

THE EFFECT OF CASE-BASED LEARNING IN A HIGH SCHOOL ANATOMY  
AND PHYSIOLOGY CLASS ON STUDENT MOTIVATION, HIGHER-ORDER  
THINKING SKILLS, AND COLLEGE READINESS

by

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## ABSTRACT

This study considers the effectiveness of case-based learning (CBL) on student motivation, the development of higher-order thinking skills, and college preparedness in a high school anatomy and physiology classroom. Data was collected over four units of study; one of which acted as a non-treatment group, two were treatment groups that used CBL once during the unit to help solidify the information being taught, and one treatment group used CBL as the main method to teach the students the content of the unit. Surveys, interviews, classroom monitoring, pretests, and posttests were all used as means to collect data. They compared the engagement levels, the skills developed for career and college readiness, and critical thinking skills of students using traditional methods versus CBL. From the data collected, there was no conclusive evidence to support an improvement in college preparedness. Student motivation and engagement increased slightly for CBL and there was a definite improvement in higher-order thinking skills after the use of any CBL throughout these units.

## INTRODUCTION AND BACKGROUND

The purpose of this study is to evaluate the effects of case-based learning (CBL) in a high school anatomy and physiology classroom. The use of case studies is a teaching method that can be used to provide relevancy in any science classroom as their approach is inquiry-based and relates to real world issues. Relevance can be defined as being “pertinent” or “bearing upon or connecting to the matter at hand” (Dictionary.com, 2013). As a teacher, relevance has a very similar meaning except the “matter at hand” could be more specifically defined as topics that are of interest to my students. While these may vary quite significantly, common ground can be found for many subjects that have the potential to engage a student through its relevance alone.

The idea of using CBL in anatomy and physiology developed after exposure to it in a course through my Master’s degree. The course used case studies as a method to teach the content of four different systems in the body. Not only was I extremely engaged with the content, but also found myself learning far more than I feel I have ever learned, especially from a nine week, online, summer course. In addition, I found that the content learned was relevant to my experiences and the world around me. Regardless, I have always had an interest in human physiology, but the content learned applied to much that I hear about in my everyday life. This really inspired me to see how my students would react to CBL. Because of this, the use of case studies has become a passion of mine and a reason to focus my action research-based classroom project on CBL.

I teach at a small, rural high school in Big Piney, Wyoming. Currently, we have 177 students enrolled in the high school. The local economy is supported mainly by the

oil and natural gas industry. Because of this, we see a good mix of Hispanic students as well as students who get relocated frequently (Big Piney High School, 2013). Both of these factors can make teaching and learning difficult. This year, my anatomy and physiology class consists of 11 seniors and 1 junior. Of these students, one is an exchange student from Korea. It is a requirement for all high school students to take at least three years of science. Many of my students in anatomy and physiology are seniors in their fourth year of science. One trend I have noticed during my time at Big Piney High School is the lack of motivation from most of the student body. Although my seniors have chosen anatomy and physiology through a partial interest, I still feel that it is hard to get a majority of my students to want to be in school and learn. Also, I feel you never can be prepared enough for college. All of my anatomy and physiology students plan to attend college but most of my students lack the skills to be successful. Finally, I feel my role as an educator is to provide a positive environment in which students can explore and build on their higher-order thinking and problem-solving abilities.

Considering my positive experience with CBL, I started to experiment with it last year in anatomy. After using at least one case study for every unit taught on differing systems on the body, I interviewed my students to get some feedback. I was surprised to find that every one of my students enjoyed working with case studies. Most shared that they found the case studies relevant and they helped them understand the concepts learned during lecture. Several of the responses I received from the students suggested different ways that would make case studies more enjoyable. With those ideas in mind, I began to question the best method for CBL in anatomy and physiology. These thoughts and responses helped formulate my research question: *What method of instituting CBL is*

*most effective in my classroom?* This question can be broken down into the following sub-questions:

1. How can CBL improve motivation and engagement amongst my students?
2. How can CBL better prepare my students for college?
3. Can CBL improve my students' abilities to solve complex problems presented in these scenarios by improving higher-order thinking skills?

### CONCEPTUAL FRAMEWORK

Case-based learning (CBL) is a teaching strategy using case studies which can be used in a science course to promote relevance of subject matter among students, as case studies present real-life situations. "The purpose of this method is to provide students with the opportunity to apply what they are learning in the context of real-life situations, while at the same time sharpening critical thinking, problem-solving, and decision-making skills" (Wilcox, 1999, p. 668). Case studies are stories with real-life scenarios that can help a student relate to situations by appealing to their interests, their educational focus, or their past experiences. With these connections established, students will be more apt to commit the content learned in the process to their long-term memory. Students will also have the opportunity to develop more adept problem-solving and critical thinking skills (About Us, 2012).

Case studies are also a means to promote inquiry in the classroom, which in turn promotes critical thinking. Inquiry-based activities endorse critical thinking, problem-solving strategies, and thus, higher-order thinking skills. Students are able to learn context by formulating questions, researching and exploring possible answers (Graves, 2009). CBL defers students from relying on rote memory, but instead uses inquiry to

direct students toward a system of learning. This can encourage students to develop experiences with concepts that otherwise would have been lost through the learning process of memorization (Cliff & Wright, 1996). According to Llewellyn, “inquiry assists in (a) connecting our prior understandings to new experiences, (b) modifying and accommodating our previously held beliefs and conceptual models, (c) providing opportunities for discourse, and (d) constructing new knowledge” (2013, p. 6).

Rote memory is at the knowledge level of Bloom’s taxonomy, whereas the process of inquiry-based learning through case studies highlights the higher levels of analysis, synthesis, and evaluation (Overbaugh & Schultz, 2012). Case studies seek to question, analyze, support, and evaluate a scenario to come to an educated and well-defended conclusion of the situation. When using a case study, a student is responsible for identifying the key points, discerning important or irrelevant points, interpreting the clues, and coming to an educated decision using supporting evidence, reputable research and critical thinking (Cliff & Wright, 1996). Case studies not only activate the cognitive level of learning but, because of their nature, can also help students develop the affective level of learning to develop and support views that have an emotional basis. On the cognitive level, a student learns to analyze a case study by critiquing the structure and using organization and key facts to make inferences. A student can then piece together these different facts, focusing on the synthesis aspect of cognition. Finally, the students will be able to evaluate their knowledge and background information to support a final conclusion. In terms of the affective domain, the variety of case studies available allows students to better support their judgments, allow respectful discussions to occur, develop

collaboration with their peers, and learn how to communicate with intelligence and well supported theories (Clark, 2010).

Case-based learning can serve as a means to engage students too. Not all students have an affinity for science, but if relevancy is brought into the classroom, they can still gain a desire to explore and learn about science. Relevance is a great addition to any lesson taught by a teacher. If a lesson has no meaning to students and their experiences, information will be lost due to the lack of importance. Relevance provides an opportunity for a student to relate to a topic and see how it can be important or apply directly to him- or herself. Relevancy supports knowledge retention and allows one to make connections with future experiences. This ability to connect and question different experiences helps to improve higher-order thinking skills. In a study completed through the National Center for Case Study Teaching in Science, teachers using the CBL method reported that they saw a large increase in the motivation of students both inside and outside of classes. A vast majority also said their students felt they learned more with the use of case studies (Herreid, 2005). With students more engaged in their learning environment, there can also be a significant increase in the teacher's motivation as well. The time put into developing and instituting appropriate and effective case studies is reflected positively by the students. This gives more reward to the instructor and can be very helpful to encourage more motivation and meaningful instruction from the teacher's end (Ramaekers, van Keulen, Kremer, Pilot, & van Beukelen, 2011).

Case studies can be brought into the classroom using multiple techniques. These include combinations of lecture-based case studies, use of case studies in small or large groups as discussion-based learning, or using case studies in a one-on-one situation.

Each of these strategies may have certain benefits and disadvantages. For instance, in a large group discussion, certain students may run the conversation while others may not feel confident enough to interject. Some of these strategies also work best with more controversial issues (Herreid, 2005). All in all, each scenario is different and would require different means of organization.

Case studies come in a variety of formats, each with their own specific uses and highlights. Case studies range from interrupted, jigsaw, directed, discussion, role play, debate, or problem-based cases (About Us, 2012). Each of these cases has different strengths and weaknesses and should be used in different scenarios based on the teaching goals of the instructor. For instance, jigsaw case studies give different groups different pieces of information. When the groups collaborate, they are able to combine their findings to visualize the main theme of the case. On the other hand, interrupted case studies provide the students with progressive bits of information so they develop their conclusions one piece at a time. Case studies like discussion, debate, and role play work best when learning about more controversial issues. Problem-based learning case studies are practical as they allow students to become problem-solvers when faced with issues that can be related to health care. Using a variety of case studies may allow a better fit for each individual lesson (Herreid, 2005).

“A case study is an excellent way to help students think like scientists as they work to solve a dilemma...Students must think critically about the evidence provided and evaluate which factors are most relevant to the study’s driving questions” (Graves, 2009, p. 24). Case studies can be used as an instructional tool to help engage the students and the teacher alike, help students develop a greater sense of investment in a science class,

provide opportunities to improve problem-solving skills and critical thinking, better prepare students for their educational futures, and increase the frequency of higher-order cognition in the classroom. If used properly, case studies will provide depth to an anatomy and physiology classroom and will have a very beneficial effect on the students as they progress through a class.

### METHODOLOGY

For this capstone project, I examined the effects of case-based learning (CBL) on problem-solving skills, student motivation and engagement, and college preparedness. For a non-treatment group, I instituted standard classroom techniques such as lecture, discussion, note-taking, reading articles, individual work, partner work, and some lab work. 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.

I used two treatment groups to carry out my research. First of all, I tested the efficiency of CBL in a blend of traditional methods mentioned above. For my first treatment group, I used one case study in addition to traditional lecture and classroom methods. I taught the basics of the unit as I did before I began using case studies. I then implemented CBL to expand and broaden the content they have learned. From this perspective, I intended that the students would be getting a broader array of information on each unit. For example, through lecture, labs, and other traditional methods, the students learned about the processes of digestion, the use of enzymes in digestion, the anatomy of the digestive system, and the functions of the digestive system. Then for the case studies, the students looked at diabetes as an example to solidify some of the

functions of the digestive system as they examined the interconnectedness of all the systems of the body.

For my second treatment group, I used a blend of lecture and case studies. My focus here was more toward the use of case studies. Lecture and other methods were used less, but in accordance with the case studies. For example, to introduce the cardiovascular system, I began the unit with a case study found on the National Center for Case Study Teaching in Science website, titled Wake Up Call, that examines a young lady who may possibly be having a heart attack (Appendix A). Through this case study, they were introduced to the anatomy of the heart as well as some functions. Following the case study, I lectured and the students took notes covering all that they had learned. They then began a second case study that introduced them to problems associated with blood pressure. All other class-based materials focused on anatomy of the cardiovascular system, blood flow, homeostatic regulation, and blood basics. Finally, we closed the unit with a third case study that solidified many points taught throughout the unit. The breakdown of the treatment groups can be found in Table 1.

Table 1  
*Description of Treatment Groups*

Group	Traditional Methods	Case Studies	Units
Non-Treatment Group	Projects, Lecture, Notes, Worksheets, Small Assignments	None	Nervous System
Treatment Group 1	Lecture, Notes, Worksheets, Small Assignments	Use of 1	Respiratory System, Digestive System
Treatment Group 2	None	Use of 3	Cardiovascular System

The nervous system was the first unit I collected data from using traditional, non-treatment methods. The first treatment group was used in both the respiratory and digestive system units. The second treatment groups focused on the cardiovascular system. These Data Collection Unit Assignments were arranged based on modified levels of Bloom's Taxonomy (Appendix B).

