This is to certify that the

thesis entitled

A Circulatory Unit in a High School
Human Physiology Course

presented by

Lori Buwalda

has been accepted towards fulfillment
of the requirements for

Masters degree in Science

Major professor

Date July 23, 1998

A CIRCULATORY UNIT IN A HIGH SCHOOL HUMAN PHYSIOLOGY COURSE

By

Lori L. Buwalda

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTERS OF SCIENCE

College of Natural Science
Division of Science and Mathematics Education

1998

ABSTRACT

A CIRCULATORY UNIT IN A HIGH SCHOOL HUMAN PHYSIOLOGY COURSE

By

Lori L. Buwalda

A one semester high school physiology course was revised with a focus on using the constructivist/conceptual change method of teaching. There are three reasons I chose to revise this unit: To provide situations for students to apply what they were learning to every day life; to enhance a hands on approach through increasing laboratory activities and class discussions; to further develop the unit content with the Michigan Essential Goals in Science Education (see appendix A) in mind. Students were encouraged to enhance communication skills through group work toward solving specific problems. By being more actively involved with the concepts, the students were able to instruct their class mates in certain aspects of the unit, and to ask one another questions that helped lead to a deeper understanding of the circulatory system in humans.

ACKNOWLEDGMENTS

I would like to thank all of those in the Division of Math and Science for their wonderful Master's program. I appreciated the way the courses were scheduled to accommodate a working educator's schedule.

I would also like to thank my best friend and husband, Scott Lounds, for all of his constant love and support. Without your help I would not have been able to write this thesis. I want to also thank Connor Lounds, my two month old son, for giving me an easy pregnancy and delivery during this past year. You are a wonderfully curious bundle of joy and energy that makes me smile with delight every day. To my loving dog Cypress, thank you for keeping my feet nice and warm during those cold, late winter nights and patiently waiting for me to take you out.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Teachers tend to teach the way they were taught. If their experience was one in which the teacher was in charge and dispensed the knowledge and the students were expected to learn from this non-interactive approach, then they most likely will teach in the same manner. This method tends to develop students who can memorize but are unable to apply what they have learned because they do not understand how the concepts are related.

I chose to work on the physiology course because I felt it was not as conceptual, which I will define shortly, as the other courses I teach. Science educators should engage student's active learning by shifting emphasis away from simply presenting information that will then be tested (National Science Standards, 1996). I felt that the course would benefit from restructuring for five basic reasons: 1) the class was overly lecture oriented, as opposed to having an environment where there was an exchange of knowledge between students and the teacher; 2) students did not get a thorough understanding of how the systems of the body interacted with each other; 3) the students had difficulty applying what they were learning to everyday situations; 4) the class underutilized lab work; 5) some of the Michigan Essential Goals of Science Education (MEGOSE, 1991) were not being addressed as well as they ought to be. (See Appendix A). This thesis focuses on the circulatory system (part of the physiology course) because some of the students have prior knowledge of this subject, and it is a system in which students can easily see the functional connections with the rest of the body.

The student population of Holt High School, which is in a suburb of Lansing, MI, consists of sophomores, juniors and seniors. The high school was the recipient of the Michigan Exemplary Schools Award in both 1989 and 1993. In 1993, the National Exemplary School Award was given to Holt High School by the U.S. Department of Education. At the time of this study, the student population of Holt High consisted of approximately 1100 students including 140 with various disabilities. Although the school population is not ethnically diverse (approximately 90% are Caucasian), it is very diverse socioeconomically.

The physiology class involved in this study was taught in the Fall of 1997. The class consisted of 22 students out of which seventeen were seniors, four juniors, and one sophomore. There was an even distribution of males and females. There were six students who were classified as needing special services, four of which were of low development (LD), one was emotionally impaired (EI) and the last was physically impaired. Only four of the Senior students had not applied to a higher level educational institution. Of the non-seniors, all five plan on continuing their education. A majority of the class offerings in the sciences consists of heterogenous groups of students, meaning students on all different learning levels, because the department believes that different students bring varying experiences with them that enrich all the student's educational experiences. The mix in this class was somewhat unusual in that most classes would have a greater number of juniors and sophomores, largely because many more sophomores take the course second semester after they have learned some basic biological concepts in their first semester Cell

Biology course. The staff believes that the students need to understand cells, in general, before they start to learn about certain diseases/disorders within a specific cell type. This way the students have some prior knowledge in which to connect the new information they are learning.

All upperclassmen have taken one year of biology and either have had or are presently enrolled in chemistry. For all of these students, this physiology course was an elective. Twelve are enrolled in another specialty biology course for next semester. The high school offers five biological specialty semester courses which are: 1. Botany; 2. Human Genetics I; 3. Human Genetics II; 4. Human Physiology and 5. Zoology. As a prerequisite to these five choices every student is required to take a semester of Cell Biology. Furthermore, they are required to take a second semester course which is to be chosen from one of these five. The remaining choices can be taken as electives. This is a unique way of offering students a choice in their life science course work. Many high schools offer a one year biology course and then a possible upperclassman advanced physiology and anatomy course. With more specific areas to choose from the students gain much more knowledge and understanding of the life sciences. For example, instead of learning about genetics for a two or three week period in a year long biology class, the students get twenty weeks in which to gain a much more thorough understanding.

The National Research Council in 1996 lists several assumptions about the nature of science teaching. These indicate that students are greatly influenced by how they are taught. Teachers are charged with the responsibility of transmitting knowledge of and attitudes toward science. In fact, educators are asked to allow and encourage students to

construct knowledge from activities that stimulate both individual and social processes, hence the "constructivist" approach. Students often work more effectively in groups where they benefit from the interaction with, and informal tutoring of, others. Each individual has the opportunity to make a contribution to the end product, which frequently is better due to the convergent, or equally so the divergent, thinking of the group members. Additionally, group centered activities "place greater emphasis on student activity; on pupil participation, initiative and responsibility" (Ausubel, 1968). I have found this to be true in my own teaching, but there are some highly self-motivated students who do an excellent job on individual projects as well. On the whole, if the students did not work in groups, many enriching conversations and learning experiences would not take place. I have been using this type of teaching method in my Genetic and Cell Biology courses for six years and I believe the students really benefit from it. One should keep in mind that group work requires the instructor to really think about the activities that are assigned. A prefabricated work sheet assignment is probably not a good task for a group to work on. An ideal group work situation is one where critical thinking skills are needed and where the input of each group member is crucial.

Since the Spring of 1990, the high school has been heavily involved with the professional development of its staff. In the Fall of 1989, a few staff members developed a new schedule where Wednesday mornings were "free of students" for a 2.5 hour time block. They did this by consolidating the required half-hour before school preparatory time and adding a few minutes to each class. This block of time gave the staff opportunities to work with the faculty from Michigan State University College of

Education, in addition to a few other public institutions and to collaborate with others on such things as teaching methods, curriculum development, and student educational objectives. Out of this relationship with Michigan State University, the high school became what is known as a Professional Development School (PDS). Today the school is still involved with PDS; as a result of this the students report Wednesdays at 10:55 a.m. for classes which are on an alternating schedule every week. On the first week of school the students report to their first three hours, then on the next Wednesday they report to their last three hours. This alternating schedule is very straight forward and ensures that no instructional time is forfeited. As a result of the Wednesday morning work time the staff has been able to be very innovative. Change is not a stranger to an experienced staff, whose average teaching experience is approximately twenty years. They are willing to try innovative ideas and techniques to improve the education of their students. Support for change is often given within departments and/or the entire staff. One such change was the embracing of the constructivist/conceptual change model of education by much of the faculty.

Constructivist/conceptual change models are similar pedagogical educational philosophies with strong ties to Piaget and other studies from the 1970's. Essentially, these philosophies emphasize that a student's prior experiences and knowledge play a large role in how they learn and relate to new concepts. Students try to make sense of the world around them on an ongoing basis. The conclusions they draw from experiences may not be scientifically correct, and misconceptions develop that can persist indefinitely. Studies indicate that misconceptions commonly found in elementary students are also r

c

a

e

c

N

b

f

te

th

h

in

o

p

found in high school and even college graduates (Kyle & Shymansky, 1989). By the process of exploration, concept introduction, and application, students are able to disclose and discuss conceptions and then construct patterns and relationships (Lawson, 1988). The aforementioned process is called the learning cycle; a starting point for the instructor is to assess the student's prior knowledge to see if misconceptions do exist. The process of exposing a misconception can be one where a simple question is asked and all students are asked to respond with a written answer. When the answers are verbally shared, a disagreement between student responses could occur. Then a student often will be motivated to question or even discard their previous understandings and construct new ones. "The learner must first recognize his/her current knowledge is insufficient to explain an experience" (Schulte, 1996). By assessing the students' prior knowledge, "the teacher examines each student's understanding and develops instructional techniques that create cognitive conflict to help adjust the students' alternative conceptions" (Alkove & McCarty, 1992). The instructor will then have the students investigate a given situation by performing various hands-on-activities that include working with others, reading texts for reference, and concept mapping. For example, when teaching problem solving techniques students often need to have an example or "model" of the process. Then as they start to understand the process they need to be "coached", or asked questions about how it relates to their previous knowledge. Finally the students need to apply this new information to a problem on their own, so the instructor is said to "fade". According to one educational researcher, hands-on learning requires that "a constructivist takes the position that the learner must have experience with hypothesizing and predicting, manipulating objects, posing questions, researching answers, imagining, investigating, and inventing." (Fosnot, 1989)

Sometimes when students are reading, they construct their own meanings or misconceptions from what they read (Beck, 1989). It is crucial that instructors do not assume that all the students correctly comprehend what they read, especially if the reading relates to new topics. Students often become overwhelmed by new terminology and instead of trying to relate the terms to one another they will try to memorize them. "Teachers can use strategies such as concept mapping to help students find relationships between terms rather than memorizing their definitions" (Yager, 1991). A concept map takes a main topic word and diagrams the different connections it has with all the sub-topic words; this is a technique often used in conceptual model teaching.

Real-world contexts, such as case studies, are also important situations where the students can apply or relate their knowledge to complete the learning cycle. Case studies, or story lines in the biological sciences, are about a particular problem(s) an organism is facing and are used to introduce new concepts which can stimulate a student's interest.

Often high school texts do not present enough challenging information because of the breadth of material they must address; I choose to give the students a more in depth look at the dynamics of the human body than is presented in introductory high school texts. By this I mean that I prefer to use the same vocabulary and detail found in a college level course. The high school texts lack real-world examples of the interrelationships of the physiological systems. Case studies are a good way to address this shortcoming. Not only does the case study describe an everyday occurrence, but also just gives enough information so the students begin to question why seemingly unrelated systems, or symptoms, are all being affected due to the problem described in the case study.

