP^+$
NADPH	ADP
Thylakoid	Light- Dependent Reactions (Calvin Cycle)
Stroma	e^-

$C_6H_{12}O_6$ (Sugar)	ATP
Photosystem II	H^+
O_2	Sunlight
CO_2	Photosystem I
Light Independent Reactions	ATP Synthase

APPENDIX G

INFECTIOUS DISEASE CHOICE BOARD

Infectious Disease

Choice Board

Directions: Choose two activities from the choices below. You may only complete one activity per shape. All students will complete the third activity which is designated with the smiley face.

<u>Verbal/ Linguistic</u> In your own words explain how diseases are spread. Give examples. ☐	<u>Logical/Mathematical</u> Compare and contrast the different ways diseases are spread. ☐	<u>Visual/Spatial</u> Draw a picture showing the different ways diseases are spread. ☐
<u>Interpersonal</u> Create a skit showing humoral immunity. 	<u>Multiple Intelligences</u> ALL STUDENTS Create a movie in Movie Maker of an infectious disease of your choice 	<u>Body Kinesthetic</u> Create a model or 3-D poster illustrating humoral immunity. 
<u>Musical/Rhythmic</u> Create a song that explains humoral immunity. 	<u>Naturalist</u> Read about the ways diseases are spread. Then, create a chart to classify a given list of diseases. ☐	<u>Intrapersonal</u> Write a poem about humoral immunity. 

APPENDIX H

POST-TREATMENT SURVEY

Delhi Charter School x Delhi Charter School - Intr x

www.delhicharterschool.org/subgroup_res_view_survey.asp?ts=341

Delhi MSN Suggested Sites Web Slice Gallery Imported From IE Actions of Caffeine i... file:///C:/Users/Rac... Easy Homemade Fal... Homemade Body Sc... Oatmeal

BIOLOGY (235-235) > Survey

Survey

Post Treatment Survey

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1: Which of the following units best matched your learning style: Earth Cycles, Photosynthesis and Cellular Respiration, or Health and Disease?

☐ Earth Cycles
☐ Photosynthesis and Cellular Respiration
☐ Health and Disease

2: During which of the following units did you feel the most comfortable in learning the material: Earth Cycles, Photosynthesis and Cellular Respiration, or Health and Disease?

☐ Earth Cycles
☐ Photosynthesis and Cellular Respiration
☐ Health and Disease

3: As a result of the activities we completed during the Photosynthesis and Cellular Respiration unit and Health and Disease unit do you feel more comfortable in class and with your peers?

☐ Yes
☐ No
☐ Undecided

4: During which of the following units do you feel you learned the most: Earth Cycles, Photosynthesis and Cellular Respiration, or Health and Disease?

☐ Earth Cycles
☐ Photosynthesis and Cellular Respiration
☐ Health and Disease

5: Did working with your peers have a positive effect on the classroom environment?

☐ Yes
☐ No
☐ Undecided

6: Did team challenges, such as making skits motivate you to work better with your peers?

☐ Yes
☐ No
☐ Undecided

7: Did you communicate with your teacher through the online mailbox?

☐ Yes
☐ No

8: Did having an online mailbox to communicate with your teacher make you feel more comfortable about asking questions?

☐ Yes
☐ No
☐ Undecided

9: Did having a choice in activities motivate you to complete your work in class?

☐ Yes
☐ No
☐ Undecided

10: Did having a choice in learning activities help you understand the material more?

☐ Yes
☐ No
☐ Undecided

11: Did peer feedback on your movies positively encourage you in class?

☐ Yes
☐ No
☐ Undecided

12: Is there anything you want to add in regards to the learning environment, working with peers, communication with the the teacher, or student choice activities?

APPENDIX I

POST-TREATMENT INTERVIEW

POST-TREATMENT INTERVIEW QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1. Do you feel that your teacher listened to any problems you had in class? Explain.
2. Did the online teacher mailbox help you communicate problems with the teacher better? Why or why not?
3. Do you feel that your teacher encouraged you in class? Why or Why not?
(If the student answers no, proceed to question 3. If the student answers yes, proceed to question 4.)
4. What were some ways that your teacher could have encouraged you more?
5. Did the classroom environment facilitate your learning? Explain.
6. Do you feel that you had a choice in selecting group members for group activities? Explain.
7. How did you select members for your group?
8. Did participating in team building activities help you feel more comfortable in class and with other students?
9. What learning activities helped you learn best? Explain.
10. Do you feel that having had a choice in learning activities helped you learn better? Explain.
11. What did the teacher do to make lectures more interesting?
12. Is there anything else that you would like to add?

APPENDIX J

DELAYED CONSTRUCTED RESPONSE QUESTIONS

How is carbon related to the flow of energy between the environment and organisms?

- Name the carbon compound that is exchanged between plants and their environment.
- Describe how plants use carbon from the atmosphere to create more complex molecules.
- Describe how animals that eat plants change these molecules and return carbon to the atmosphere

This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Constructed Response 2

Photosynthesis and Respiration

Read the following question carefully. Answer each part of the question on the lines provided.

Compare photosynthesis and respiration with regard to each of the following:

- organisms that carry out each process
- reactants and products of each process
- location of each process in the cell

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

A. Suppose a new type of bacteria invades a person's body. Name the first components of the immune system that will move to defend the body from the bacterial infection. Describe the action these components take.

B. A year later, the same person's body is infected with the same type of bacteria. Explain why the immune system will most likely be able to defend the body from the infection more quickly this time than the first time.

This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

APPENDIX K

LOUISIANA BIOLOGY END OF COURSE CONSTRUCTED RESPONSE RUBRIC

Constructed-Response Rubric	
Score Point 2	The student's response provides a complete and correct answer. There are no errors.
Score Point 1	The student's response is partially correct; the response demonstrates limited awareness. There may be one or more errors.
Score Point 0	The student's response is incorrect, irrelevant, or too brief to evaluate. Student fails to respond.