Before beginning to collect data using the instruments in class, I discussed with the students why they were doing each particular task and reminded them that the instrument was voluntary and would not count against their grades in class. I also encouraged them to be very thorough, because the more information they were able to provide, the easier it would be for me to help improve their learning as best as possible.

To demonstrate the effect of CBL on student motivation and engagement, college preparedness, and problem-solving skills, a wide range of methods was used. Before beginning any of the treatments, the students were tested on prior knowledge they had on the unit using the Unit Pretests/Posttests (Appendix C). These pretests covered many of the main concepts that were taught during the unit. The two components of each outcome covered the anatomy, basic functions, and physiology of the given human body system. These pretests were given in simple multiple choice form as an introduction to the unit and again after the closure of the unit. This was in addition to the regular assessments for that unit. The students' performances on these pretests were scored and compared to their performances on the posttests, which were identical to the pretests. A class average was also used in comparison.

After each unit and corresponding treatment or control group, I randomly interviewed five of my anatomy and physiology students using the Student Opinion

Interview Questions (Appendix D). The interview group consisted of a mix of both male and female students as well as students from various educational backgrounds and cultures. These interviewed students were randomly chosen for each round of interviews. The Student Opinion Interview Questions had three different sections. At the end of each section there are questions denoted by an asterisk. These questions were only asked after a treatment group because they are applicable only to the use of case studies. The first set of questions applied to the use of higher-order thinking skills and problem-solving skills. This set of questions was asked after each treatment group. The second set of questions was applicable to college preparedness and was also asked after every treatment group. The final set of questions involved general classroom methods and student opinions toward these as well as toward CBL. This set of questions was also asked after every unit. I took notes on each of the students' responses, recording quotes that would be constructive to research. The student responses for all of these units were used as qualitative data to back up trends that may have been seen in the quantitative data. Responses for this were also arranged in data tables based on the content matter of the three sets of questions: higher-order thinking, college preparedness, and general classroom methods including CBL. This helped me gain insight into any changes in motivation, higher-order thinking and college preparedness and how they may apply to the use of CBL.

The final piece of data for higher-order thinking skills was the Critical Thinking Skills Student Survey (Appendix E). This survey was developed based on the levels of critical thinking from Bloom's Taxonomy. From Bloom's Taxonomy, I summarized these different levels into five areas of critical thinking: Knowledge, Understanding,

Application, Synthesis, and Dispositions. Each of these areas is described in the survey. To set the stage for this instrument, our school's Instructional Facilitator and I sat down with my students and discussed in detail, each of these levels so that they had a clearer understanding of each. Then, this quick survey was given to each student after the unit was completed; however, the students worked in small groups. They marked the skills they thought they used and listed the particular methods from that unit that exercised these levels. In groups, they were able to collaborate and share their opinions on what levels were utilized. I was able to use this data to evaluate whether CBL or traditional methods of instruction rely more or less on higher-order, critical thinking skills.

To collect data on college readiness, students completed the College Preparedness Questionnaire over skills they felt they will need in order to be prepared for college (Appendix F). From this questionnaire, they highlighted which skills they felt are important for them to succeed in college or in a career readiness program of their choosing. This instrument also inquired as to which skills they already have acquired or are proficient in and which skills they lack or need to work on more. I compiled the different skills my students believe they will need to be prepared for college and I developed a College Preparedness Likert Survey (Appendix G). Also included in this survey are eight skills highlighted in the ACT as standards of achievement for college and career readiness programs. In this scale, a score of 5 represents a student attitude of *Very Well Prepared*, a 4 signifies *Fairly Well Prepared*, a 3 signifies *Somewhat Prepared*, a 2 represents *Not Very Well Prepared*, and a 1 will indicate *Not Adequately Prepared*. To analyze the data from the College Preparedness Likert Survey, I averaged the responses of the whole group. I was then able to identify positive or negative changes

in these averages from unit to unit, reflected as a percent. This provided a little insight toward the effect of the instructional methods used in each group on each student's preparedness as well as the class as a whole.

Twice during each group, I completed a 30 Minute Target Survey (Appendix H). In five minute intervals, for at least 30 minutes throughout the class period, I tracked the productivity of all my students. During each of these five minute intervals, I counted the number of students on task. Out of twelve total students, I calculated a percentage of those on task. I also randomly selected two students during this time interval and wrote down specifically what they were doing at the time of the survey. I completed this target survey twice during each group: either during case studies or during regular assignments. The 30 Minute Target Surveys were not limited to CBL during my treatment units so that I obtained equal amounts of data toward traditional methods and CBL. The percentages of those students on task during CBL were compared to the percentages of those on task during traditional instructional methods. This allowed me to analyze the data from each of these target surveys to see if the case studies are more engaging than the traditional methods similar to the non-treatment group.

Another instrument to measure engagement was the Academic Engagement Monitoring Form (Appendix I). Twice during each unit, either corresponding to the 30 Minute Target or at a separate time, I had the Instructional Facilitator for the school district visit my classroom to conduct this survey. During the survey, the Instructional Facilitator went through my seating chart at five minute intervals and marked the productivity of each student. A plus sign signified the student was on task and a minus sign signified that the student was not working. This gave me an unbiased view of the

engagement levels of each of my students for instructional methods used in each of my treatment and non-treatment groups. I then converted this information into percentages and analyzed the data to see if there was any correlation between the students' levels of engagement and the instructional methods being used.

My final measure of student engagement and motivation was the Student Productivity Survey (Appendix J). Twice during each treatment and non-treatment group, I administered a Student Productivity Survey. For the non-treatment group, the survey was given after traditional instructional methods such as a worksheet, lecture, or lab. The survey asked the students about the amount of time from their class period that was spent engaged and the amount of time that was spent off-task. They also explained the activities supporting each of these factors so I could get a more clear view of the activities that keep them engaged and learning and which did not.

The questions posed for this capstone project evaluated the effectiveness of case studies in my high school anatomy and physiology class. Subtopics of this question included the effect on student engagement and motivation, college preparedness, and problem-solving skills. Data for all of these questions was triangulated between multiple data sources (Table 2). Problem-solving skills were measured based on the results on the pretests, posttests, student interviews, and the Critical Thinking Student Survey. Data to measure college preparedness gained from the treatment groups was triangulated between student interviews, College Preparedness Likert Surveys, and the College Preparedness Questionnaire. Finally, data was triangulated between the Academic Engagement Monitoring Form, the 30 Minute Target Surveys, the Student Productivity Surveys, and

student interviews to draw conclusions based on the relationship between case studies and student motivation and classroom engagement.

Table 2  
*Data Triangulation Matrix*

Questions	Data Source 1	Data Source 2	Data Source 3	Data Source 4
Problem Solving	Pre/Posttests	Interviews	Critical Thinking Student Survey	
Engagement and Motivation	Academic Engagement Monitoring Form	Productivity Survey	30 Minute Target Survey	Interviews
College Preparedness	Interviews	College Preparedness Questionnaire	College Preparedness Likert Surveys	

### DATA AND ANALYSIS

The Academic Monitoring Data shows that students were engaged, on average, 85% of the time while working on case-based learning methods of instruction (N=12). While working on traditional methods, the students averaged only 76% productivity (Figure 1). Aside from the averages, the individual activities that were monitored varied. Low engagement included a workday on their nervous system project with only 53% engagement, while in contrast, the next monitored workday on this project boasted 91% engagement. Overall, the lowest score on case-based learning (CBL) engagement was

only 77% on the Fainting case study, part of the cardiovascular system unit and the highest score was 93%, again, for that same case study.

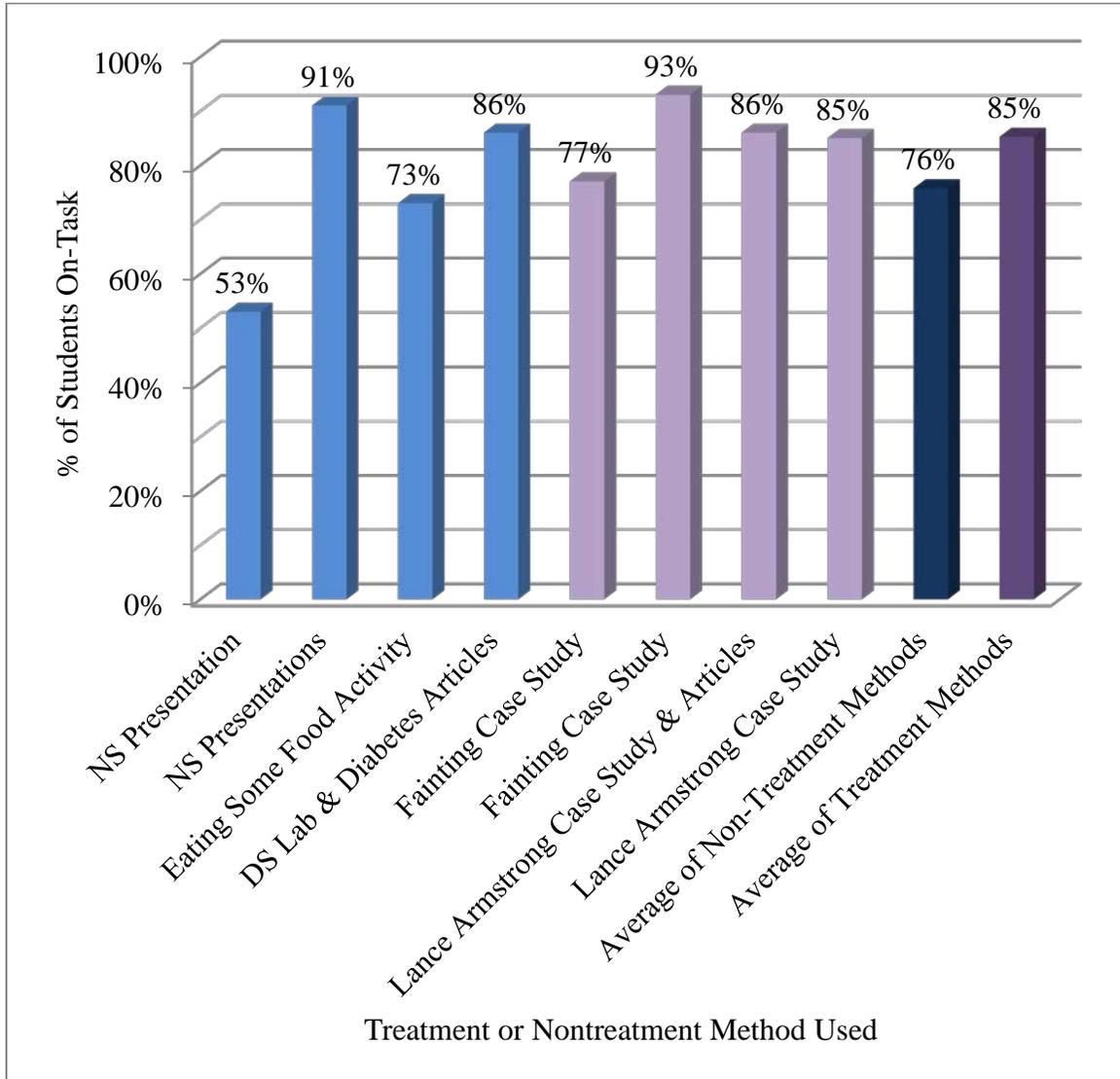
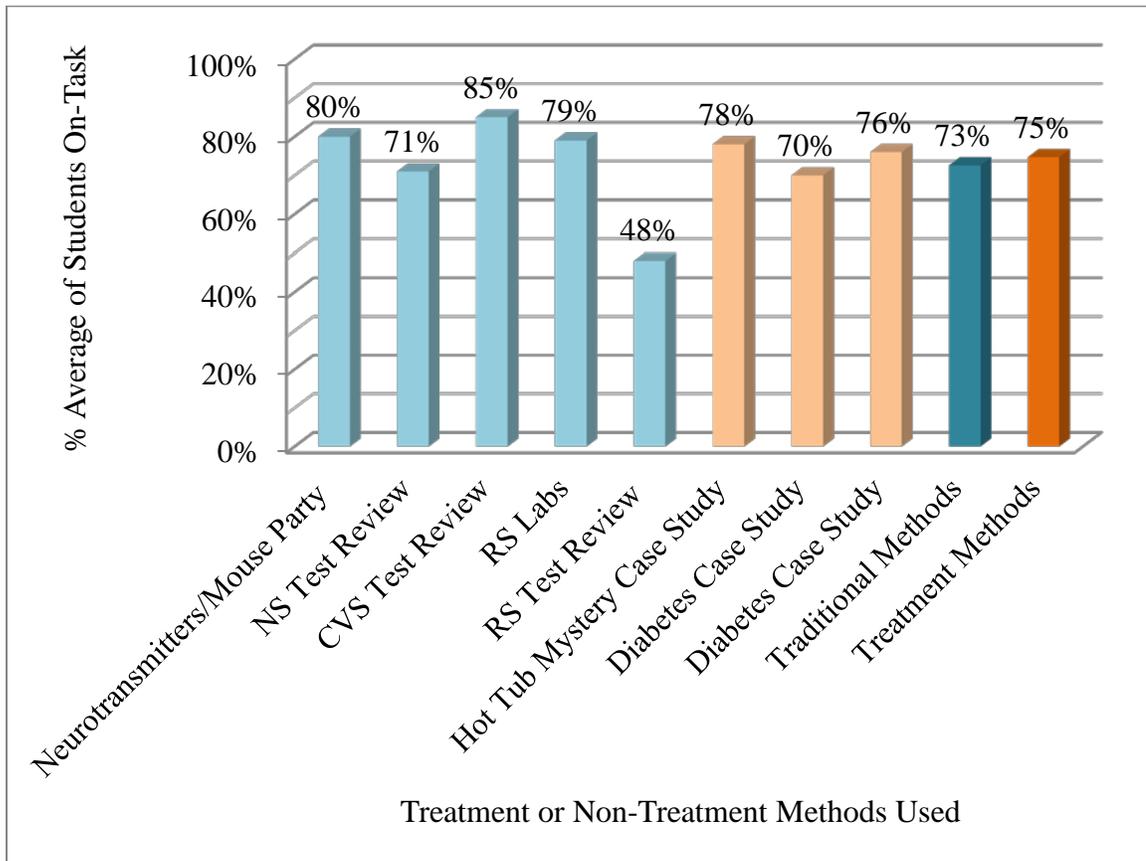