Even when using a textbook, my class was not able to study all of the human physiological systems. I began to wonder if I really needed to discuss all the systems with the students if they ended up with only a basic and sometimes imperfect understanding and little applicable knowledge. The question remained, would the students be better served studying many systems, which could sacrifice a thorough knowledge as well as a thorough foundation in critical and scientific thinking, or studying fewer systems? Recently, in the Spring of 1998, the Third International Mathematics and Science Study (TIMSS) was released. The results were not very positive for the American secondary students; in fact they scored "low". A professor of education at Michigan State University explained on CNN that a possible reason why Americans scored so low was that American students are taught a breadth of science and math topics with little time for depth and reflection. The professor described how some of the high scoring foreign students are taught very few concepts in a year, but that they are taught in great detail so the students have a thorough knowledge and understanding of the material.

I first started teaching this course similarly to the way it had been taught when I was a high school student, because of a lack of pedagogical training with respect to physiology content. I have found that many novice teachers are not permitted to teach such detailed, or upper level, courses early in their career. My hypothesis for this is that most novice teachers have not been prepared to teach these relatively complex courses (Rubba, 1981). Although many have taken one or more of the pertinent college courses, the course material has been at an advanced academic level. The content was not intended to expose new educators to activities and teaching techniques they might use in the classroom (Hershey, 1992).

This is my sixth year of teaching. I was dissatisfied with how my students were learning physiology each time I taught this course. I felt as though I had to cover as many systems as possible during the span of only a semester. When I first taught physiology in 1994, I tried to cover several systems by having the students read sections from a text, answer some questions, listen to me lecture and take tests and quizzes. This approach was very typical of the traditional instruction method (AAAS, 1989). Looking back I did not enjoy the course, because it was being text-driven and the students were not actively engaged in constructing knowledge or understanding. Clearly, there is a positive correlation between student engagement and student achievement, as any working educator will acknowledge. If I asked questions during the lecture, it was like looking at twenty-four blank screens which were waiting for me to turn them on by supplying the answers. In that situation "students were passive receivers who learned what the teacher told them to learn . . . students strived only to complete the activity quickly or correctly. . . ."(Schulte, 1996). As was mentioned in my reasons for wanting to change the curriculum of the physiology course, the students undertook few labs, and during the few labs students attempted, it was difficult to get the students to apply information. None of my other courses were like this. This led me to begin considering why this was the case. My deliberation on the lack of labs was exactly the kind of thinking I wanted my students to do as a result of laboratory exercises "Deliberation begins with a concrete practical situation that disturbs us, and is the means by which we develop and construct curriculum" and " the purpose of deliberation is to probe into the nature of the problem in order to orchestrate change" (Tamir, 1974). I realized that I needed to involve the students more so their role in the course would be a more active one. The students must feel that the class is a collaborative effort, that their input is needed and encouraged and that learning depends on the shared experience of all those in the community that is the classroom (Posner & Strike, 1982). Also, I believe it is counterproductive to lecture on the complexities of the cardiovascular system because the instructor is having to do most of the thinking and investigating. Given the responsibility of teaching students that science is a process, it is incumbent on practitioners to extend science from the classroom into other activities so that students can experience them with all their cognitive and affective abilities. The students needed to be more actively involved with the material. I undertook an examination of the troubling aspects of my curriculum and instruction with the goal of making a change. Making changes can be a time and energy consuming process, but exciting and rewarding, especially when those changes attempt to ". . . eliminate teaching practices that have become entrenched in our culture." (Schulte, 1996). I know my own high school physiology course was very general, while my college courses went into intricate detail. I regretted that this was the case because my high school experience did not accurately portray the depth and breadth of study that physiology entailed. Also with quite a few of my students planning on going to college, and possibly facing the same situation, I informally asked them what sort of course they would appreciate. I got a resounding response for more detailed systemic knowledge. I also received suggestions from colleagues on how to get the students more actively involved by having groups of students research different topics related to the system being studied and teaching the class about it. I also received and reviewed suggestions on possible ways to increase the amount of laboratory time in the course. A colleague and I developed an idea in which the students would do independent research papers and lab demonstrations to illustrate those systems that would not be studied by the class. I took these suggestions, and my knowledge of the constructivist/conceptual change model method of teaching, which I was using in my other courses, and decided to make some major changes to the physiology course. As Paige L. Schulte states "Constructivists believe that . . . education should be student centered and that the teacher facilitates learning rather than acts as an authority who transmits information to students" (Schulte, 1996). This quotation illustrates the very mode of education I was, and am, striving to deliver in all of my courses. When I began talking about some of the changes I wanted to make, I looked to my fellow faculty for reflection and support. One of the veteran teachers in my department took an especially keen interest in my making changes to the approach used in teaching physiology and hoped to implement them in his course as well.

I began to prioritize the main concepts I wanted the students to know, and cross-referenced them with the Michigan Essential Goals of Science Education objectives to insure that these priority concepts parallel what the state mandates. I found that some of the genetic concepts were not emphasized enough, like mitosis, meiosis and protein synthesis and tried to construct ways to incorporate the concepts into my new physiology course. Also, I thought that incorporating a study of an inheritable blood disorder could be easily implemented by me and grasped by students and would work well in the physiology problem solving scenarios as well as investigate a number of important concepts. Also, I wanted to use effective activities that focus on cooperation among students rather than individualism. I began to think that the students would be motivated and encouraged to do more communicating about their understanding of the concepts.

One way to enhance student/teacher communication would be to incorporate journal writing into the course. Journal writing as a classroom assessment tool is a way of enabling students to reflect on their feelings and understandings regarding the activities or discussion in the classroom. To promote interactive learning in the classroom, it would help to know the student's level of prior knowledge going into the unit, and during the unit. I thought I could use their responses to a journal question to start a discussion or to lead into an activity to determine if their predictions were correct. Therefore, some of the activities would have to be effective in helping the students understand that they had either a lack of understanding or misconceptions about the material. The activities should allow them to inquire and construct new meanings about the content. As Schulte says, the teacher should "... create cognitive conflict to help adjunct the student's alternative conceptions"(Schulte, 1996).

In the past, I allowed the students to choose the order in which the systems of the body were studied. However, I realized that this had an adverse effect on the ability of students to make connections. I found I needed to demonstrate the desired thought process for them in at least one physiological system. To be precise I felt that starting with two systems that were quite clearly linked would help the students strive to make the connections between systems investigated in the future and to see how the intricate interaction of various systems leads to the overall functioning of an organism. I now start the semester with the integumentary system as it is easy to observe. Also, the interaction between the integumentary and circulatory systems is easy for students to understand via the dermal blood supply. It has been noted that interest is mediated by a sense of adequacy about a topic. (Bloom as cited by Baird, Lazarowitz, and Allman, 1984).

Complaints about certain biological topics, such as botany and ecology, are that they are not taught enough, or if they are taught a poor job is done. (Hershey, 1992). Yet few have voiced such complaints about the study of human physiology. Due to a historic interest by humankind in our own health and mortality students are eager to apply physiological information to life experiences. Also the amount of knowledge gained about how the body works has increased tremendously with the use of newer technologies. This inherent intrigue and curiosity has made it fairly easy for educators to teach the subject of human physiology. Since there is such a vast amount of information available, I think that students sometimes get overwhelmed and cannot see the big picture of how all the systems interrelate and depend on one another. It is the instructor's duty to choose the most important topics, teach the concepts, then aid the students in applying the concept to other areas. To alleviate any possible confusion, the next step would be to model the thought processes in small increments, which would allow the students to begin to understand the multitude of systemic connections that are possible. Constructing an ongoing concept map during the unit might help them to see the connections better, instead of giving them pre-fabricated one. By the end of studying a model physiological system, the students should be prepared to make a thoughtful choice as to the next system to be investigated. In fact, the final decision could be made by students debating the merit of their personal choice of the system to be investigated next, by making appropriate connections between the system just completed and the proposed system in order to convince their classmates.

IMPLEMENTATION

The main goal of this project was to increase the effectiveness of the physiology course I teach, specifically the circulatory system. I strove to make the course more conceptually based by using the constructivist /conceptual change model as outlined in the introduction. The implementation of changes was a multi-step process. First I made the students and their parents aware that they were participating in the master's thesis requirement of their instructor. Consent forms were designed and distributed prior to instruction and the unit was discussed at parent-teacher conferences (Appendix B). Students could choose to participate in the study or not. If they declined there were not to be any academic repercussions for the student. The mere fact that students were allowed to choose to participate has been shown in several studies to correlate with interest and achievement. (Lazarowitz and Lazarowitz, 1979). In fact, no students declined to participate, and from the comments received from the students seemed to be very interested in helping me.

Prior to any instruction on the human circulatory system, the students were given a pre-test to determine their level of understanding of both the structure and function of this system. Pretests help the instructor to avoid making improper assumptions about the students background knowledge. It is common that the students learn much from having their prior misconceptions shown to be faulty, in this case by a pre-test, especially when they can be shown why these misconceptions exist and when provided with sufficient reason to change these ideas.

One technique that I used was construction of a concept map with the students to help them gain a better understanding of how the technical terminology they were about to study was related to previous knowledge. This practice allowed students to incorporate their prior knowledge into the unit and gave them an idea of where we were headed. This assisted them in developing a context in which to anticipate instruction. To start making a concept map we had a "brainstorming" session on the topic at hand. The students became immediately involved in learning. This activity also gave the students a chance to challenge their own misconceptions. They understood that the instructor would not answer their questions at this time. However, through discussion and their own and their peers' prior knowledge, each person's questions were addressed. This created curiosity about where these concepts would lead the unit. Since some of the students had a two year lapse since their Cell Biology class, I had the students read about the concepts which allowed me to avoid having to lecture about these topics. I also had them answer a few direct questions or problems from their readings. I encouraged them to write down any questions that came to mind, which were included in later discussions (I adopted this technique from an article by Lozauskas and Barrell titled "Reflective Reading: a journal for inquiring minds." published in 1992).

The following is the basic overview of the 3 to 4 week cardiovascular unit: An evaluation of these activities can be found in the next section of this thesis.

Table 1: Cardiovascular Unit Overview

I.	Pre-testing instrument	
II.	Concept mapping/case study information	
III.	Subunits/main concepts	
	A.	Lecture/discussion** on blood composition and volume
	B.	*Microscope activity on blood composition
	C.	Lecture/discussion** on blood cell origin and production`
	D.	*Mitosis microscope activity, using whitefish slides
	E.	Lecture/discussion** on erythrocyte characteristics
	F.	*Protein synthesis activity
	G	Lecture/discussion** on erythrocyte destruction
	H.	Lecture/discussion** on white blood cell types and functions
	I.	Lecture/discussion** on blood groups (ABO, anti-body/antigen, Rh factor)
	J.	*Blood typing lab
	H.	Lecture/discussion** on the heart and cardiovascular operation
	K.	*Microscope lab to observe blood vessel types - using live goldfish
	L.	*Deer or sheep heart dissection
	M.	*Blood Pulse and Respiration Rate lab
	N.	*Blood Pressure lab
	O.	Group research and report on specific aspects of the cardiovascular system
	P.	Oral presentations by student groups on the above research
IV.	Post-test	

*- denotes new labs or activities that were implemented into the unit due to my summer research

**-accompanied by a journal entry by students to begin discussion focus or as a follow up to see if the material was understood.

One big change in the curriculum of this unit was to develop a case study story line (see APPENDIX C) similar to that used successfully by instructors of the Cell Biology and Genetics courses. Case studies are a valuable teaching tool for a number of reasons: they serve as an introduction to concepts we want to focus on; they encourage student involvement early on by tapping into their prior knowledge; we could get the students to see practical applications and relationships; it would establish a problem, or problems, to be solved once some knowledge had been gained about the topic. The case study I used involved a man hospitalized for several weeks as the result of a car accident. While the patient was recovering, he displayed multiple anomalies which would lead into the main concepts I wanted to have the students investigate. Some of the concepts were anemia, leukemia, hematopoiesis, heart disease, slow hemostasis, thrombus, high blood pressure, and respiratory and renal difficulties. As the students gained an understanding of the cardiovascular system they were able to determine what was happening to the patient. Also, the students began to understand the interactions between some of the body systems. For example, in hematopoiesis, a negative feedback system regulates the release of erythropoietin primarily by the kidney if the systemic oxygen concentration within the blood drops; this hormone then stimulates the production of more erythrocytes in the red bone marrow.

As one can gather from the course outline, student journal entries (for examples of journal topics see APPENDIX D) were an integral part of the learning process. They served, depending how they are used, either as a starting point for the day's discussion or as a means for the instructor to get immediate feedback on whether the information discussed was comprehended fully by each student. To promote interactive learning in the classroom, it is helpful to know their level of knowledge before talking about a new sub-topic. During the unit, I would have them respond to a journal question which we would then discuss as a group. I always made sure to collect the papers and read them so that I could better understand what and how each of my students were thinking. If we were to have meaningful interactions, it was essential that the students felt comfortable in sharing prior knowledge in discussion or journals. "Teachers are requested to build strong relationships with students based on trust, integrity and mutual respect." (National Science Standards, 1996). The lack of experience and knowledge did not penalize them for incorrect assumptions as long as their responses showed thoughtfulness and demonstrated an effort was made. I always made it clear that if this new format of teaching/learning was to work, no one was to degrade or discount someone on their questions or comments.

If a large number of students showed a lack of clarity on a subject in their journals, then I knew we needed to investigate the topic further. This is an effective technique because the students are sometimes more forthcoming in their journals about what they failed to understand than they are in the class discussion. Sometimes shyness, or reticence, keeps students from participating in class discussion, which makes it difficult for the instructor to get a good evaluation of where that student stands in the learning process. Practice in expressing themselves in written form is also valuable to the students, who often need work on applying what they learn in English class into other areas. An example of a typical journal question which I used to measure the students understanding is, "Name and describe the location of the heart valves, explain when they would be either

open or closed, and why." A typical response I received was, "The tricuspid valve is located between the right atrium and right ventricle and the folds open to let blood flow through - stops blood from going backwards. The pulmonary valve is connected to the right ventricle, when it contracts the blood is forced through this valve toward the lungs by the pulmonary arteries. It prevents blood from going back into the ventricle, which might sound like a heart murmur. On the left side the bicuspid or mitral valve is found between the atrium and ventricle so blood can't get pushed back into the atrium when the ventricle contracts. The aortic valve opens from the ventricle when it contracts so the oxygenated blood goes to the systemic loop. Both atriums contract at the same time and so do the ventricles so they [sic] heart muscle is more efficient." Responses like this one indicated an appropriate level of understanding so we continued with the next topic in the unit.

An example of my goal to make the course more conceptually based was the way the students and I investigated the structure and function of the human heart. We began by discussing their prior knowledge of the heart. The class was divided on the idea of where the blood flow was within the heart. All of them agreed that there were four chambers, but half the class thought the blood traveled in on one side and then out the other, thus making a "U" pathway. The other half thought that only one-half of the heart contained the deoxygenated blood and the other the oxygenated blood, although they did not know which side the different circulatory pathways were on. Since there was a disparity in their ideas, I had the students investigate the structure of a deer or sheep's heart. Half of the students were able to dissect fresh deer hearts, as it was hunting season, and some of my students had donated fresh deer parts to the class. The students were able to see the four chambers of the mammalian heart and noticed that there was a thick wall (septum) separating it laterally. They began to ask questions about the valves and tendons and try to figure out the exact blood flow pathways within the heart. They also used the resource books to help them identify the names of the specific parts of the heart afterwards. After the lab the students had many questions that helped to drive the following two-day discussion. A few of the questions were: What could happen if there is a hole in the septum? How does the heart regulate its beat during different activities? How do the muscle cells communicate if there aren't any nerve endings? By having the students perform the lab prior to any formal lecture, I found that the students had a more meaningful discussion of the heart. In the past more of the students struggled to change their misconception, by only having me tell them what the correct structure of the heart was they only demonstrated a memorization of the structure without having any practical knowledge of the integration of all parts of the heart in serving its function. Now the students were very actively engaged and would think about each others ideas and even try to answer each other's questions, in the end coming to know the "why" of the heart's structure, not just the what.

One technique I used to get the students started is to have them read texts. I then gave each group a list of detailed questions, one of which they were to teach to the class. The best physiology resource text I have found is one by John W. Hole, et al. Human Physiology and Anatomy, seventh edition. This text is written in an understandable format, yet has the rigor that I believe the students deserve and expect. Another resource that I

Corpo

were N

of Boo

Institu

and "T

new te

is very

system

it force

body. E

they hac

discussi

students

The fina

whether

the answ

that I used during this course was a laser disc, The Human Body (Optical Data Corporation, 1992). Two other physiology texts I had the students use for references were Molecular Biology of The Cell, by Alberts and Human Physiology: the Mechanisms of Body Function by Vander, et al.. I also used two of the Howard Hughes Medical Institute educational biomedical publications "Blood: Bearer of Life and Death" (1993) and "The Race Against Lethal Microbes" (1996) that helped to clarify the concerns and new techniques scientists have been engaged in. For some educators, novice or veteran, it is very challenging to incorporate new technical information into the curriculum.

By using their new knowledge, the students were able to debate about which system to study next. This was an improvement over the method I formerly used because it forced the students to make connections and draw conclusion about the systems of the body. By modeling how I wanted the students to solve problems using the information they had just learned, I then coached them through another example. In subsequent discussions and problem-solving exercises, I faded out of the discussion and allowed the students to answer one another's questions about what they had found out during the lab. The final step was that the hands-on lab activities challenged the students to determine whether or not their predictions were correct. By posing key questions, uncertainty about the answers helped increased the students' curiosity and eagerness for further learning.

EVALUATIONS OF STUDENT ACTIVITIES

This section gives a brief summary of all the activities or laboratory exercises that were incorporated into this unit. New activities are designated by an asterisk (*).

1. **<u>*Microscope warm-up activity</u>**: (APPENDIX E)

The microscope is a useful tool for examining different tissues and is a standard tool that the students use in a life science course. This exercise allows students to familiarize themselves with the parts of a microscope and the correct operating procedures by making observations of a simple newsprint letter. This activity is very quick, simple and leads into the next laboratory exercise, which is more directly related to the circulatory system. The students said this activity was worthwhile because the next activity requires the use of a microscope. (Note: Most students will have undertaken a nearly identical activity during Cell Biology, which is a prerequisite for this course.)

2. **<u>*Microscopic examination of different blood components</u>**: (APPENDIX F)

The students use the microscope to investigate different vertebrate blood cells by closely examining their structure. They also use the knowledge they have gained to this point in the unit, as well as any prior knowledge they may have, to predict the function of each observed cell. The students have a few different blood cell abnormalities or diseases to examine, and they predict what symptoms the patient has due to the cell type's altered function. This activity is challenging in that it requires the students to really think about each blood cell's function, and what happens to the body in response to a disruption of the blood's homeostasis. Members of working student groups have some very interesting discussions about the symptoms the patient has because these discussions are based solely on their prior knowledge.

3. ***Microscopic examination of mitotic whitefish slides**: (APPENDIX G)

The life science curriculum is based on the MEGOSE objectives and this activity was developed to enhance student's understanding of mitosis, which is one of those objectives. The purpose of this investigation is to involve the students in discovering and predicting the phases of a blood cell's reproduction. By observing and diagraming several different phases of mitosis the students can begin to organize the phases logically by looking at the chromosomal positions. The students then combine their drawings in a cartoon flip book. This combining of drawings is effective because they can quickly flip through those drawn pages and check to see if the chromosomes move in a logical sequence. Afterwards, using visual aids, the students can debate the process based on this previous knowledge. (Each cell has 46 single chromosomes and ends up with a daughter cell having the same number of chromosomes.) This activity is helpful in engaging the students in a discussion about mitosis instead of just being told about it in a lecture. Since they have actually seen cells in the different phases, they have an easier time discussing what the logical chromosomal positions should be if one cell is to become two genetically similar ones.

4. **Protein Synthesis Activity**: (APPENDIX H)

This activity was taken from a Woodrow Wilson presentation which I attended during the 1997 National Association of Biology Teachers Convention (NABT) in Minneapolis, MN. Using visual aids to show the processes of transcription and translation, the students then apply this knowledge to a type of BINGO game. The game is structured so that the students have to decode by transcription and translation from a DNA sequence. As one student writes the DNA codon from the sequence I give them, they both can decode the transcription and translation on a separate sheet and then look quickly for the associated amino acid that is on their bingo card. Then while they are finding the amino acid sequences they put markers on their "Bingo" cards. Once the pair of students has a row of markers they yell out "Bingo" and then they must read back to me the amino acids marked. This activity reinforces the processes of transcription and translation. This activity should be done with a partner so the fast-paced game becomes less frustrating to all students. This game is not only fun, but also gives the students ample practice with this process that is difficult to understand. The retention of the knowledge of this process was greatly improved, compared to past years, a fact that I attribute to this activity. Previously, students did not get enough practice writing out protein synthesis because they would "get bored" doing sample problems. By using a game to learn about protein synthesis the students got more practice and had a lot of fun. When questioning the students about some of the activities we had done for the unit all of them remembered this one and most importantly could describe the process of protein synthesis easily.

5. **<u>*Simulated Blood Typing Lab</u>**: (APPENDIX I)

Blood typing used to be an exciting laboratory experience for the students, but with the fairly recent OSHA health regulations regarding use of human blood, teachers at our school have not typed blood for approximately ten years. Therefore, a blood type simulation lab was developed using very inexpensive and easily found household substances. The agglutination process looks identical to the real process and occurs quickly (on the laser disc I show them the real process and the students cannot tell the difference). Students are given unknown "blood types" and must deduce what type it is and explain how they know this. Once again, the students have learned some background information about the different blood types and the anti-body/antigen reaction to apply to this exercise. The goal of this lab exercise is to increase the student's understanding of the agglutination process and to explain how and why blood typing is done. In my opinion this lab was highly effective because it demonstrated the scientific principles on which human blood typing is based in such a way that the students were able to take hypothetical transfusion scenarios and make accurate predictions of the blood type compatibilities. The students certainly demonstrated in their journals and lab reports a increased knowledge of the key points addressed by this activity.