Figure 1. Academic Monitoring Data, ( $N = 12$ ). Key: DS= Digestive System, NS= Nervous System

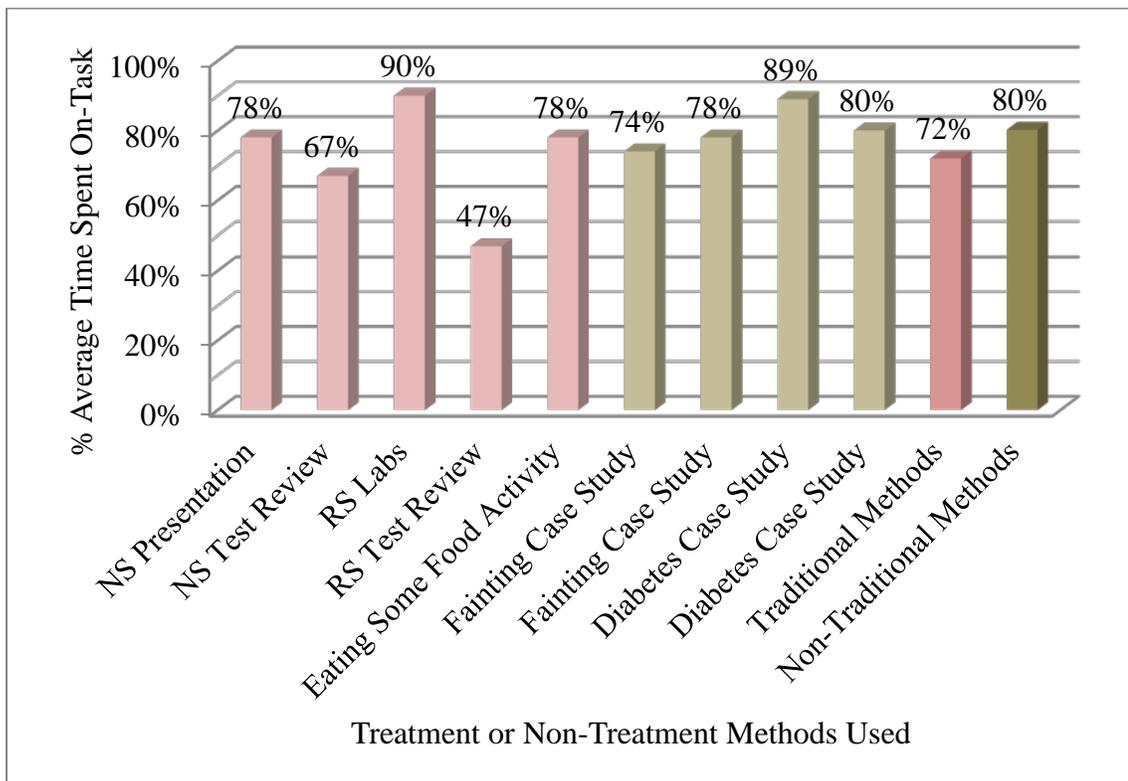
Similarly, the results of the 30 Minute Target Survey also suggested that CBL was slightly higher in engagement with 75% productivity ( $N=12$ ). On days where traditional methods were assigned, only 73% productivity was seen from the students (Figure 2).



*Figure 2.* 30 Minute Target Survey Data, ( $N = 12$ ). Key: CVS = Cardiovascular System, RS = Respiratory System, NS = Nervous System

This data collection instrument featured less data collection of CBL than the Academic Monitoring Data and more non-treatment methods. With that said, the averages were closer in range between the traditional methods and CBL. For the non-treatment, traditional methods, the lowest of these values was 48% engagement on the respiratory system test review, but the highest was 85% for the cardiovascular system test review, a very similar activity. The percentages for the CBL methods were more consistent with each other, only ranging from 70% on the Diabetes case study to 78% on the Hot Tub Mystery case study.

“‘Motivate’ is a strong word,” was a quote given by one of my students when asked what motivated them most during the respiratory unit. He also responded that “I like the activities where get to get hands-on experiences like labs and case studies.” The final piece of data collected for engagement and motivation was the Student Productivity Survey which again represented a slightly higher engagement of 80% for CBL (N=12). This was in comparison to only 72% productivity for non-treatment methods of instruction (Figure 3).



*Figure 3.* Student Productivity Survey, (N = 12). Key: NS = Nervous System, RS = Respiratory System

This data set also showed similar trends to the other two sets, including a larger range of productivity for non-treatment activities. This range included a low of 47% engagement on the respiratory system test review and a high of 90% for the respiratory

system lab. The range for CBL methods was only varied from 74% on the Fainting case study to 89% for the Diabetes case study. After one of the treatment groups, a student stated that she enjoys CBL because “they all have different scenarios and they do make me want to work. That’s necessary. You need that.”

The College Preparedness Likert Survey was used to analyze how prepared the students felt they were for certain college readiness standards derived from the College Preparedness Questionnaire (Figure 4). Then survey was then administered after each unit. This survey did not really show any consistent trends in the five themes of college preparedness: career pathways, literacy skills, study habits, and lifestyle (N=12).

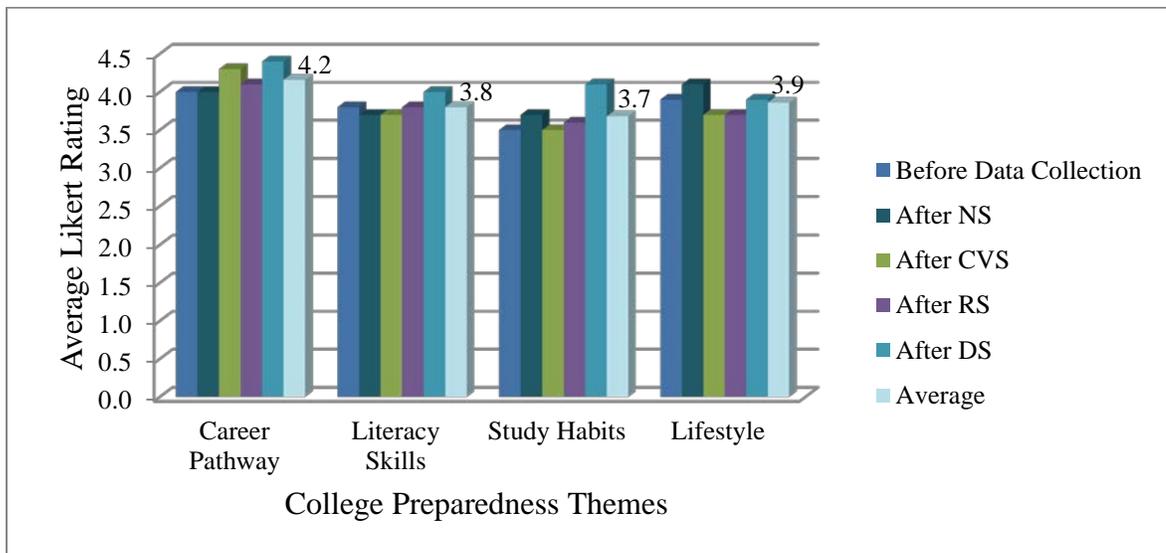


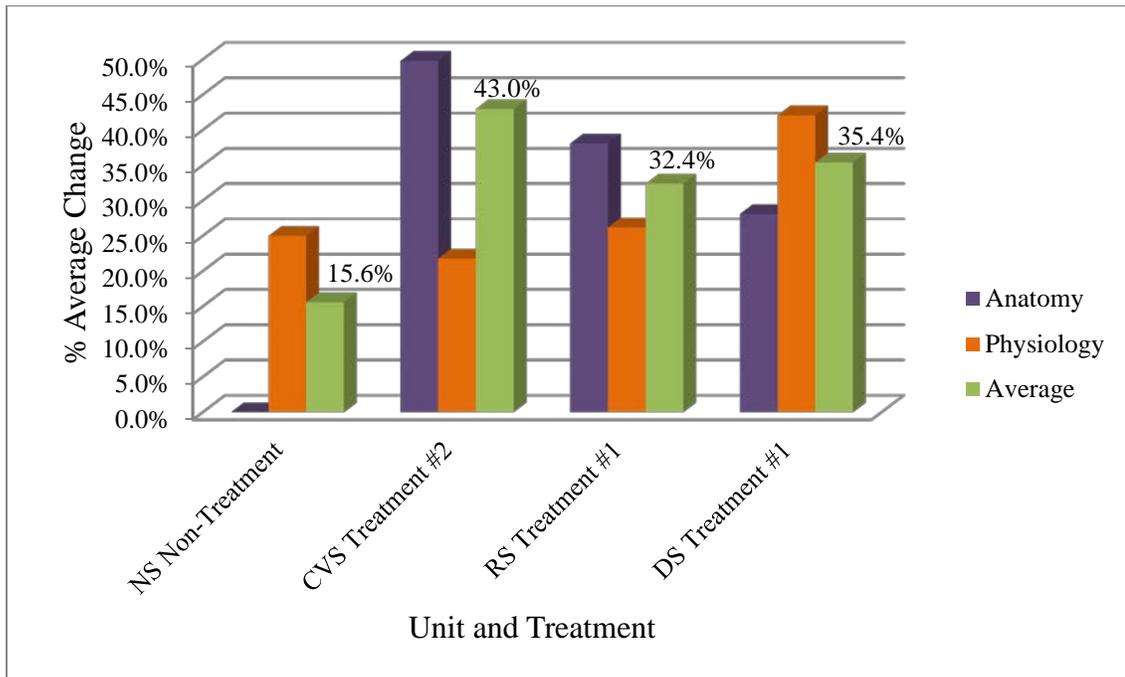
Figure 4. College Preparedness Likert Survey Data, (N=12). Key: 5 = Very Well Prepared, 4 = Fairly Well Prepared, 3 = Somewhat Prepared, 2 = Not Very Well Prepared, 1 = Not Adequately Prepared, NS = Nervous System, CVS = Cardiovascular System, RS = Respiratory System, DS = Digestive System