6. **<u>Microscopic examination of Mr. Fishy's Tail</u>**: (APPENDIX J)

In this laboratory exercise the students are able to examine a live small goldfish's circulatory system. A few students were squeamish about touching a live fish, but once they got the fish on the petri dish with the cotton it was manageable for them. The students really enjoyed this activity because they observed a live animal and they could see the blood flowing in the different vessels. They had no problem observing and noting a few of the differences between the blood vessels. Afterwards the students were asked questions, which once again drove a class discussion instead of having to give a lecture. Examples of these questions are: Why do some of the big blood vessels [artery] pulsate? and In humans how come the blood doesn't pool in your feet like it does when you do a handstand? The goal of this lab was to have the students identify the different blood vessels based on their observations. This lab was very effective because the students could explain that the arteries pulsated and the blood flowed faster toward the tail; where as the veins did not pulsate and the slow blood flowed toward the fish's head. The student's were also able to identify and observe the capillaries by the single file movement of the red blood cells.

7. ***Deer or Sheep Heart Dissection**: (APPENDIX K)

When discussing prior knowledge about the heart, the students knew the very basic structure, but not much more. They knew that the heart consisted of four chambers but really did not have a grasp of how the blood flowed within those four chambers and how it related to oxygenated or deoxygenated blood. This activity was successful in enhancing their knowledge because they were able to see and feel for themselves the internal structure of the heart. The deer hearts were excellent specimens for the students to use because the tissue was still very pliable and the valves with the tendons were very easy to examine. Every group thoroughly explored the hearts to better understand the pathways of blood flow by poking a small digit into the different blood vessels running in and out of the heart. They asked many questions about the anatomy of the heart as well. This lab allowed the students to get a very clear view of the structure of the heart. This lab was very effective because the students were able to come back after the lab and answer most of their pre-lab questions for themselves.

8. ***Arterial Blood Pulse and Respiration Rate**: (APPENDIX L)

Discussion of the blood flow pathway naturally incorporated the concept of oxygenated/deoxygenated blood which lead to a discussion about the respiratory system's connection to the circulatory system. To show this relationship, I had the students perform a lab exercise where they were the specimen being studied. The students chose a partner and one would be at different states of exercise while the other recorded their pulse and breathing rate. They were able to predict the correlation between the rate of exercise and the rate of respiration, but they also wondered why the different groups could have such varying numbers for the different levels of activity. This lead to a discussion of healthy habits and the benefits of exercise. This was a quick lab and the students enjoyed being able to do various physical exercises.

9. **Arterial Blood Pressure Activity**: (APPENDIX M)

This activity was very interesting to the students because all of them had experienced having their blood pressure taken before and were very curious about the sphygmomanometer. I had them take the blood pressure of a partner at different levels of activity so they could see the relationship between the previous lab and this one. The students found taking someone's blood pressure frustrating because they did not have enough practice and were impatient. Some students complained when they could not immediately hear the systolic beat, but heeded my warning and kept trying. Eventually everyone was able to hear the beats and experience taking someone's blood pressure. The students were very curious about the systolic/diastolic ratio. They began asking questions about how different environmental factors would effect blood pressure. For example how, hypertension, obesity, or lack of exercise could play apart in a person's blood pressure. The students then tried to relate the environmental factor to what would be going on with the person's heart. Some students were very curious about what was a normal blood pressure reading. This lead us into a discussion of healthy habits and how some unhealthy ones can affect the circulatory system. A few students were taking Health concurrently and were able to really contribute to the discussion.

10. ***Group Research**: (APPENDIX N)

From the pre-test and brainstorming session I realized that the students really had little or no concept of the heart's ability to compensate for different activity levels, that it has its own circulatory system and especially how the heart beat is regulated by the

Sinoatrial node (SA node) and Atrioventricular node (AV node). To avoid lecturing and to involve the students I decided to have each group do some research on these parameters and then teach what they learned to the rest of the class. The topics were randomly distributed to the students in there usual lab groups. It took two days for them to research and prepare for their instruction time. For their research I supplied several different college texts, diagrams, and the laser disc (I instructed individual groups on how to use this technology). The librarian also provided some appropriate resources, and the Internet was also available at school. If some student groups finished early due to drawing a less complicated question, they were to work on answering some of the tougher questions so they could have a basic understanding of the content to be covered. The students found some of the more unfamiliar topics to be quite challenging to teach because they had to have a good understanding of the material. Many gained a new respect for the job that I do every day. I still needed to clarify some points that were asked by the student audience afterwards, but from the journal writing, I could detect that the students could apply the new knowledge they learned from one another so I felt they had a good grasp of the material.

EVALUATION OF THE UNIT

The development of the unit on the circulatory system was a work-intensive undertaking, some of which was done in the Summer of 1997 while doing research on campus. To ensure that the impact of this work was documented I employed various means to evaluate the effectiveness of the unit. Prime among these was the difference in scores students achieved on the pre- and post-tests (see APPENDIX O). An increase in scores from pre to post test normally would be expected. The question for me was how substantial the change would be. The increase in a student's score from one test to the other would indicate to some degree the students success in learning the material presented. These tests, however, were not the only mode of evaluation I used during this unit. I also used student journal entries, achievement on laboratory exercises, student responsiveness during discussions, and anecdotal discussion with students to gauge the effectiveness of the unit.

Determining their depth of understanding was important to me, which is why I used a short answer/essay style test for the pre/post test instead of a multiple choice style test. While multiple choice testing would eliminate any subjectivity in my grading, it would also show only whether or not students could remember what we covered, not whether they could apply that knowledge and show some depth of understanding. The possibility of correctly answering questions through chance is also eliminated with subjective tests.

On the first day of the unit I had each student take a pretest to measure their prior knowledge. On the last day of the unit, four weeks later, I had the students take the same test as a post-test. By evaluating the mean scores obtained from the testing, both prior to and following the unit, it appears that the students did learn the material and were able to apply their knowledge of this unit (see Table 2).

If two sets of data with the same score scaling are collected on one group of subjects, a correlated *t*-test is appropriate to analyze the differences between the means of the two sets. From their scores (Table 3) I computed the summary statistics. I then tested the null hypothesis, or that there was no change in student knowledge after the unit, at the 5% level of significance. I used a one-tailed test on the basis of the rationale that the circulatory unit would not hinder their knowledge of circulation; if anything, the unit would either maintain the student's current understanding or improve it. From a standard table, the critical value of *t* with 21 degrees of freedom (df) at 5% for a one-tailed test is 1.721. Because the calculated *t*-value for this data exceeds the critical *t* value ($7.03 > 1.721$), the null hypothesis would be rejected. The alternative hypothesis is that any increase in post-test scores would be due to real learning on the part of the students. Consequently, I am confident that the unit had a positive effect on the measure of understanding for this population of students.

Table 2a: Introductory Statistical Analysis of Pre-Test Data

High Score	**28 (70%)**
Low Score	**2 (5%)**
Mean Score	**16 (40%)**
Median Score	**15 (38%)**
Mode Score	**16 (40%)**

Table 2b: Introductory Statistical Analysis of Post-Test Data

High Score	**40 (100%)**
Low Score	**14 (35%)**
Mean Score	**32 (80%)**
Median Score	**30 (75%)**
Mode Score	**36 (90%)**

Table 3: Pre and Post-test Scores

Individual	Pre-Test Score	Post-Test Score
1	8 (20%)	26 (65%)
2	10 (25%)	32 (80%)
3	16 (40%)	36 (90%)
4	16 (30%)	32 (80%)
5	20 (50%)	36 (90%)
6	24 (60%)	36 (90%)
7	18 (45%)	36 (90%)
8	14 (35%)	34 (85%)
9	28 (70%)	40 (100%)
10	14 (35%)	30 (75%)
11	10 (25%)	28 (70%)
12	16 (40%)	38 (95%)
13	18 (45%)	34 (85%)
14	20 (50%)	40 (100%)
15	8 (20%)	26 (65%)
16	24 (60%)	36 (90%)
17	26 (65%)	37 (93%)
18	22 (55%)	37 (93%)
19	6 (15%)	20 (50%)
20	4 (10%)	15 (38%)
21	2 (5%)	14 (35%)
22	26 (65%)	40 (100%)
	Avg. 40%	Avg. 80%

The case study was useful in giving the students both a real world application, and a preview of upcoming information. The students' curiosity was also heightened as a result of the use of technical terminology. Also, some of the students shared with me that they used the case study as a means to quiz themselves on various subtopics within the unit. They said they pretended to be one of the physicians that would keep the patient's family updated. Sometimes they taught their own families the information they were learning in class as a means of studying. The students found this application amusing because they were able to give detailed answers to their parents who had various background knowledge about the topic(s). Therefore, I found the case study to be a useful tool in teaching this unit.

The student journals (like the example given earlier) also were an important means of evaluating how well the students were able to assimilate the knowledge being presented in class. The journal assignments were of two types. One was a request to answer certain context questions (for example see APPENDIX D). Other.assignments merely asked the students what they thought they learned from a certain discussion or lab assignment. Also, the students often were asked how they felt the class material and their learning was going for them personally. This type of inquiry was often a part of either of the two types of journal assignments. These journals were given a grade of check plus, check, or check minus depending on the thoroughness of the responses. These grades had little effect on the students' grade, but helped to keep the students putting effort into them. The main purpose of these journals was to evaluate the effectiveness of the unit. Using these tools, I was able to obtain feedback on the success of an activity or discussion session, without punishing the students with a poor grade if the activity was ineffective. Also, the students were able to directly express their opinions on how any particular activity had impacted their learning.

The lab activities were a very important part of the unit. There were nine total, three of which worked especially well. These were the protein synthesis activity, which the students verbally stated they enjoyed very much. This particular activity was excellent practice leading to understanding of the processes of translation and transcription. Another activity that worked extremely well was the simulated blood typing lab. This lab forced the students to think, observe, and draw conclusions about the different compatible phenotypes involved with blood transfusions. The third highly successful lab was the examination of a living specimen's circulatory system, a gold fish's tail. This was certainly the most popular lab among the students. It was also the most effective because it was not simulated or abstract in any way; the observations were of a living organism and the mechanisms and functions of circulation observed were actually taking place at that very moment. One thing all three of these labs had in common was that they tested the students grasp of the material as well and reinforced the concepts of protein synthesis, blood typing and peripheral blood circulation. To assess the effectiveness each student was required to complete a lab report. This report required that each student answer a number of questions that were designed to evaluate how well the student picked up the important points in the lab, as well as how well the students understood the purpose of the lab itself. (For specific examples of questions for each lab exercise please see the APPENDIX section.)

Of the remaining labs, three more were very successful, albeit not to the same extent as the three mentioned above. Based on the lab grades the students definitely excelled in, the gold fish, protein synthesis, and blood typing labs. The grades for these three activities ranged from 88% to 100%. These next three activities, the mitotic white fish cell activity, the blood pressure activity, and the microscopic examination of cellular blood components, had grades ranging from 66% to 85% for various reasons. The mitotic white fish cell activity was very good in that it showed the students exactly what the different mitotic phases looked like. Its weakness was in some students' failure to logically order the mitotic stages. Perhaps some of the students were not thorough enough in their examination of the cells or thinking about it after making observations. By giving more direct guidance I could have ensured most of the students getting the correct answers. However, in this lab it was challenging to figure out the mitotic sequence. The weakness seems to lie in the critical thinking skills of some of the students. The blood pressure activity was a highly effective tool in reinforcing what blood pressure is and what the numbers indicate. Also, it provided a good real-world usage for a concept we were covering. However, students' were frustrated by not being able to find the systolic pressure. Also, the effectiveness of this lab was dependent on a quiet atmosphere which makes it easy for one or two students to ruin the lab for everyone. The last activity in this category, what I would consider highly effective with some reservations, is the microscopic examination of different cellular components of blood. The single weakness of this activity is that it can be too challenging for some students. Some of the abnormal cells being looked at required the students to relate the deformity to the possible loss of cell function. This lab is especially exciting and rewarding for those students who have learned the most about the blood's components. In the case of all three activities the lab reports showed that while the majority of students were able to get the important points of the topics, some areas of knowledge were not displayed to a wholly satisfactory degree.

Two of the three labs not already mentioned could be described as somewhat effective. These labs are necessary in many ways; however, they are also redundant to what many students previously have done. The microscope warm up activity is effective, but it does nothing in and of itself to further the students knowledge of the circulatory system. It's purpose is just to familiarize the students, especially upperclassmen, with the proper procedures and workings of a compound microscope. The pulse and respiration lab's results are too predictable, but it does serve to reinforce the respiratory and circulatory relationship. I still need to work on these two activities. The lab reports for these activities showed that students who made a valid effort to complete and participate in the lab were able to demonstrate the important concepts that were the goals of these activities. The problem lies in whether the time spent on these activities would be better served by more challenging and less redundant exercises.

The final lab activity to discuss is the mammalian heart dissection. Some of the students dissected a preserved sheep's heart. Those who did found the lab to be marginally beneficial because of the rigor mortis of the heart. Other students dissected a much fresher white tail deer's heart. These students found the lab to be extremely effective in showing the structure of the heart, much more so than with the preserved hearts. The tissues and divisions were much clearer and well defined in the deer heart, which made it easier for the students to identify the structures. Only a coincidence of timing allowed the dissection of a few "fresh" deer hearts, however. Unfortunately, the spring semester classes will never get this opportunity.

Another area of assessment were the individual research projects undertaken by the students. These projects were useful for varied reasons, for example, experience doing research, experience in addressing groups, and practice in being able to express ones ideas both orally and in written form. All of the above are important skills for the students, especially those planning to attend college, to acquire. The problem with these projects is the difficulty in assessing the effectiveness of each student's learning experience because of an unevenness in the difficulty of the topics. Also, for the instructor the unevenness of difficulty makes this undertaking difficult to grade.

The only manner of evaluating student progress remaining to address is the class discussions. It is difficult to determine how and what the students are learning in class discussions. It is not possible to say that only the students who are participating in the discussion are learning the information. Some students who may know the subject better, and have learned more than their peers, may not participate. It is a teacher's job to create a classroom environment where all of the students feel comfortable participating in class discussions. By encouraging the students to respect other people's opinions and questions, one can create this comfortable atmosphere, but some students will not participate no matter how much they are encouraged. This makes evaluating the level of understanding of some students difficult during a discussion. However, class discussions do provide the teacher a chance to further evaluate those students who are willing participants and to teach the more passive people. This is particularly important when dealing with students who have a difficult time with written expression; they might be able to better express their knowledge verbally.

The true usefulness of a discussion style classroom over a lecture style classroom is that it keeps both the teacher and the student mentally attuned to the topic being learned. Students are encouraged to actively participate in the educational process, not simply sit and absorb as much as they can. It provides the teacher with a more exciting teaching experience. Instead of five classes a day of saying the same thing over and over the teacher gets to answer direct questions, ask direct questions, and overall stay more intellectually stimulated.

DISCUSSIONS AND CONCLUSIONS

My goal was to design a circulatory system unit for a high school physiology course that would teach the students more, give them a greater ability to apply the concepts, and involve the students in a deeper thought process than was the case in the past. To attain this goal I redesigned the unit using the constructivist/conceptual change approach to teaching. This is the approach that I have used in my other courses for the six years I have been teaching. The physiology course has never seemed to fit with the way I taught my other classes and I have felt unsure as to whether the students were having a positive experience in the class. I felt that the method of teaching the class did not suitably prepare the students for a college level course in physiology. These were my motivating factors for changing the course.

My experience in this endeavor was certainly a positive one. I can honestly say that the students had a positive experience as well. Certain alterations to the course greatly increased the student's learning and their enjoyment of the class. The case study in particular helped the students enjoy the class because it gave them some real life scenarios. In fact, the case study was so effective that I am working on continuations of the story line to accompany the rest of the units in the class. The case study is not the only characteristic of this unit that I will implement into the rest of the class. The style of instruction, and student interaction, that occurred in this unit is superior to the other units in the physiology class. Eventually, all of the units will be changed to resemble the model developed in the circulatory system unit.

There are some aspects of the unit that either worked poorly or need some improvement before next year. Foremost, as discussed in the evaluation section, some of the laboratory exercises need to be made more challenging, to serve the best interests of the students.

Another area that is in need of improvement is the independent research undertaken by the students at the end of the unit. The topics need to be rewritten so that each has about the same level of difficulty. Unfortunately, some of the topics were too difficult to easily research and some were too easy, leaving some students with an overabundance of leisure time in class. Perhaps ten percent of the topics were too difficult and ten percent were too easy, while eighty percent were basically on par with each other. Through narrowing or broadening the topics on each end of the difficulty spectrum I hope, in the future, to have a more equitable student experience in this portion of the unit. Another option I may use is assigning the topics. By assigning the topics I could ensure that the more difficult topics go to those students requiring a challenge, and the easier topics could go to the students who are most likely to struggle with the assignment.

I do not wish to give the incorrect impression that this particular portion of the unit was not worthwhile. In fact, I have incorporated a final research project based on this smaller research assignment. At the end of the last marking period the students will be doing research, and making presentations on, the systems of the human body that have not been covered in the class. As I said earlier, I have made a effort to give each of the systems we do cover a thorough examination. This means we will cover fewer body systems, but the students will know far more about each of the systems we do cover. To make sure that the students have at least been exposed to all of the major physiological systems, the last portion of the class will be comprised of student groups doing research on a particular system, writing individual papers on the system, and giving group presentations, including a demonstration or activity, on the structure and function of the system they have been assigned. I anticipate some problems with the amount of work involved in the different systems not being equal, but I hope to be able to adjust the number of students in each group so as to minimize this problem. This may not benefit the students this year but over a couple of semesters I should be able to get the correct balance. If all goes well, I may try to integrate similar projects in the other subjects I teach.

Another change I will make in the future is to assign a final journal entry on the case study scenario. The topic will be something like: "How do you think the patient's symptoms were related and how did each problem compound or counteract other symptoms?" While each of the symptoms were discussed separately, in class I had no way of discerning if each of the students had some idea of the complex relationships involved. I only knew how well the students who volunteered to respond in class understood, but had little idea, in this particular case, how well the students who did not volunteer understood.

An aspect of the class the students particularly enjoyed was learning about commonly encountered diseases. This is a topic that I may decide to include more (in the future); that is, giving the students not just the proper functioning of a system, but, also going into more detail as to the ways in which a system may malfunction. Students find inheritable diseases especially interesting and I will try to incorporate as many of these as I can, covering the disease itself without going in to great depth as to the genetic basis for the disease. For example, introducing the symptoms of a "common" incomplete closure of the heart septum during fetal development and formation. This is something that can be implemented in each of the units of the course.

The students who took the physiology course, reported that the class as a whole was enjoyable, especially the circulatory unit. Many commented that the circulatory unit was more interesting, and more easily learned through the various activities involved. One comment I received frequently was that the course was more challenging than some students thought it would be. Apparently the buzz among students was that Human Physiology had been a "blow-off" class and an "easy A". The students were under the impression that if one got a certain teacher the class would be "really easy." This could explain why some students who signed up for physiology as an elective seemed to have no interest in the subject, and accordingly, struggled in the class. If Human Physiology has lost its reputation for being easy I am very pleased. I believe that the students should be challenged. They should be made to think, to have to stretch the limits of their knowledge, to venture into subjects that challenge them and prove to themselves that they can meet these challenges. While student enjoyment of a class is important, it certainly makes it easier for the students to learn when they enjoy the subject, enjoyment is not the prime directive, learning is. The students should be challenged. Too often I hear former students telling tales of how certain classes did not prepare them well for the future.

Classes that should have given them a base to build upon did not. I want my students to enjoy learning, not just enjoy the class because it is fun and games, and I believe that with the changes I have made to the circulatory unit and future changes to the rest of the class I have approached my goal more closely.

I have continually evaluated the course in an effort to improve it. Even after this thesis project is finished, the course will constantly be evolving; striving to improve curriculum is a never ending process. Through seminars, journals, conventions, classes and especially my fellow faculty I am continuously given new and exciting ideas for modifying the course. I believe that if a class does not evolve it stagnates and becomes mundane for the instructor, which is reflected in the quality of teaching. If the course is not intriguing to the educator how then does that person make it inspiring and intriguing to those to be educated?

BIBLIOGRAPHY

BIBLIOGRAPHY

Alberts, B, et al. (1994) Molecular biology of the cell. 3rd edition Garland Publishing, New York, NY.

Alkove, L.D., and B.J. McCarty. (1992) "Plain talk: Recognizing positivism and constructivism in practice. Action in Teacher Education 14(2):16-22.

Anderson, T.W. and S.L. Sclove. (1986) The Statistical Analysis of Data, Second Edition Scientific Press.

Arico, Anthony. (1995) The American Biology Teacher. February, pg. 108-110.

Ausubel, David P. (1968) Educational Psychology: A Cognitive View. Holt, Rinehart and Winston, Inc., New York, NY.

Baird, Hugh J., Reuven Lazarowitz, and Verl Allman. (1984) "Science Choices and Preferences of Middle and Secondary Students in Utah." Journal of Research in Science Teaching, 21:1, 47-54.

Beck, Isabel L. (1989) "Reading and reasoning." The Reading Teacher. May, 676-682

Fosnot, C.T. (1989) "Enquiring Teachers, Enquiring Learners: A Constructivist Approach for Teaching." New York: Teachers College Press.

Gottfried, Sandra, et al. (1986). Biology. 3rd edition. Prentice-Hall, Englewood Cliff, NJ.

Hershey, David R. (1992) "Making Plant Biology Curricula Relevant." Bioscience. 42:3, 188-191.

Hole, John W., et al. (1996) Human Anatomy & Physiology. William C. Brown, Dubuque, IA.

Howard Hughes Medical Institute. "Blood: Bearer of Life and Death." 1993.

Howard Hughes Medical Institute. "The Race Against Lethal Microbes." 1996.

Kaskel, Albert, Paul J. Hummer, and Lucy Daniel. Biology Laboratory Experiences. Merrill. Columbus, OH. 1988.

BIBLIOGRAPHY

Lawson, A.E. (1988) "A better way to teach biology." The American Biology Teacher. 50(5):266-274.

Lazarowitz, Reuven and Rachel Hertz Lazarowitz. (1979) "Choices and Preferences of Science Subjects by Junior High School Students in Israel." Journal of Research in Science Teaching. 16:4 317-323.