Some notable information from this data, however, was the fact that the students ranked themselves lower overall on their study habits with an average of 3.7. Study habits included time management, methods to study, motivation, focus, work ethics,

organization, and team work. While interviewing the students, many of them explained that their study habits were used the most during each unit. One student claimed that “I put a lot of effort into studying and I’ll probably retain more than others but I still think I could have studied a lot more.” After the respiratory unit, when asked if the unit helped prepare her more for college, a student stated, “If I’d actually done what I was supposed to, then yeah, it would have helped a lot.” This same student also stated that time-management was her biggest problem. The students’ main confidence lies in their decisions of their future careers and their post-high school pathways, with an average of 4.2. With the exception of the respiratory system, the students’ decisions on their career pathways became slightly more confident. This included their post-secondary plans and their knowledge about their desired careers. One student stated that the unit on the nervous system “helped me decide a little more about what I want to do for my career.” The students’ abilities to maintain a healthy lifestyle, their confidence, and their ability to live on their own had the next highest average at 3.9. Finally literacy skills, like reading comprehension, reading speed, math skills, computer skills, public speaking, listening skills, and writing skills were averaged out at 3.8. In terms of treatment and non-treatment groups, there were really no consistent increases or decreases seen between the pre-data collection and non-treatment groups and the treatment groups.

To measure problem-solving skills and higher-order thinking, I used Unit Pretests and Posttests and Critical Thinking Skills Surveys. The largest change seen between the two was an improvement of 43.0% between the cardiovascular system pretest and posttest (N=12). The cardiovascular system was the only unit taught using mainly CBL methods. The smallest change was between the nervous system pretest and posttest, with

only an improvement of 15.6% (Figure 5). The nervous system unit taught without any CBL. Both the respiratory system and digestive system were taught using some CBL both also fell in the middle of this data set with improvements of 32.4% and 35.4%.

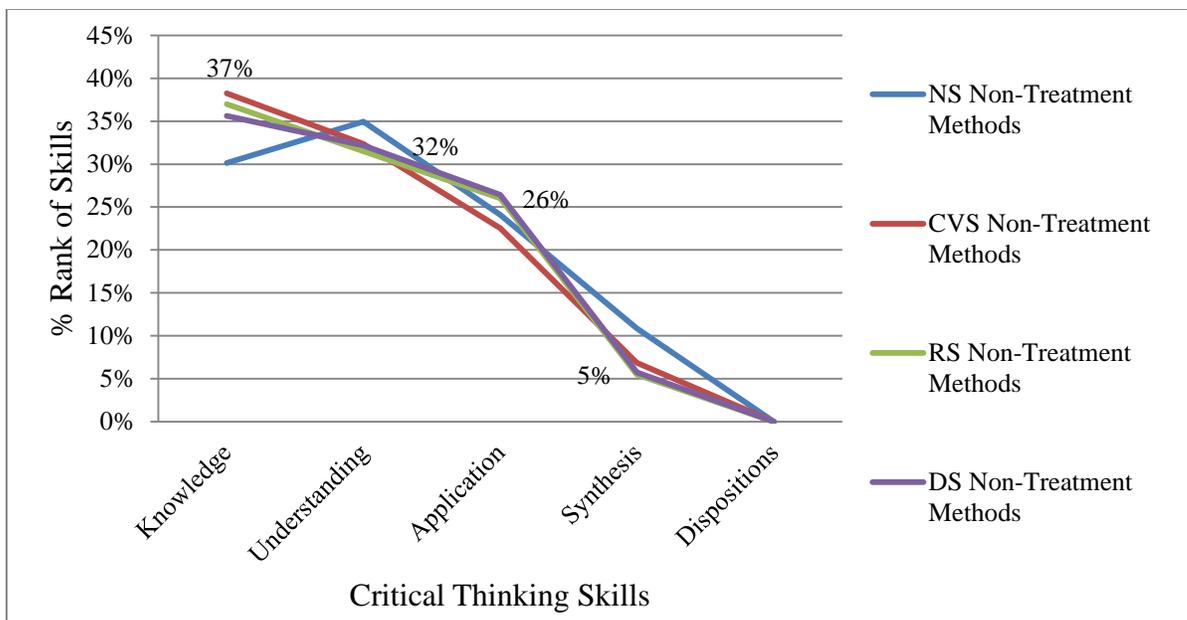


*Figure 5.* Changes in the Average Scores of Unit Pretests and Posttests, ( $N=12$ ). Key: NS = Nervous System, CVS = Cardiovascular System, RS = Respiratory System, DS = Digestive System

The questions on the pretest were classified into two categories: body system anatomy and body system physiology. Each division of these tests showed improvement all around, with the exception of the nervous system. Students did not change between the anatomy questions provided on the pretest and posttest on the nervous system. On the other hand, the largest improvements of anatomy were for the cardiovascular system, followed by the respiratory system. The students also showed improvement on the digestive system but not as much as the other treatment groups.

Overall, the changes seen between the pre- and posttest questions, based on the physiology of the system, also increased but not to the magnitude of the anatomy sections. The increases shown in the physiology sections remained fairly constant from the non-treatment group to the different treatment groups. The exception to both of these trends was the digestive system, treatment group 1 which showed an increase around 41% between the pretest and posttest.

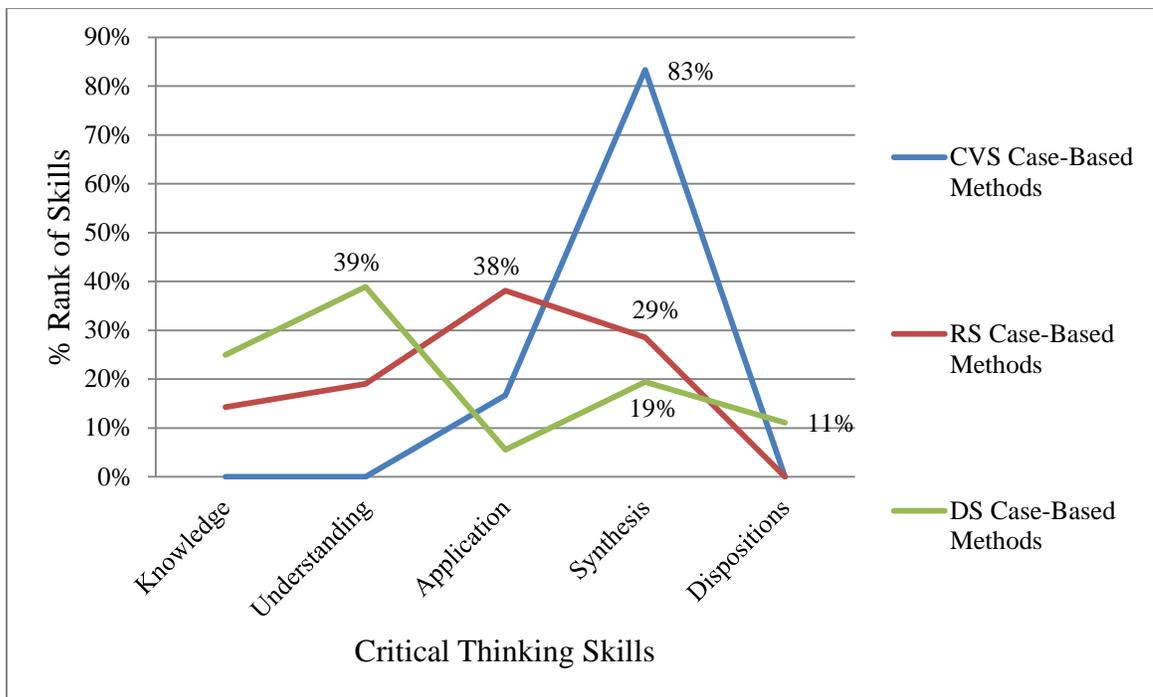
For the final piece of data to measure problem-solving and higher-order thinking skills, the Non-Treatment Methods Critical Thinking Skills Data, showed that 37% of all traditional methods used knowledge most (N=12). From there, the methods used decreased as the critical thinking skills became higher (Figure 6). All of the four units studied showed a very similar trend in this decrease.



*Figure 6.* Non-Treatment Methods Critical Thinking Skills Data, (N=12). Key: NS = Nervous System, CVS = Cardiovascular System, RS = Respiratory System, DS = Digestive System

In contrast, the Case-Based Methods Critical Thinking Skills Data portray a much different and more variant picture of the critical thinking levels of CBL (Figure 7).

Eighty-three percent of the case-based methods used in the cardiovascular system were ranked by the students as using synthesis the most (N=12). One student stated that “case studies are the most challenging for me. It’s more of a ‘go at it on your own’ and there’s never really a definite answer. Just makes you think.”



*Figure 7.* Case-Based Methods Critical Thinking Skills Data, (N=12). Key: NS = Nervous System, CVS = Cardiovascular System, RS = Respiratory System, DS = Digestive System

The cardiovascular system was taught using the methods corresponding to treatment group 2. Overall, three case studies were used to help teach these key points of this organ system. Some application was also documented by the students as being used in these CBL methods. The other two data sets also represent a greater concentration around application and synthesis. The respiratory system peaked at 38% in application

and dropped slightly to 29% for synthesis for those CBL methods. The digestive system had a high point for understanding for the CBL methods at 39% and synthesis followed with 19%. Dispositions was also used in the digestive system with the use of research articles on diabetes, as well as an activity that encouraged the students to learn about the daily life of a person with diabetes.

When interviewed about their higher-order skills, one student stated when using problem-solving in CBL that “I had to use a lot of different research to try and find the common thing between two points.” Another student was asked whether he felt if memorization or CBL was most applicable to anatomy and physiology and his post-secondary pathway and he responded that “[B]oth are important. Case studies really make me think but memorizing- it’s kinda nice just to know things. Memorizing it means that you don’t have to go back to your notes every single time. It gives you a good basis for the human body.” Another student stated that “[T]he case studies because you use your problem-solving skills instead of being a note-copying monkey.”

#### INTERPRETATION AND CONCLUSION

The three factors studied in this research were higher-order thinking skills, student motivation and engagement, and college preparedness. I feel my most conclusive data was higher-order thinking skills. Not necessarily by treatment group, but when case-based learning (CBL) was used, the students responded accordingly with the improvement of their problem-solving strategies. While the data tables all suggest these improvements, I feel the strongest piece of data was the student interviews. Most of the students interviewed acknowledged that CBL was the most difficult methods used because it caused them to think outside of the box.

Next, I studied student motivation and engagement. This area of data collection was slightly less conclusive. On all three instruments, there were slight increases seen in student productivity and motivation on average, although the data had jumped around a bit for some of the non-treatment methods that were used. I think this would be pretty typical for any data collection in these instances. Basically, I think that students have good days and students less productive days. Sometimes the productivity comes from the activity but again, I feel this can vary a lot from day to day regardless. For the most part, I liked the data collection instruments used for this section. However, even though it was beneficial for the students to be aware of their productivity and rank how hard they worked, I feel that a standard should have been set to help them rank this. For instance, one student may have rated himself a “5” for productivity for the day but then wrote that they only worked 30 out of 50 minutes, where another student ranked herself the same but worked the whole class period. Also, if I were to change anything else in regards to motivation, I would not have picked seniors in their last semester of high school on which to conduct this data collection. I feel that my results would have been a little more solid because I have seen a huge decrease in their overall motivation in the last month or two.

Finally, in regards to college preparedness, I feel that the data collection instruments that I created were not that well thought out. I was also very limited in these tools because two of the three were used to collect data while the third, the College Preparedness Questionnaire, was used mainly to build the College Preparedness Likert Survey. Therefore, this section of data turned out to be very inconclusive. One thing I could have done differently would be to show the students their previous College Preparedness Likert Survey as they were filling the new one out. This would give the

students a frame of reference to either change the previous one if they felt they overestimated or to more accurately gauge if there had been improvement in their skills. One thing I did notice with this data was the fact that the students' perceived study skills decreased after a few of the data collection units. Through the interviews and my own observations, I know that study skills would be a deficient area and usually seems to be the biggest problem when they head off to college. From this data, I have drawn the conclusion that the rigor associated with CBL may have opened their eyes more toward where they need to get with their study skills.

#### VALUE

I think because some of my data was inconclusive or was not as strong as others that it is hard to say exactly what case-based learning (CBL) contributes to my classes, in terms of college preparedness and engagement. One trend I did notice about engagement was the use of any student-centered activities. I noticed that my students, in general, responded better to student-centered activities like inquiry or labs, rather than teacher-centered learning like lecture. Even without looking at the data, I was able to see the connections students would make while working on the case study and I was able to see these connections evolve naturally. I feel that this was not something easily measured but as a teacher, to see this, made me feel like I was doing something right by them.

Through this research, I felt like I learned a lot about what works with my students in my anatomy and physiology class. In my background I stated that motivation was hard to come by in my school and many of the kids taking this class did not necessarily want to pursue a career or education related to the content, however, I feel that by using CBL to supplement the learning I made it relevant to each and every kid

because they have all heard about the ailments we study like diabetes or know who Lance Armstrong is and what is athletic background looks like. As far as each treatment group goes, I think the kids benefitted more from CBL when it was used only as a supplement because they still received the relevancy of the case study but were not burned out by too much CBL, indicative of the unit taught mainly using CBL.

Finally, I feel the greatest change seen through this whole process of research as well as my Master's courses is how much more reflective I have become as a teacher. This expands well outside of the realm of just CBL but also to smaller activities and methods that are more time and effort consuming. I ask myself more often to observe how effective I feel my teaching is and what I can do to improve it. This process has also opened my eyes to the wealth of different methods I can try and I now have a more structured system of evaluating these methods and how they work in my own classroom. Overall, this was a very insightful, reaffirming study to the use of CBL in my anatomy and physiology classroom.

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APPENDICES

APPENDIX A

“WAKE UP CALL” CASE STUDY

# Wake-Up Call

## Part I—"Panic!"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of New York

It was 4:36 a.m. She was in a cold sweat and having difficulty breathing. She felt as though she had run a marathon. Fear swept through her—something terrible was going to happen.

Panic-stricken, she woke her husband, Jeremy.

"Denise, what is it? Is it a nightmare?"

"No, it's like I'm having an asthma attack. I feel lightheaded and I can't catch my breath. My heart feels like it's beating a thousand times a minute."

Afraid to upset her husband further, Denise didn't tell him that an immense feeling of apprehension suddenly overcame her. She got up to drink some water and waited for the anxiety to subside. Her mind was racing. Jeremy had a family history of heart disease. This couldn't be happening to her. It was his problem. A few months earlier Jeremy was diagnosed with coronary artery disease. He was only 48 years old, the same age as Denise. The scare had encouraged him to gradually end years of chain smoking and adopt a healthier lifestyle. He was currently working on giving up the occasional cigarette for good.

"No," Denise thought to herself. "There's no way this was a sign of heart troubles. I didn't have a pain in my chest, I'm physically fit, and I have no family history. There's just no way."

After assuring herself of this, Denise was somehow able to fall back asleep.

### Questions:

- 1 How likely is this to be a heart problem? Asthma? Panic attack? Or...?
- 2 Why do you say this? What are the symptoms that are consistent with your preliminary diagnosis? Is there anything unusual?

# Wake-Up Call

## Part II—"A Voice from Within"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of New York

The next day at work, Denise was having a hard time focusing. Maybe the stress of her job was finally catching up with her. Managing a catering business was no easy task. On top of that, her only daughter, Emily, had left for college this fall and, being the overprotective parent that she was, Denise found herself constantly worrying about how her daughter was faring in a different city, away from the comforts of home. Also, Denise was starting to go through the early stages of menopause. The hormonal changes, combined with fatigue, stress, and her general worrisome nature, were catching up to her. Not only that, she couldn't get last night's scary episode out of her thoughts. Was it just part of the whole perimenopause thing or was it more? Her body was trying to tell her something, but Denise wasn't sure she was ready to hear.

"I wonder if Denise realizes how all those years of second-hand smoke have taken a toll on her lungs and on ME, her heart! All that tobacco inhalation has constricted her coronary arteries. Sure, Denise tries to stay physically active but genetics and her food choices have brought her blood cholesterol up pretty high to 245 mg/dl. She could be headed for heart disease. A person's total cholesterol level shouldn't get above 200 mg/dl. That's right. I ought to know! Denise has hypercholesterolemia, a major contributor to heart disease. Geesh. Get with it, Denise.

That was a major warning last night. I'm oxygen-starved! Luckily, only a small area of my left ventricle had a big decrease in blood flow and oxygen supply (cardiac ischemia). Thank goodness. If nothing else happens, my body will start growing some new collateral vessels (bypass channels) and I can get some repair work done. Denise didn't experience chest pain (angina pectoris). But her rapid heart beat and shortness of breath sure got her attention. She had better shape up because I don't know if I can handle much more oxygen deprivation. And, hey, all this unstable plaque lurking around is not a good sign either. No indeed. Who knows when it may rupture? I don't like the looks of this at all."

### Questions:

- 1 Draw a sketch of the heart and show where the coronary blood vessels lie.
- 2 List in order the blood vessels that a drop of blood would follow as it makes a complete journey around the body starting as it enters the right atrium until it returns to the right atrium.
- 3 What are the characteristics of Denise's lifestyle that might lead to a heart problem?
- 4 Has Denise suffered a heart attack?
- 5 Define these terms: cholesterol, hypercholesterolemia, cardiac ischemia, collateral vessels, angina pectoris, and plaque.

# Wake-Up Call

## Part III—"Heart Attack Basics"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of New York

It appears that Denise has suffered mild heart trauma, which may lead to a more severe heart attack if not treated. But wait ... isn't a heart attack when the heart stops beating? Not exactly.

**Cardiac arrest** is the term used when the heart muscle literally stops pumping blood. A heart attack, also known as a **myocardial infarction**, may lead to cardiac arrest, but it's defined as a sudden event where at least one of the **three major coronary arteries** (right coronary artery, left anterior descending coronary artery, and left circumflex artery) becomes partially or totally blocked, usually by a blood clot (**thrombus**). A more rare cause of coronary occlusion is an artery spasm that shuts down blood flow to the heart. This can occur with cocaine use and severe emotional stress. Other rare causes of heart attack include sickle cell crisis, allergic reactions, carbon monoxide poisoning, extreme hypoxia, and an unmet increased need for blood flow to the heart such as may occur during extreme physical exertion, shock, or hemorrhage.

Heart cells can live for about 20 minutes without oxygen. The loss of oxygen-rich blood to the heart cells during a heart attack leads to cell damage, which may be permanent and lead to **cell necrosis** (death), depending on the severity of the attack and the amount of heart tissue that the blocked artery supplies. **The area of infarction** is where cell necrosis occurs, if it does. Surrounding it is the **area of injury**, which may or may not suffer permanent damage. The outermost affected area is the **zone of ischemia**, which is weakened but regains function within two to three weeks.

Besides the possibility of cardiac arrest, other possible complications include the following: **cardiogenic shock** (where the heart is too weak to adequately pump blood), **pulmonary edema** (where a weakened heart causes blood backup and leakage of plasma into the lungs), irregular heart rhythm (**arrhythmia**), rupture of a heart wall or valve, or death.

It is a misconception that having a heart attack leads to chronic **coronary artery disease (CAD)**. In reality, CAD and accompanying **atherosclerosis** (hardened, narrowed arteries) is the number one cause of heart attacks. What causes CAD? The main culprit is **arteriosclerosis**, or plaque buildup in the coronary arteries. **Plaque** is a material composed mainly of lipids, cholesterol (lipoproteins), and calcium. **Cholesterol** (a type of lipid necessary for synthesis of hormones, vitamin D, and bile) is carried through the bloodstream by two main types of **lipoproteins: high-density lipoproteins (HDLs) or "good" cholesterol, and low-density lipoproteins (LDLs) or "bad" cholesterol**. Studies by the American Heart Association and the well-known NHLBI-supported Framingham Heart Study show that HDLs help prevent heart disease by transporting lipids and cholesterol from the arteries to the liver. LDLs, which contain more fat and less protein, are unstable and stick to artery walls to help contribute to plaque formation.

LDLs (**cholesterol-handling system**) produce toxins that form tiny lesions on the inner walls of arteries. These lesions attract triglycerides and other substances in the bloodstream. White blood cells (**inflammatory system**) rush to the injury site, but cause the inner wall to become stickier and thus attract more LDLs. Platelets (**blood-clotting system**) collect at the lesion

site, only to trap more lipids and white blood cells. Plaque build-up slowly occurs. (Note that cholesterol is not the sole cause of plaque formation.) Over time, some of the plaque can develop a thick, hard, calcified fibrous cap and is called **stable plaque**, yet causes the arteries to become narrower and harder (atherosclerosis). Other plaque can develop a large lipid and macrophage core, decreased smooth muscle cell content, and a thinner, softer, more unpredictable fibrous cap (due to increased metalloproteinase enzyme activity). This can rupture, producing a **thrombosis** (artery blockage), **cardiac ischemia**, and a heart attack can ensue.

# Wake-Up Call

## Part IV—"Call 911!"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of  
New York

It was March. Emily was home for spring break and Denise was enjoying having her 19-year-old daughter around. Unfortunately, it was going to be hard to spend much time with her because it was that time of the year when weddings and other catered events were picking up again after the post-New Year's lull. Denise was feeling the pressure pile up again. She constantly felt fatigued and out of breath, but she attributed these to perimenopause. Emily could sense that her mother was tense and out of sorts, so she planned a relaxing evening for her parents and offered to cook mushroom lasagna, her mother's favorite dish. All was going well until dessert, when Emily noticed her mother's face growing paler by the minute. Suddenly, just like that night back in October, Denise began to have severe trouble breathing and her heart began racing. The room began to spin and, without warning, she fainted on the dining room floor.