Lozauskas, Dorothy and John Barell. (1992) "Reflective Reading: A journal for inquiring minds." The Science Teacher. Nov. p. 42-45

Mannix, Cynthia. "Bingo, Babies & Feasting". Woodrow Wilson National Fellowship Foundation. 7607 Bishop's School, La Jolla, CA. 92037

Michigan State Board of Education (1991) Michigan Essential Goals and Objectives for Science Education.

Miller, Kenneth R. and Joseph Levine. (1993) Biology. Prentice-Hall, Englewood Cliffs, NJ.

National Research Council. (1996) National Science Standards. National Academy Press, Washington D.C.

Optical Data Incorporated. (1995) Laser Disc "The Human Body".

Rubba, Peter A. (1981) " The Inservice Needs of Biology Teachers." The American Biology Teacher. 43:1, 51-52, 64.

Schulte, Paige L. (1996) "A Definition of Constructivism." Science Scope. National Science Teachers Association. Arlington, VA. 20:3 p 25-27.

Science for All Americans. (1989) American Association for the Advancement of Science. Washington D.C. p. 4-5; 25-28.

Strike, Kenneth A. and George J. Posner. (1992) " A Revisionist Theory of Conceptual Change." Philosophy of Science, Cognitive Psychology, and Educational Theory and Practice. Albany: State University of New York Press. P 147-176.

Tamir, P. (1974) " Botany and Zoology - A Curriculum Problem." Journal of Research in Science Teaching. 11:1, 5-16.

BIBLIOGRAPHY

Vander, Arthur, James Sherman, and Dorothy Luciano. (1991) Human Physiology: the mechanisms of body function. 5th edition. McGraw Hill, New York, NY.

Yager, R.E. (1991). " The constructivist learning model."The Science Teacher. 58(61):52-57.

APPENDICES

APPENDIX A

APPENDIX A

MICHIGAN ESSENTIAL GOALS AND OBJECTIVES FOR HIGH SCHOOL IN THE LIFE SCIENCES

Cells:

1. Classify cells/organisms on the basis of organelle and/or cell types.
2. Explain how multi-cellular organisms grow, based on how cells grow and reproduce.
3. Compare and contrast ways in which selected cells are specialized to carry out particular life functions.
4. Compare and contrast the chemical composition of selected cell types.
5. Compare the transformation of matter and energy during photosynthesis and respiration.
6. Explain how essential materials move into cells and how waste and other materials get out.

Living Things:

1. Classify major groups of organisms on the basis of the five kingdom system.
2. Describe the life cycle of an organism associated with a human disease.
3. Explain the process of food storage and food use in organisms.
4. Explain how living things maintain a stable internal environment.
5. Describe technology used in the prevention, diagnosis, and treatment of diseases.

Heredity:

1. Explain how characteristics of living things are passed on from generation to generation.
2. Describe how genetic material is passed from parent to young during sexual and asexual reproduction.
3. Explain how new traits may be established in individuals/populations through changes in genetic material.

APPENDIX A

Evolution:

1. Describe what biologists consider to be evidence for human evolutionary relationships to selected animal groups.
2. Explain how a new species or variety may originate through the evolutionary process of natural selection.
3. Explain how new traits might arise and become established in a population.

Ecosystems:

1. Describe common ecological relationships among species.
2. Explain how energy flows through familiar ecosystems.
3. Describe general factors regulation population size in ecosystems.
4. Describe responses of an ecosystem to events that cause it to change.
5. Describe how water, carbon dioxide, and soil nutrients cycle through selected ecosystems.
6. Explain the effects of agriculture and other human activities on selected ecosystems.

Constructing Knowledge:

1. Develop questions or problems for investigation that can be answered empirically.
2. Suggest empirical tests of hypotheses.
3. Design and conduct scientific investigations.
4. Gather and synthesize information from books and other sources of information.
5. Discuss topics in groups by being able to restate or summarize what others have said, ask for clarification or elaboration, and take alternate perspectives.
6. Reconstruct previously learned knowledge.

Reflecting on Knowledge:

1. Justify plans or explanations on a theoretical or empirical basis.
2. Describe some general limitations of scientific knowledge.
3. Explain how common themes of science, mathematics, and technology apply in selected real-world contexts.
4. Discuss the historical development of key scientific concepts and principles.
5. Evaluate alternative long-range plans for resource use and byproduct disposal in terms of environmental and economic impact.

APPENDIX A

In May of 1993 the science curriculum was aligned for every grade (K-12) to avoid repetition and voids. A sub-committee, represented by at least one teacher from every grade and every building was a part of this substantial yet prosaic process. For the secondary level (8th - 12th grade) the following table illustrates the main objective areas:

Table 1: Designated Science Objectives for grades 8-12

Grade Level	Main Science Objective(s)
8	Physical Science
9	Earth Science and Ecology
10	Life Science
11	Physical Science/Life Science
12	Physical Science/Life Science

By aligning the curriculum it also helped to prepare the students for the High School Proficiency Test, which has just recently been moved to some time in the month of May.

APPENDIX B

APPENDIX B

PARENTAL/STUDENT CONSENT FORM

TO: The parents/guardians of
FROM: Ms. Buwalda (Biology teacher)
RE: Requesting permission to use student's work in a Master's thesis paper.

For the past three years I have been spending my summers working on a Master's of Science degree which focuses on modifying the Human Physiology course so it will be more applicable to every day occurrences.

To have a sound thesis I need to collect data on the amount of knowledge gained by each student during a unit covering one of the body's systems, this unit will last approximately three to four weeks. The data needs to come from the student's who will be participating in the course for this semester. The purpose of this letter is to seek your permission to use your student's confidential scores and responses in my study. Your student's pretest and posttest scores will be statistically analyzed to indicate whether or not the unit was effective. Also, some journal responses may be quoted. I want to personally assure you that in the thesis your student's name will in no way be associated with any of his/her scores or written responses. The data collection process will be virtually unnoticeable and will not effect the students in any way.

I would encourage you to discuss this with your student as it involves them directly. I have discussed this with the students already and hopefully if you have questions they should be able to answer them. If you have any further questions I can be reached at the high school at 694-2162. I want to indicate that a withdrawal in no way exempts the student from doing the same work as everyone else, it just means that I will be unable to use his/her data.

Thank you for your time and I hope to see you at parent-teacher conferences. If you ever have concerns about your student please contact me, for we are a team in your child's education.

Sincerely,

Ms. L. Buwalda
Holt High School
Biology Teacher

_______ I give Ms. Buwalda my permission to use my data collected from the pre and post test. I understand that Ms. Buwalda will not use my name and that all my student data will remain confidential.

_______ I do not wish for Ms. Buwalda to use my data in her thesis. I understand I will not be penalized for choosing to withhold my results.

______________________________ ___________
Student Signature Date

______________________________ ___________
Parent or Guardian Signature Date

APPENDIX C

APPENDIX C

CASE STUDY SCENARIO

As our saga of the hit and run accident continues we find the patient in the hospital recovering from his injuries. With your investigations and conclusions from the integumentary system the suspect is in jail. The patient's dog is still in the animal hospital recovering, but still is not out of danger. The patient's body is fighting the infections trying to invade his left arm which, as you will remember, suffered from sever lacerations and second and third degree burns during the accident. Doctors are being vigilant of their patients condition due to the extensive internal and external bruising. They are having some difficulty stopping the bleeding, so many transfusions have been required due to injuries the patient received as a result of failing to wear his seat belt. The multiple symptoms the patient has at first seem unrelated. Some of the symptoms are: an irregular heartbeat and breathing; abnormal blood count; lethargy; the presence of blood in his urine; possible thrombosis and embolisms; fever; and a pulse rate that varies from hour to hour. The external worries the patient is having is also causing a physiological distress.

The stress on his heart from high blood pressure, worry over his sister's battle with leukemia, his father's up coming bypass surgery (since angioplasty has failed and heart disease is suspected), his faithful canine companion's dire health, and the mounting medical bills, has left the attending physicians deeply troubled.

APPENDIX D

APPENDIX D

SAMPLE JOURNAL QUESTIONS

1. What characteristics do arteries possess that allow us to measure pulse and blood pressure from outside our bodies?

2. Explain what the systolic (top number) and the diastolic (bottom number) blood pressure numbers represent physiologically speaking?

3. What keeps blood from back flowing from veins to capillaries, and why would back flowing be really harmful for us?

4. Describe the pattern of conductive activity (including the nodes and conductive fibers) in the heart that causes it to pump. Then sketch a graph of the ECG and explain what is going on in the heart's conduction system at the different lettered points of the ECG.

5. Explain what causes a heart attack and describe two techniques used to relieve the cause of this malady.

6. Name and describe the location of the four heart valves, explain when they would be open or closed, and why.

APPENDIX E

APPENDIX E

MICROSCOPE ACTIVITY

Introduction:

The microscope is a very integral part of many life science courses and should be used regularly. Sometimes though the students do not get as much exposure or practice with the microscope. Therefore, this activity is to help them become reacquainted with its parts and how to properly use the tool.

Methods and Materials:

compound microscope
scissors
tweezers
eye dropper
slide
cover slip
newspaper
lens paper

Procedure:

1. Obtain a compound microscope from the cabinet, and carry it back to your lab table.

2. With a piece of lens paper, lightly wipe any dust and grease from all exposed glass surfaces. Never use anything else to do this job.

3. Spend the next few minutes reviewing the names, locations and functions of the various important parts of the instrument.

APPENDIX E

Before going on make sure you read the following, because it will help you to do this activity much more efficiently:

a) To find an object, always start your examination with the low power objective, never with the high. The low power reveals an area on the slide some 20 times greater than the high-power, making it 20 times easier to locate the desired object.

b) To bring the object into focus, always focus upward, with the coarse adjustment. You will want to do this so as to not crush any specimens that are on the slide.

c) When the high power objective is being used, never use the coarse adjustment.

4. Cut the letter "e" from a newspaper. Place it on a clean slide, and with an eye dropper, place 1 drop of water on the letter.

5. Wait a moment before covering it with a cover slip.

6. Place the slide on the stage, do not use the stage clips. Move the slide so that the letter is in the middle of the hole in the stage. Make certain that the low-power objective is in place. Viewing the stage from the side, use the coarse adjustment wheel to lower the objective until either the stop is reached or the object is visible through the ocular.

7. Turn the substage illuminator on.

8. Now, looking through the ocular, if the image is not sharply focused turn the fine adjustment knob until it is.

9. Open and close the diaphragm by turning the dial located below the stage. This controls the amount of light reaching the specimen. Adjust it to make the image as sharp as possible.

10. To change to the high power, make sure that you have focused sharply under low power on the object and centered it in the field. Then carefully swing the medium power lens into place and focus the image again. Next the high power objective should be carefully swung into place. The high power objective should not strike the slide, though it will come very close. A slight turning of the fine adjustment knob should suffice to bring the "e" into sharp focus.

APPENDIX E

11. Draw the "e" shown on high power on your paper.

MICROSCOPE QUESTIONS

1. When you examined the "e" under the low power objective of the compound microscope was the image right side up?

2. What is the total magnification at low, medium and high power?

3. Write down the mathematic process you did to get the answer to question 2.

4. If you move the slide to the left, what happened to the "e"'s movement when looking through the ocular? And if you move the slide to the right?

APPENDIX F

APPENDIX F

BLOOD CELL LAB

Introduction:

Many times students know the different types of blood cells, but they do not always know the structure of each type. Therefore, by looking at different vertebrate blood slides the students are able to identify the three main types of cells.

The students also tend to have a basic understanding of the different functions of the various blood cells. To try to get them to apply this basic knowledge I have them observe various blood disorders and answer some questions.

Methods and Materials:

compound microscope

prepare blood slides of :	Trypanosoma	Bird blood
	Malaria	Dog blood
	Sickle Cell Anemia	Snake blood
	Leukemia	Fish blood
	Normal human blood	

Procedure:

1. Get a compound microscope from the cabinet and take it to your lab table. There should be one microscope for every two people.

2. Examine and compare (to the human blood) each of the prepared slides in the slide tray at your table. Be sure to make detailed sketches of each on your paper and label them thoroughly.

3. When finished return the slides to the slide tray. Be sure to return the microscope as well.

APPENDIX F

BLOOD CELL LAB QUESTIONS

1. What major observable differences are there between the different types of blood cells (e.g. erythrocytes, leukocytes and thrombocytes)?

2. What is the easiest way to tell if you are looking at mammalian blood or blood from some other vertebrate animal?

3. What main characteristic do each of the diseased kinds of blood have that identifies them?
   A. Malarial blood -
   B. Sleeping sickness (Trypanosoma) -
   C. Sickle Cell -
   D. Leukemia -

4. Knowing the function of each one of the blood cell types, why would this particular cellular abnormality cause the patient to be sick?
   A. Malarial blood -
   B. Sleeping sickness -
   C. Sickle cell -
   D. Leukemia -

APPENDIX G

APPENDIX G

MITOSIS MICROSCOPE LAB

Introduction:

The students prior to the lab exercise have been introduced to the concept of mitosis and that there are 46 chromosomes in every cell. Therefore, some how a cell that starts off with 46 chromosomes has to some how end up creating another entire daughter cell that also only contains 46 chromosomes. The students are to observe and diagram the whitefish slides in order to figure out the possible chromosomal phase order.

Methods and Materials:

compound microscope
1 prepared whitefish mitosis slide

Procedure:

1. Observe cells on high power (400 x).

2. Look for and draw any cells where the chromosomes are visible (purple shoe strings). Draw any cells you find and thoroughly label them.

3. After drawing at least five very different chromosomal arrangements number them in sequential order.

4. Write an explanation as to why you and your group decided on the above order.

APPENDIX H

APPENDIX H

PROTEIN SYNTHESIS ACTIVITY

Introduction:

This activity was developed by Cynthia Mannix during one of the Woodrow Wilson National Fellowship Foundation Sessions. Codon Bingo is a stimulating game that involves deciphering the genetic code. It is a game designed for students to practice transcription and translation of codons. It has the advantage the it is a game that students enjoy while they actively participate. All students become engaged in this activity as it generates a lot of enthusiasm. As they play the game, they develop increased proficiency at unraveling the genetic code found in the base pairs. After playing this game, the task of transcribing the DNA base pair messages into mRNA codons and then translating the mRNA codons into amino acids becomes much easier.

Methods and Materials:

1 bingo card
several markers (pennies work well)
1 codon chart with RNA codons and their respective amino acids
1 list of twenty amino acids
colored pencils (optional)

APPENDIX H

Procedure:

1. The students are given a bingo card with blank spaces.

2. They choose where all twenty amino acids will be placed and write the amino acid names on the bingo card.

3. As the names of the DNA triplets are called, they transcribe the DNA into a mRNA codon and then into its respective amino acid.

4. If the codon for an amino acid they have on their card is called, they place a marker on the appropriate spot.

5. Once the students have five markers placed across, down or diagonally, they win!

6. The student(s) read back their amino acids, which has become a polypeptide of four or five amino acids, while the teacher checks for accuracy. The students get immediate feedback on their ability to decode DNA.

AMINO ACID LIST

Phenylalanine	Serine	Tyrosine	Lysine	Tryptophan
Leucine	Proline	Histidine	Aspartic Acid	Arginine
Isoleucine	Threonine	Glutamine	Glutamic Acid	Glycine
Methionine(start)	Alanine	Asparagine	Cysteine	Valine

Do not forget the "stop" codon

APPENDIX H

First Base in Code Word	Second Base: A	Second Base: G	Second Base: U	Second Base: C	Third Base in Code Word
A	Lysine	Arginine	Isoleucine	Threonine	A
A	Lysine	Arginine	Methionine	Threonine	G
A	Asparagine	Serine	Isoleucine	Threonine	U
A	Asparagine	Serine	Isoleucine	Threonine	C
G	Glutamic acid	Glycine	Valine	Alanine	A
G	Glutamic acid	Glycine	Valine	Alanine	G
G	Aspartic acid	Glycine	Valine	Alanine	U
G	Aspartic acid	Glycine	Valine	Alanine	C
U	"Stop" codon	"Stop" codon	Leucine	Serine	A
U	"Stop" codon	Trytophan	Leucine	Serine	G
U	Tyrosine	Cysteine	Phenylalanine	Serine	U
U	Tyrosine	Cysteine	Phenylalanine	Serine	C
C	Glutamine	Arginine	Leucine	Proline	A
C	Glutamine	Arginine	Leucine	Proline	G
C	Histidine	Arginine	Leucine	Proline	U
C	Histidine	Arginine	Leucine	Proline	C

Second Base in Code Word

Figure 1: RNA Codons and Amino Acid Chart

Reference: Miller, Kenneth R. and Joseph Levine. (1993) Biology. Prentice-Hall, Englewood Cliffs, NJ.

APPENDIX H

		FREE SPACE		

Figure 2: Codon Bingo Card

APPENDIX H

D *AAG* R **UUC** phenylalanine	D *TAA* R **AUU** isoleucine	D *AGA* R **UCU** serine	D *TGA* R **ACU** threonine
D *AAT* R **UUA** leucine	D *TAG* R **AUC** isoleucine	D *AGG* R **UCC** serine	D *TGG* R **ACC** threonine
D *AAC* R **UUG** leucine	D *TAT* R **AUA** isoleucine	D *AGT* R **UCA** serine	D *TGT* R **ACA** threonine
D *GAA* R **CUU** leucine	D *TAC* R **AUG** methionine	D *AGG* R **UCG** serine	D *TGC* R **ACG** threonine
D *GAG* R **CUC** leucine	D *CAA* R **GUU** valine	D *GGA* R **CCU** proline	D *CGA* R **GCU** alanine
D *GAT* R **CUA** leucine	D *CAG* R **GUC** valine	D *GGG* R **CCC** proline	D *CGG* R **GCC** alanine
D *AAA* R **UUU** phenyalanine	D *CAT* R **GUA** valine	D *GGT* R **CCA** proline	D *CGT* R **GCA** alanine
D *GAC* R **CUG** leucine	D *CAC* R **GUG** valine	D *GGC* R **CCG** proline	D *CGC* R **GCG** alanine

Figure 3: Protein Synthesis Codon Cards #1

APPENDIX H

D *ATA* R **UAU** tyrosine	D *TTA* R **AAU** asparagine	D *CTT* R **GAA** glutamic acid	D *TCA* R **AGU** serine
D *ATG* R **UAC** tyrosine	D *TTG* R **AAC** asparagine	D *CTC* R **GAG** glutamic acid	D *TCG* R **AGC** serine
D *ATT* R **UAA** stop	D *TTT* R **AAA** lysine	D *ACA* R **UGA** stop	D *TCT* R **AGA** arginine
D *ATC* R **UAG** stop	D *TTC* R **AAG** lysine	D *ACC* R **UGG** trytophan	D *TCC* R **AGG** arginine
D *GTA* R **CAU** histidine	D *CTA* R **GAU** aspartic acid	D *GCA* R **CGU** arginine	D *CCA* R **GGU** glycine
D *GTC* R **CAC** histidine	D *CTG* R **GAC** aspartic acid	D *GCG* R **CGC** arginine	D *CCG* R **GGC** glycine
D *GTT* R **CAA** glutamine	D *ACA* R **UGU** cysteine	D *GCT* R **CGA** arginine	D *CCT* R **GGA** glycine
D *GTC* R **CAG** glutamine	D *ACG* R **UGC** cysteine	D *GCC* R **CGG** arginine	D *CCC* R **GGG** glycine

Figure 4: Protein Synthesis Codon Cards #2

APPENDIX I

APPENDIX I

BLOOD TYPING LAB

Introduction:

In the past students were often allowed to draw and type their own classmates' blood. But with the prevalence of blood-borne diseases the use of human blood in experiments is neither prudent nor safe. Therefore, alternatives which simulate blood typing are necessary if instructors wish to safely teach students what the blood typing procedure is like and what results they can expect.

Methods and Materials:
spot plate
8 test tubes
8 disposable pipettes
4 simulated blood samples

Table 2: Blood typing observations

RESULTS:	A	B	AB	O
unknown 1				
unknown 2				
unknown 3				
unknown 4				

Procedure:

1. Take a spot plate to your lab station.

2. There are 4 labeled test tubes : "donor A"; "donor B"; "donor AB"and "donor O". These are the known blood types.

APPENDIX I

3. There should also be 4 test tubes designated by numbers: "1"; "2"; "3" and "4". These are your unknown recipients blood type that you are required to find out.

4. Place no more than 1 ml of the "unknown 1" blood in 4 wells.

5. A) Place no more than 1 ml of the "donor A" in the first well.
   B) Place no more than 1 ml of the "donor B" in the first well.
   C) Place no more than 1 ml of the "donor C" in the first well.
   D) Place no more than 1 ml of the "donor D" in the first well.

6. Gently swirl the spot plate for approximately 30 seconds.

7. Record your observations in your data table.

8. Rinse out your spot plate so that you do not contaminate the next part of your lab.

9. You will be doing the same process again, but this time you will use "unknown 2". See steps 4 and 5 for directions if they are necessary.

10. Repeat step 4 - 8, but with each of the remaining unknowns. Remember to thoroughly rinse your spot plate after each test.

BLOOD TYPING QUESTIONS

1. Did you see any reactions? If so describe what they looked like and what causes that to happen.
2. How close were the class predictions to the actual results -- explain which ones were not correct and why?
3. Which blood type(s) could be called universal donor(s) and why?
4. Which blood type(s) could be called universal receiver(s) and why?
5. What blood type(s) would be the easiest to detect and why?
6. What blood type(s) would be the hardest to detect and why?
7. What is going on when the sample agglutinates?
8. How could an incorrect transfusion harm someone physiologically?
9. What is the Rh factor?
10. How do people get an Rh factor?
11. How would the Rh factor effect the blood transfusion process?
12. What possible problems could result if, an unborn child who has the opposite Rh than the mother does? (Make sure you account for both scenarios.)