"Oh my God! Dad, call 911!"

"Uh oh. Oh! Oh no! Denise. Denise! Do you read me? I'm in the middle of a heart attack!! I know it. I can feel it! That plaque in your left anterior descending coronary artery just ruptured. Now everything is going crazy. Everyone in the whole body seems to be swimming by. High levels of fibrinogen, C-reactive protein (CRP), and interleukin-18 (IL-18-inflammatory markers present in the bloodstream when there's unstable plaque) are combining with your high blood serum cholesterol. BAD things are happening, Denise. Really, really BAD!

Plaque ruptures. Platelets stick to the exposed lipid core at the site of rupture. The blood clot grows...too big. Oh too big. Is it going to break? Say it isn't going to break. Not thrombosis, please....

.... It's been 10 minutes since my heart cells supplied by the blocked artery have been without oxygen. If something isn't done soon, my cells are going to die. Necrosis! I never thought I could say that word. They say a heart attack can take over four to six hours. This first hour is horrible—the most critical period. Parts of the blood clot may break loose, travel in the blood, and stick in some tiny little blood vessel. My God, it could get in a coronary artery or the brain! An embolism. I need help! Now... NOW. HELP!!

I've got to get my self in hand. It's the only way in a crisis. Right? Right! Why

didn't Denise go to her doctor to complain about her chronic breathlessness, fatigue, and nausea? All this stress elevated her blood pressure and further increased her risk for a heart attack. Alright, so she didn't know that she had a mutation in her LDL receptor gene. How could she know that LDL was not being efficiently removed from her blood? Whatever. At least she should have known her LDL blood levels were very high. So were her levels of lipoprotein (LP a). This stuff increases heart disease risk. Why didn't anyone warn her? Sure, I know I'm involved. I'm taking it personally. Wouldn't you? But maybe, if Denise had been more aware of the symptoms of heart disease she would have sought help. I happen to know that heart attacks are the number one cause of death in the U.S. More people die from cardiovascular disease (including heart attacks, atherosclerosis, and hypertension) each year than the next six leading causes of death combined, including cancer and automobile accidents. It's an epidemic that people need to be educated about. So get it. I'm here to tell you. Denise. If you won't listen to me, who will you listen to?

**Questions:**

1. Why is the first hour of a heart attack the most critical?
2. What do fibrinogen, C-reactive protein (CRP), and interleukin-18 (IL-18) indicate?
3. What is the cause of Denise's breathlessness, fatigue, and nausea?
4. What are platelets and what do they have to do with Denise's heart problem?
5. What is an embolism and what is its connection to thrombosis?
6. What does LDL have to do with heart attacks?
7. How does hypertension develop and what does it have to do with a high risk of heart attacks?

# Wake-Up Call

## Part V—"Emergency Room"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of  
New York

The doctor spoke calmly to Jeremy in the waiting room. "Mr. Belmore, your wife is in no immediate danger but she has suffered a heart attack to her left ventricle. She's in the emergency room right now, with the aid of an oxygen mask. We noticed some scar tissue, meaning that some prior heart trauma occurred as well. Is this your wife's first attack?"

"Yeah. I'm actually the one who has been diagnosed with heart disease in the house, and I'm the one with a family history. I don't understand. Where did this come from? Denise is conscious of her weight, and she's healthier than I am. She's the one who usually looks out for me and my daughter."

"Well, from her records, your wife hasn't had her blood pressure and cholesterol tested in a few years. Unfortunately, they were highly elevated, which greatly increased her risk of heart disease. Although she looked fit on the outside, blood work would have revealed hidden dangers. Tell me, had your wife been feeling out of sorts these past few months?"

"She has always been an on-the-go person and tends to worry a lot. Her job is pretty stressful. I did notice that these past few months she seemed more tired than usual and acted almost asthmatic. But, don't heart attack victims experience chest pain? Denise has never complained of that."

"That's a good question. The simple answer is that women's heart disease symptoms can be subtler than men's and are often overlooked. Take a look at the charts on the wall over there and you'll see what I mean. Patients may experience all, some, or none of those symptoms. It is even possible to have a silent heart attack."

experience all, some, or none of those symptoms. It is even possible to have a silent heart attack."

### Women's Symptoms

**Angina** (chest pain may radiate into jaw and down left shoulder and arm)

**Breathlessness** (especially at night)

**Chronic fatigue** (usually overwhelming)

**Dizziness** or even blackouts

**Edema** or swelling, especially in the ankles

**Fluttering** (rapid heartbeat) and pallor

**Gastric upset** (nausea) and sweating

### Men's Symptoms

1. Sudden *immense* pressure or pain in the chest center (may persist or occur on and off)

2. Pain that radiates from chest center to neck, shoulders, and arms

3. Dizziness, nausea, sweating

4. Sudden onset of rapid heartbeat

The doctor continued, "This is a pamphlet that gives you some background on cardiovascular disease and the factors that go into them. You'll notice that some of these are things you can't change. We call them "non-modifiable." They include your gender, age and your hereditary background; we're all stuck with these. Then there are the "modifiable" factors, things like smoking, stress, and a high fat diet. When more than one factor is present, risk further increases. Once Denise is better I think you both need some time together to consider how you might change your lifestyle."

# Wake-Up Call

## Part VI—"The Aftermath"

by **Lisa A. Rubin** and **Clyde Freeman Herreid** University at Buffalo, State University of New York

"Well, it's been four hours since the chaos began here in Denise's heart. I'm pooped! Here's the way I see it. A bunch of my cells are dead. So now there's an inflammatory response of neutrophils and monocytes and an elevated body temperature. Enzyme levels in the bloodstream are up. I don't know one enzyme from the other. They're all just proteins to me. But here's what I heard the doctors say—I mean it, they really use these big words: Creatine phosphokinase (CPK) has become elevated and will peak within 12 to 24 hours since the attack and with luck it'll return to normal within 48 to 72 hours. Its isoenzyme, CK-MB, is also elevated. CK-MB2 undergoes a change to CK-MB when released into the bloodstream. The ratio of CK-MB2 to CK-MB1 is more than 1.5 for heart attack patients, which is a benchmark doctors use to diagnose myocardial infarction within 6 hours of symptom onset. The blood level of aspartate aminotransferase (AST or GOT) has become elevated due to cell injury, will peak in 24 to 48 hours, and will return to normal in five days. In contrast to the rapid rise and decline of these enzymes, lactate dehydrogenase (LDH) will begin to elevate within a day of the attack onset and will persist at high levels for 10 to 20 days. Cardiac troponins T and I (which help me contract) will remain elevated in the blood for 10 to 15 days after myocardial injury. This means that if the doctors find that the troponins levels are up, they can really be sure the heart has been injured. Well, that's sure to be what happened to me. So now what have I got to look forward to? Some rest and healing time. With luck, four to six weeks from now, Denise's body will have deposited collagen fibers and scar tissue at the plaque rupture site. Some more collateral vessels will have been built. But for me, things will never be the same. Any of my heart tissue that died from oxygen starvation will be lost and replaced with scar tissue ... unless doctors can find a way to regenerate it. Geesh, I never thought this would happen to me. Denise is so young...."

### Assignment:

Denise is back home and on cholesterol-lowering medication and is learning how to better handle stress. Your assignment is to help Denise and her family research the key measures in preventing heart disease, or in Denise's case, another heart attack. Answer the following questions briefly and directly. You may include a table if desired. The sources cited in the [References](#) for this case are good sites to utilize.

1. Heart-Healthy Diet
  - a. What foods/nutrients should be limited and specifically what foods/nutrients are beneficial and why? (Example: what are the benefits of folic acid, monounsaturated fats, omega 3 fats, etc? Why are saturated fats bad?)
2. Lifestyle Changes
  - a. What activities are hazardous to heart health and what are some solutions? (Example: handle stress with stress management, not overeating)
  - b. What are the benefits of exercise concerning heart health?
3. Aspirin
  - a. How can aspirin help in preventing heart disease?

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APPENDIX B  
DATA COLLECTION UNIT ASSIGNMENTS

## DATA COLLECTION UNIT ASSIGNMENTS

<b>Nervous System Non-Treatment Assignments</b>	
<b>Assignment Name</b>	<b>Modified Level of Bloom's Taxonomy</b>
Nervous System Notes	Knowledge, Understanding
Nervous System Drug/Disease Presentation	Knowledge, Understanding, Application, Synthesis
Divisions of the Nervous System Worksheet	Knowledge, Understanding
Mouse Party Drug Online Activity	Knowledge, Understanding, Application
Neurotransmitter Function Worksheet	Knowledge, Understanding
Nervous System Review Worksheet	Knowledge, Understanding, Application
Nervous System Review Jeopardy	Knowledge, Understanding, Application
Nervous System Packet	Knowledge, Understanding, Application
Nervous System Anatomy Worksheet	Knowledge, Understanding

<b>Respiratory System Treatment 1 Assignments</b>	
<b>Assignment Name</b>	<b>Modified Level of Bloom's Taxonomy</b>
Respiratory System Notes	Knowledge, Understanding
Respiratory System Lab	Understanding, Application
Interactive Respiratory System Lab	Knowledge, Understanding, Application
"Lance Armstrong" Case Study	Knowledge, Understanding, Application, Synthesis
Respiratory System Review Worksheet	Knowledge, Understanding, Application
Respiratory System Review Jeopardy	Knowledge, Understanding, Application

<b>Digestive System Treatment 1 Assignments</b>	
<b>Assignment Name</b>	<b>Modified Level of Bloom's Taxonomy</b>
Digestive System Notes	Knowledge, Understanding
Food Interactive Online Lab Activity	Knowledge, Understanding, Application
Eating Some Food Online Worksheet	Knowledge, Understanding
Chemical Digestion Lab	Knowledge, Understanding, Application
Diabetes Case Study	Knowledge, Understanding, Application
Diabetes Article Summaries	Understanding, Application
Digestive System Review Worksheet	Knowledge, Understanding, Application
Digestive System Jeopardy	Knowledge, Understanding, Application

<b>Cardiovascular System Treatment 2 Assignments</b>	
<b>Assignment Name</b>	<b>Modified Level of Bloom's Taxonomy</b>
Cardiovascular System Notes	Knowledge, Understanding
Cardiovascular Packet	Knowledge, Understanding, Application
Blood Basic Notes and Worksheet	Knowledge
"Fainting" Case Study	Understanding, Application, Synthesis
"Hot Tub Mystery" Case Study	Understanding, Application, Synthesis
"Wake Up" Case Study	Understanding, Application, Synthesis
Heart Pump Activity	Knowledge, Understanding
Blood Typing Lab	Knowledge, Understanding, Application
Heart Anatomy Labeling Quiz	Knowledge
Homeostasis Hormone Worksheet	Knowledge, Understanding
Cardiovascular Crossword	Knowledge
Cardiovascular System Review Worksheet	Knowledge, Understanding, Application
Cardiovascular System Review Jeopardy	Knowledge, Understanding, Application
Blood Pressure/Sodium Intake Worksheet	Knowledge, Understanding

APPENDIX C  
UNIT PRETESTS/POSTTESTS

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

Period: \_\_\_\_\_

### *Nervous System Pretest/Posttest*

1. \_\_\_\_\_ Which of the following is not a direct function of the nervous system?
  - a. Reaction to a stimulus
  - b. Receive signals from the body's external environment through the body's senses
  - c. Detect changes in the body's internal environment
  - d. Process signals sent to the brain from the nerves
  
2. \_\_\_\_\_ What is the name used to describe the functional cells of the nervous system?
  - a. Neurotransmitters
  - b. Axons
  - c. Neurons
  - d. Glial Cells
  
3. \_\_\_\_\_ What is the name used to describe the supporting cells of the nervous system?
  - a. Neurotransmitters
  - b. Axons
  - c. Neurons
  - d. Glial Cells
  
4. \_\_\_\_\_ What are the two anatomical divisions of the nervous system?
  - a. Autonomic and Somatic
  - b. Central and Peripheral
  - c. Sympathetic and Parasympathetic
  - d. Efferent and Afferent
  
5. \_\_\_\_\_ What are the two main functional divisions of the nervous system?
  - a. Autonomic and Somatic
  - b. Central and Peripheral
  - c. Sympathetic and Parasympathetic
  - d. Efferent and Afferent

6. \_\_\_\_ What division of the nervous system refers to the “fight or flight” response of the body?
  - a. Sympathetic
  - b. Parasympathetic
  - c. Autonomic
  - d. Somatic
  
7. \_\_\_\_ A nerve cell that controls movement through a muscle is called a:
  - a. Neurotransmitter
  - b. Sensory Neuron
  - c. Receptor Neuron
  - d. Motor Neuron
  
8. \_\_\_\_ What is the main function of the central nervous system?
  - a. Process sensory and receptor signals from the nerves
  - b. Reaction to a stimulus
  - c. Receive signals from the body’s external environment through the body’s senses
  - d. Detect changes in the body’s internal environment for homeostasis
  
9. \_\_\_\_ All of the following are a function of the peripheral nervous system except:
  - a. Receiving signals from the external environment through the five senses
  - b. Detect changes in the body’s internal environment for homeostasis
  - c. Sending information to motor neurons
  - d. Processing sensory and receptor signals information
  
10. \_\_\_\_ What is the function of a neurotransmitter?
  - a. Send signals down the axon of a neuron to the synapse
  - b. Send signals from neuron to neuron or from a neuron to another cell
  - c. Process information sent from the neurons
  - d. Receive signals from the body’s external environment
  
11. \_\_\_\_ What is an action potential?
  - a. An electrochemical change in charge across a membrane.
  - b. The movement of a muscle.
  - c. The conditions needed prior to signal transmission in nerves.
  - d. Hormones that carry signals across a synapse of a nerve.

12. \_\_\_\_\_ All of the following are phases of a nerve impulse except:
- Resting phase
  - Recovery phase
  - Electrochemical phase
  - Action potential phase
13. \_\_\_\_\_ Depolarization is a change in electrochemical potential that:
- Makes the axon more negatively charged
  - Makes the axon more positively charged
  - Does not change the charge of the axon
  - Negatively exceeds the resting potential of the neuron.
14. \_\_\_\_\_ Repolarization is a change in electrochemical potential that:
- Makes the axon more negatively charged
  - Makes the axon more positively charged
  - Does not change the charge of the axon
  - Negatively exceeds the resting potential of the neuron.
15. \_\_\_\_\_ Hyperpolarization is a change in electrochemical potential that:
- Makes the axon more negatively charged
  - Makes the axon more positively charged
  - Does not change the charge of the axon
  - Negatively exceeds the resting potential of the neuron.
16. \_\_\_\_\_ The movement of which two ions across the neuron membrane aide in the propagation of an action potential?
- Calcium and Sodium
  - Calcium and Potassium
  - Iron and Potassium
  - Potassium and Sodium

\*\*Your performance on this assessment will not count against your grade. It is strictly a measure of your change in knowledge before and after a unit of instruction.

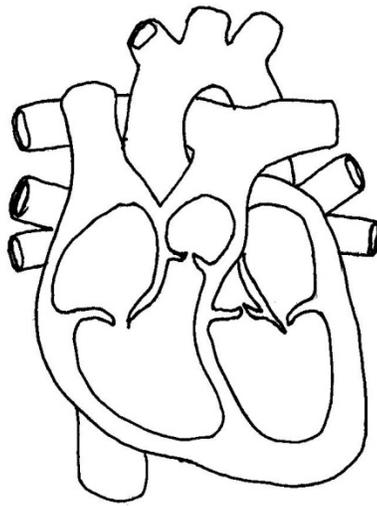
Name: \_\_\_\_\_

Period: \_\_\_\_\_

### *Cardiovascular System Pretest/Posttest*

1. \_\_\_\_\_ Which of the following is not a direct function of the cardiovascular system?
  - a. Transport carbon dioxide
  - b. Filter wastes
  - c. Transport oxygen
  - d. Transport nutrients
  
2. \_\_\_\_\_ What characteristic of cardiac muscle cells attributes to fast communication of signals between cells?
  - a. Automaticity
  - b. Striations
  - c. Mono-nucleate
  - d. Intercalated discs
  
3. \_\_\_\_\_ What are the two anatomical divisions of the cardiovascular system?
  - a. Pulmonary and Systemic
  - b. Systemic and Peripheral
  - c. Mediastinal and Peripheral
  - d. Pulmonary and Mediastinal
  
4. \_\_\_\_\_ What are the two classifications of cardiac cells found in the heart?
  - a. Conducting and Reflexive
  - b. Contractile and Conducting
  - c. Contractile and Pulmonary
  - d. Pulmonary and Conducting
  
5. \_\_\_\_\_ Arteries carry blood:
  - a. That is oxygen-rich
  - b. That is oxygen-poor
  - c. To the body from the heart
  - d. To the heart from the body

6. \_\_\_\_\_ Veins carry blood:
- That is oxygen-rich
  - That is oxygen-poor
  - To the body from the heart
  - To the heart from the body
7. \_\_\_\_\_ Capillaries:
- Facilitate gas exchange
  - Release blood into the tissues
  - Have high blood pressure
  - Have thick walls
8. \_\_\_\_\_ What is diffusion?
- Movement of water across a membrane to dilute a higher concentrated solution
  - Movement of molecules from high concentration to low concentration
  - Movement of molecules from low concentration to high concentration
  - Movement of water across a membrane to dilute a lower concentrated solution
9. Label the following parts of the heart: *Aorta, left atrium, right atrium, left ventricle, right ventricle, inferior vena cava, superior vena cava, pulmonary arteries, and pulmonary veins.*



10. \_\_\_\_\_ Which of the following correctly identifies the direction of the electrical impulse generated by the heart?
- AV Node, Bundle of His, SA Node, Internodal Pathway, Left/Right Bundle Branches, Purkinje Fibers
  - SA Node, Internodal Pathway, AV Node, Bundle of His, Left/Right Bundle Branches, Purkinje Fibers
  - AV Node, Internodal Pathway, SA Node, Bundle of His, Left/Right Bundle Branches, Purkinje Fibers
  - SA Node, Bundle of His, AV Node, Internodal Pathway, Left/Right Bundle Branches, Purkinje Fibers
11. \_\_\_\_\_ When a heart is beating, there are two phases. The phase of contraction is referred to as \_\_\_\_\_, and the phase of relaxation is referred to as \_\_\_\_\_.
- Systole; Diastole
  - Contraction; Rest
  - Diastole; Systole
  - Contractile; Conductive
12. \_\_\_\_\_ Specialized cells of the nervous system, called \_\_\_\_\_, detect changes in pressure in the circulatory system.
- Chemoreceptors
  - Sensory Receptors
  - Baroreceptors
  - Pressure Detectors
13. \_\_\_\_\_ Specialized cells of the nervous system, called \_\_\_\_\_, detect changes in oxygen/carbon dioxide concentration in the circulatory system.
- Chemoreceptors
  - Sensory Receptors
  - Baroreceptors
  - Pressure Detectors
14. \_\_\_\_\_ Increased levels of CO<sub>2</sub> cause:
- A drop in blood pressure
  - A rise in pH
  - A drop in pH
  - A rise in blood pressure

15. \_\_\_\_\_ What is one reaction of high levels of CO<sub>2</sub> in the blood?
- Increase in respiratory rate
  - Decrease in heart rate
  - Decrease in respiratory rate
  - Vasodilation of blood vessels
16. \_\_\_\_\_ In times of extremely low blood pressure, angiotensin II is activated. All of the following are effects of angiotensin II except:
- Anti-diuretic hormone is released
  - Renin is released
  - Aldosterone is released
  - Thirst is stimulated
17. \_\_\_\_\_ What hormone increases the production of red blood cells in the bone marrow?
- Erythropoietin
  - Aldosterone
  - Angiotensin II
  - Renin
18. \_\_\_\_\_ Which of the following is a correction made to high blood pressure?
- Vasodilation
  - Vasoconstriction
  - Increased thirst
  - Increased production of red blood cells

\*Heart diagram from: "Strwythur Y Galon." *U3M1\_2*. N.p., n.d. Web. 24 Oct. 2013.  
<[http://science.taskermilward.org.uk/mod1/Yr12 Applied/Unit3/U3M1\\_2.htm](http://science.taskermilward.org.uk/mod1/Yr12 Applied/Unit3/U3M1_2.htm)>.

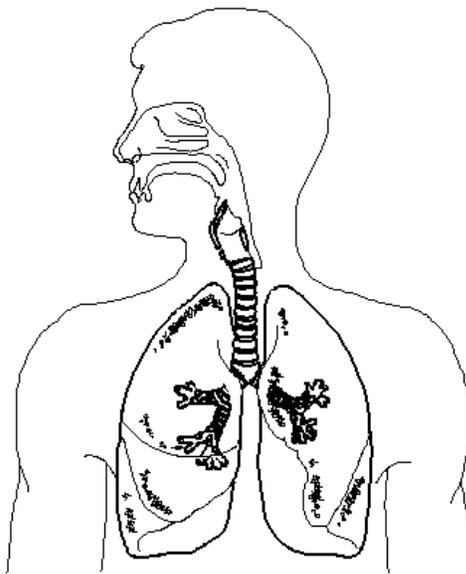
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Name: \_\_\_\_\_

Period: \_\_\_\_\_

### ***Respiratory System Pretest/Posttest***

1. \_\_\_\_\_ Which of the following is not a direct function of the respiratory system?
  - a. Gas exchange
  - b. Production of sounds/speaking
  - c. Transport of gas throughout the body
  - d. Protection against water loss, pathogens, and temperature changes
  
2. \_\_\_\_\_ What is the correct pathway of air into the body?
  - a. Nasal/Oral Cavity, Pharynx, Larynx, Trachea, Bronchi, Bronchioles, Alveoli
  - b. Nasal/Oral Cavity, Larynx, Pharynx, Bronchi, Trachea, Bronchioles, Alveoli
  - c. Nasal/Oral Cavity, Trachea, Pharynx, Larynx, Bronchi, Bronchioles, Alveoli
  - d. Nasal/Oral Cavity, Pharynx, Larynx, Trachea, Alveoli, Bronchioles, Bronchi
  
3. Label the following parts of the respiratory system: Pharynx, Nasal Cavity, Oral Cavity, Bronchioles, Bronchi, Trachea, and Larynx



4. \_\_\_\_ The vocal cords are housed in the:
  - a. Pharynx
  - b. Trachea
  - c. Larynx
  - d. Bronchioles
  
5. \_\_\_\_ What are the two functional divisions of the respiratory system?
  - a. Conducting and Lower
  - b. Upper and Lower
  - c. Upper and Respiratory
  - d. Conducting and Respiratory
  
6. \_\_\_\_ What is the function of the alveoli?
  - a. Warming air
  - b. Diffusion of gas
  - c. Moving oxygen to and from the lungs
  - d. Contracting the diaphragm
  
7. \_\_\_\_ What is the relationship of volume to pressure?
  - a. As pressure increases, volume decreases
  - b. As pressure increases, volume increases
  - c. As pressure increases, volumes remains the same
  - d. As pressure decreases, volume decreases
  
8. \_\_\_\_ Which gas law and formula governs breathing?
  - a. Boyle's:  $P_1/V_1 = P_2/V_2$
  - b. Charles's:  $V_1/T_1 = V_2/T_2$
  - c. Boyle's:  $P_1V_1 = P_2V_2$
  - d. Gay-Lusaac:  $P_1/T_1 = P_2/T_2$
  
9. \_\_\_\_ What organ increases the volume of gas in the respiratory system?
  - a. Lungs
  - b. Diaphragm
  - c. Alveoli
  - d. Trachea

10. \_\_\_\_ During a cycle of respiration, as the level of CO<sub>2</sub> \_\_\_\_\_, the levels of O<sub>2</sub> \_\_\_\_\_?
- Increases; Increases
  - Decreases; Remains the same
  - Increases; Decreases
  - Remains the same; Decreases

\*Respiratory System diagram from: "Analyzing Components of the Respiratory System." *Analyzing Components of the Respiratory System*. N.p., n.d. Web. 24 Oct. 2013. <[http://www.msncucleus.org/membership/html/k-6/lc/humanbio/3/lchb3\\_3d.html](http://www.msncucleus.org/membership/html/k-6/lc/humanbio/3/lchb3_3d.html)>.

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

Period: \_\_\_\_\_

### *Digestive System Pretest/Posttest*

1. \_\_\_\_\_ Which of the following is not a direct function of the digestive system?
  - a. Mechanically break down organic compounds
  - b. Chemically break down organic compounds
  - c. Using building blocks of organic compounds for metabolic processes
  - d. Absorbing nutrients
  
2. \_\_\_\_\_ Where does most of digestion take place?
  - a. Stomach
  - b. Mouth
  - c. Colon
  - d. Small Intestines
  
3. \_\_\_\_\_ All of the following are organs associated with the gastrointestinal tract except:
  - a. Liver
  - b. Stomach
  - c. Rectum
  - d. Esophagus
  
4. \_\_\_\_\_ All of the following are accessory organs in the digestive system except:
  - a. Pancreas
  - b. Gall Bladder
  - c. Colon
  - d. Salivary Glands
  
5. Label the following parts of the digestive system: pharynx, stomach, small intestines, colon, esophagus, pancreas, liver, gall bladder, rectum



6. \_\_\_\_ What is the purpose of mechanical digestion?
  - a. To break down food into organic building blocks
  - b. To minimize the surface area to volume ratio of the food
  - c. To aide in absorption of nutrients
  - d. To increase the surface area to volume ratio of the food
  
7. \_\_\_\_ Where does the initial breakdown of carbohydrates occur?
  - a. In the stomach
  - b. In the colon
  - c. In the mouth
  - d. In the small intestines?
  
8. \_\_\_\_ What are the building blocks of proteins?
  - a. Simple sugars
  - b. Nucleic acids
  - c. Amino Acids
  - d. Fatty Acids
  
9. \_\_\_\_ What conditions must be met the initial breakdown of proteins?
  - a. Acidic pH, 37°C
  - b. Acidic pH, 20°C
  - c. Neutral pH, 37°C
  - d. Basic pH, 25°C
  
10. \_\_\_\_ What is the function of bile?
  - a. Physically breaks down carbohydrates
  - b. Physically breaks down fats
  - c. Chemically breaks down proteins
  - d. Chemically breaks down carbohydrates
  
11. \_\_\_\_ What enzyme is responsible for the final chemical breakdown of carbohydrates?
  - a. Pancreatic Lipase
  - b. Hydrochloric Acid
  - c. Pepsin
  - d. Pancreatic Amylase

12. \_\_\_\_ What is the purpose of hydrochloric acid in the stomach?
- Acidity activates pepsinogen
  - Acidity chemically digests proteins
  - Acidity physically digests proteins
  - Allows for excretion of pancreatic protease
13. \_\_\_\_ What chemical is secreted to neutralize the acidic chyme before it enters the small intestine?
- Pepsinogen
  - Sodium Bicarbonate
  - Hydrochloric Acid
  - Bile
14. \_\_\_\_ Sugar is stored in the liver as:
- Fatty tissue
  - Glycogen
  - Glucose
  - Bile
15. \_\_\_\_ What is the main function of the large intestine?
- Water absorption
  - Nutrient absorption
  - Waste filtration
  - Nutrient digestion
16. \_\_\_\_ What two hormones are used to regulate blood sugar?
- Insulin and Glycogen
  - Glucagon and Glycogen
  - Aldosterone and Insulin
  - Insulin and Glucagon

\*Digestive System diagram from: "Digestive System." *AboutGastro Digestive System Category*. N.p., n.d. Web. 24 Oct. 2013. <<http://www.aboutgastro.com/digestive-system>>.

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APPENDIX D  
STUDENT OPINION INTERVIEW QUESTIONS

## STUDENT OPINION INTERVIEW QUESTIONS

**Question Set A**

What instructional methods in this unit challenged you most?

What methods in this unit helped you learn and retain the information?

What methods during this unit motivated you?

What methods in this unit help improve your problem-solving skills?

How did you approach solving problems in this unit?

How do you feel the information we memorize in class affects your knowledge and understanding of concepts related to the human body?

How much of this information do you actually retain?

\*Which method do you think is most applicable to this class and your education: case studies or memorization? Why?

**Question Set B**

What other college readiness skills do you feel you used during this unit?

Do you feel this unit helped prepare you more for college? Why or why not?

What skills do you wish you would have used more during this unit?

Have you developed any skill strengths from this unit?

What are your weak points after this unit?

\*What can you learn from the use of case studies that you can take with you to college?

**Question Set C**

What methods during this unit did you find to be most enjoyable?

\*Do you enjoy using case studies in anatomy and physiology?

\*Is there anything you don't like about the use of case studies?

Is there anything else you would like to add?

APPENDIX E  
CRITICAL THINKING SKILLS SURVEY

## CRITICAL THINKING SKILLS STUDENT SURVEY

1. Select the following critical thinking skills that you used in this unit:
  - Knowledge – Simple recall of facts and concepts.
  - Reasoning – Understand the main concepts and answer simple questions showing your own understanding of the concepts
  - Application – Use your knowledge and reasoning to solve problems or answer complex questions.
  - Synthesis – Relate several concepts to develop a diagnosis or formulate new opinions. Use several parts of information to infer new conclusions.
  - Dispositions – Create and support opinions and attitudes based on a solid level of knowledge and understanding
2. List the activities from class that highlighted each of these selected skills
  - Knowledge
  - Reasoning
  - Application
  - Synthesis
  - Dispositions

APPENDIX F  
COLLEGE PREPAREDNESS QUESTIONNAIRE

## COLLEGE PREPAREDNESS QUESTIONNAIRE

1. On a scale from 1 (Not Prepared at All) to 5 (Very Prepared) how well prepared are you to go to college and succeed with this part of your education? Please explain your answer.
2. Do you think college will be easy or hard for you? Why?
3. What do you feel will be the most difficult part of your college education?
4. What do you feel will be the easiest part of your college education?
5. What skills do you feel are necessary to succeed in college? Please list as many as you feel important.
6. What skills do you feel you already possess?
7. What skills do you feel you are lacking in or need to work more on to succeed in college?
8. What are some different techniques you use as study skills when studying for a test?
9. Do you feel these techniques will be sufficient in college?
10. What would best help you become more prepared for college?

APPENDIX G  
COLLEGE PREPAREDNESS LIKERT SURVEY

### College Preparedness Likert Survey

For the questions below, mark your level of preparedness for the skills necessary to succeed in college or a career readiness program (1 = *Not Adequately Prepared*, 2 = *Not Very Well Prepared*, 3 is *Somewhat Prepared*, 4 = *Fairly Well Prepared*, 5 = *Very Well Prepared*).

- |  |   |   |   |   |   |
|--|---|---|---|---|---|
| 1. Make a Decision about your Post High School Education | 5 | 4 | 3 | 2 | 1 |
| 2. Writing Skills  | 5 | 4 | 3 | 2 | 1 |
| 3. Reading Comprehension                                 | 5 | 4 | 3 | 2 | 1 |
| 4. Reading Speed   | 5 | 4 | 3 | 2 | 1 |
| 5. Study Skills  | 5 | 4 | 3 | 2 | 1 |
| 6. Mathematical Skills                                   | 5 | 4 | 3 | 2 | 1 |
| 7. Computer Skills                                       | 5 | 4 | 3 | 2 | 1 |
| 8. Public Speaking Skills                                | 5 | 4 | 3 | 2 | 1 |
| 9. Developing a Working Routine                          | 5 | 4 | 3 | 2 | 1 |
| 10. Efficiency/Time Management                           | 5 | 4 | 3 | 2 | 1 |

## 11. Financial Responsibility/Independent Living

5	4	3	2	1
---	---	---	---	---

## 12. Maintaining a Healthy, Stress-Free Lifestyle

5	4	3	2	1
---	---	---	---	---

## 13. Motivation/Focus

5	4	3	2	1
---	---	---	---	---

## 14. Work Ethics

5	4	3	2	1
---	---	---	---	---

## 15. Organization

5	4	3	2	1
---	---	---	---	---

## 16. Job Knowledge/Career &amp; Education Pathway

5	4	3	2	1
---	---	---	---	---

## 17. Listening Skills

5	4	3	2	1
---	---	---	---	---

## 18. Team Work

5	4	3	2	1
---	---	---	---	---

## 19. Confidence

5	4	3	2	1
---	---	---	---	---

APPENDIX H  
30 MINUTE TARGET SURVEY

## 30 MINUTE TARGET SURVEY

Individual or Group Task?

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

Treatment Group: \_\_\_\_\_

<b>Time Interval</b>	<b># of Students on Task</b>	<b>Percentage on Task</b>	<b>Student 1</b>	<b>Student 2</b>
<b>:05</b>				
<b>:10</b>				
<b>:15</b>				
<b>:20</b>				
<b>:25</b>				
<b>:30</b>				

Notes:

APPENDIX I

ACADEMIC ENGAGEMENT MONITORING FORM

## ACADEMIC ENGAGEMENT MONITORING FORM

Teacher: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_  
 Observer: \_\_\_\_\_ Class: \_\_\_\_\_ Activity: \_\_\_\_\_

For the next 5 minutes, focus on a different student every 5 seconds. Record a “+” symbol to indicate on-task or engaged behavior and a “-” symbol to indicate off-task behavior. When each student has been observed, begin the progression again. Continue until 5 minutes has elapsed.

Front of Class		

Divide the total number of on-task (+) marks by the total number of marks (60).  
 Time on Task (academic engagement) = \_\_\_\_\_%

Notes:

APPENDIX J  
STUDENT PRODUCTIVITY SURVEY

### STUDENT PRODUCTIVITY SURVEY

Directions: Rank your opinions based on the following statements (5 = *Strongly Agree*, 3 = *Neutral*, 1 = *Strongly Disagree*). Provide an explanation where it is required.

1. I was productive working on my assignment today.

5      4      3      2      1      N/A

- a. List all the activities you completed today that were productive?

2. I was engaged with the materials used in class today.

5      4      3      2      1

- a. List all the activities that you were engaged in today?

Directions: Answer the following questions.

3. How many minutes did you feel you were on-task and engaged today?
  
4. How many minutes of class do you feel you were off-task or not engaged?
  
5. What did you partake in that demonstrated off-task behavior?