Reference: Arico, Anthony. The American Biology Teacher. February 1995. pg. 108-110

APPENDIX J

APPENDIX J

FISH BLOOD VESSEL LAB

Introduction:

Capillaries are the smallest vessels that transport blood in the body. Because their wall are only as thick as one cell, materials are exchanged rapidly between the body cells and the bloodstream. Arteries are the thickest, therefore, the strongest blood vessels mainly due to their need to withstand the high blood pressure force exerted on them. The vein are also thick but do not need to withstand any pulsating pressure. The purpose of this investigation is to observe and identify the blood flow with in these different blood vessels.

Methods and Materials:

150 ml beaker
goldfish in an aquarium
eye dropper
absorbent cotton
petri dish
2 glass slides
fish net
compound microscope
glass plate

Procedure:

1. Fill a 150 ml beaker almost full with water from the aquarium. Keep the water and eye dropper near you at you laboratory table.
2. Using the eye dropper, moisten two pieces of cotton with the aquarium water.
3. Place one piece of moistened cotton in the petri dish and the other piece on the glass plate. Put the lass plate aside for now.

APPENDIX J

4. Place one of the glass slides on the side of the petri dish opposite the moistened cotton.

5. Very carefully using the fish net, remove a goldfish from the aquarium. Gently place the head of the goldfish on the cotton in the petri dish. Be sure that the tail is on the glass slide.

6. Place the second piece of moistened cotton over the goldfish, leaving the mouth and tail uncovered. Place the other slide on top of the thin part of the tail. Be sure to keep the cotton moist by adding drops of the aquarium water from the beaker.

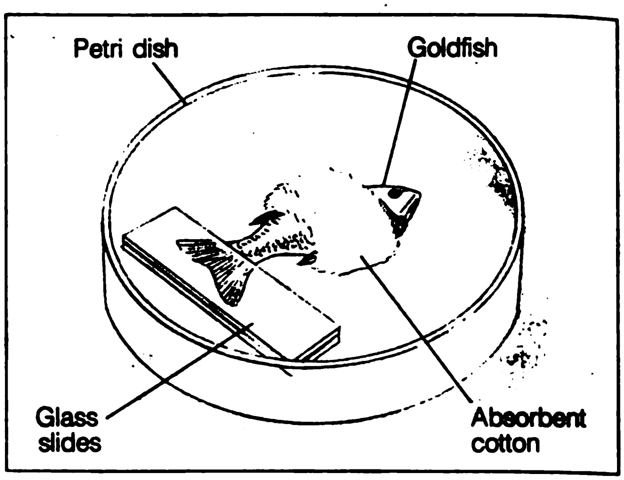

Figure 5: Fish Tail Activity Diagram
Reference: Miller, Kenneth R. and Joseph Levine. (1993) Biology. Prentice-Hall, Englewood Cliffs, NJ.

7. When the goldfish is calm, place the petri dish on the stage of the microscope. Position the petri dish so the goldfish's tail is over the opening in the stage.

8. Examine the goldfish's tail under low power only. Move the petri dish around until you see blood moving in the blood vessels.

9. Locate a blood vessel and try to determine what type it is. (Hint: by the number of blood cells traveling in it)

10. Get a detailed diagram(s) of the different blood vessels that are connected and show the blood flow by using arrows.

11. Return the goldfish to the aquarium as soon as you have completed the investigation. Clean up and put away any equipment you used.

APPENDIX J

BLOOD FLOW QUESTIONS

1. Describe the blood cells' shape and color.

2. Describe the movement of blood through a capillary.

3. In which type of blood vessel does the blood seem to pulsate? In which type of blood vessel does the blood seem to flow smoothly and at a uniform rate?

4. Describe the appearance of the blood vessels.

5. Explain why capillaries have such a small diameter?

Reference: Gottfried, Sandra, et al. Biology. 3rd edition. Prentice-Hall, Englewood Cliffs, NJ. 1986

APPENDIX K

APPENDIX K

HEART DISSECTION

Introduction:

The heart is a muscular organ which pumps blood. It is divided into four chambers. The two upper chambers are called the atrium. The two lower chambers are called the ventricles. These chambers are separated by valves to prevent blood from flowing backward. The valve acts like a door that only opens in one direction. The goals of this dissection activity are to examine the outside and inside of the heart and to trace the pathway of blood through the heart.

Methods and Materials:

preserved sheep heart
dissecting tray
scissors
2 scalpels
2 probes

Procedure:

1. Locate the heart's coronary artery, this will be the anterior part of the heart so you can orientate yourself.

2. Remember that the heart is like looking at another person so the left side of the is to your right and the right side of the heart is to your left.

3. On your sheep heart, find the parts listed in Table 1. Use the information in the table to help you.

4. Diagram and label the heart's internal/external anatomy.

APPENDIX K

5. In the above diagram include arrows showing the pathway the blood takes in the heart.

Table 1: Front parts of the Heart

Parts	Location	Traits	Name
A	across front of heart center	small blood vessel	coronary artery
B	bottom right chamber	large muscle section or chamber	left ventricle
C	bottom left chamber	large muscle section or chamber	right ventricle
D	top left chamber	small muscle section or chamber	left atrium
E	top right chamber	small muscle section or chamber	right atrium
F	top center	large blood vessel* from right ventricle	aorta
G	top center behind F	large blood vessel* from left ventricle; largest artery in body	pulmonary artery
H	top left	large blood vessel* from right atrium	vena cava

* All you will see is a hole where the blood vessel was attache to the heart

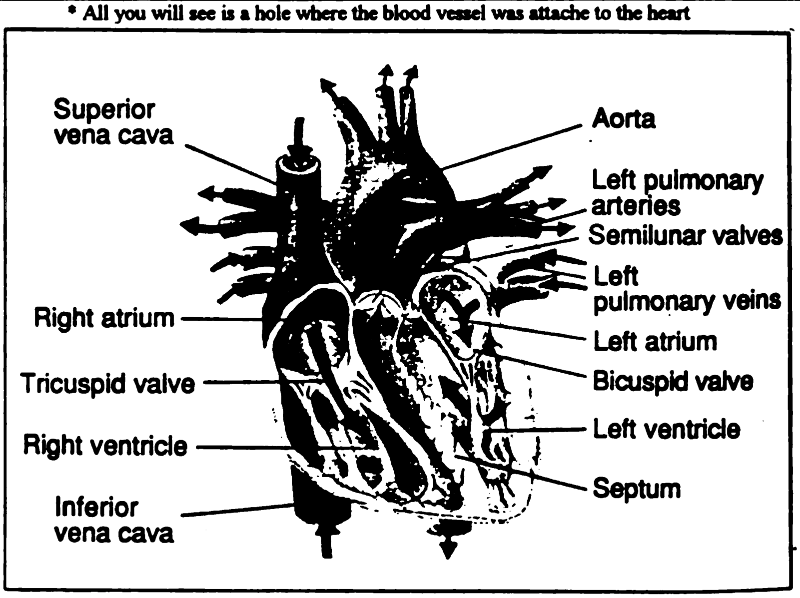

Figure 6: Heart Dissection Diagram

Reference: Miller, Kenneth R. and Joseph Levine. (1993) Biology. Prentice-Hall, Englewood Cliffs, NJ.

APPENDIX K

HEART DISSECTION QUESTIONS

1. What is the function of the coronary artery?

2. Blood is pumped from the heart through the aorta to the body.
   A) Does this blood have more oxygen or carbon dioxide?
   B) Which atrium and ventricle chambers are pumping this blood?
   C) Where does the entering blood come from?
   D) Which valves are involved in prevent back flow on this side of the heart?

3. Blood is pumped from the heart through the pulmonary artery to the lungs.
   A) Does this blood have more oxygen or carbon dioxide?
   B) Which atrium and ventricle chambers are pumping this blood?
   C) Where does the entering blood come from?
   D) Which valves are involved in prevent back flow on this side of the heart?

Reference: Kaskel, Albert, et al. Biology Laboratory Experiences. Merrill , Columbus, OH. 1988.

APPENDIX L

APPENDIX L

BLOOD PULSE AND RESPIRATION RATE

Introduction:

The pulse is an easily measured indicator of the heart's activity. The respiration rate indicates the lung's activity in supplying oxygen to the blood and the removal of carbon dioxide from the blood. The purpose of this investigation is to determine the relationship between pulse and respiration rates by measuring the changes in these rates during rest and physical activity.

Methods and Materials:

watch or clock with a seconds hand

Procedure:

1. Using your index and middle fingers, feel the pulse of your partner in the following three locations; at the temple, in the upper neck beneath the angle of the jaw, and at the wrist.

2. Count the number of breaths you take in one minute while your partner counts the pulse (step 3). Do it three times and take the average.

3. Using the location that is easiest for you, count the number of pulsations per minute while they are **standing** (do it three times and take the average). Record your results. Be sure to wait approximately 2 minutes before taking their pulse for the next position.

4. Count the number of breaths you take in one minute while your partner counts the pulse (step 5). Do it three times and take the average.

APPENDIX L

5. Count the number of pulsations per minute while they are standing in place and **walking** (do it three times and take the average). Record your results. Be sure to wait approximately 2 minutes before taking their pulse for the next position.

6. Count the number of breaths you take in one minute while your partner counts the pulse (step 7). Do it three times and take the average.

7. Count the number of pulsations per minute while they are **lying down** (do it three times and take the average). Record your results.

8. Count the number of pulsations per minute while they hold their breath (start counting 15 seconds after they start holding their breath). They do not have to hold their breath the entire minute.

9. Count the number of pulsations per minute while they breath in and out rapidly for 30 seconds. Start counting after 15 seconds. Do not forget to record the number of breaths in that 30 seconds as well.

10. Have the partner exercise vigorously (running, jumping jack, etc.) In place for 2 minutes and take their pulse rate after they finish. Again do not forget to record the number of breaths in the last minute of exercising. Wait 2 minutes before going on to step 11.

11. Count their pulse rate for one minute while they are counting their own heart rate by listening with a stethoscope (do it three times and take the average).

BLOOD PULSE AND RESPIRATION RATE QUESTIONS

1. How does the position of the body effect the pulse and respiration rate? Why do you think this is so?

2. How is the pulse rate affected by holding their breath?

3. How is the pulse rate affected by hyperventilation?

4. How is the pulse rate affected by exercise? Why?

5. How do the heart rate, pulse rate and respiration rates compare.? Why do you think this is so? Make a graph to help illustrate your explanation.

Reference: Gottfried, Sandra, et al. Biology. 3rd edition. Prentice-Hall, Englewood Cliffs, NJ. 1986

APPENDIX M

APPENDIX M

ARTERIAL BLOOD PRESSURE LAB

Introduction:

Often times students ask questions about high blood pressure and what do the ratios the nurse reports to the patient mean. Therefore, this laboratory is to investigate the students' blood pressure, determine what is happening physiologically with the heart, and to discover the effects of certain behaviors on each.

Methods and Materials:

stethoscope
sphygmomanometer
watch or clock with a seconds hand

Procedure:

1. Have your partner sit at a desk and rest one of their arms on the table.

2. The arm should be bare almost to the shoulder.

3. Place the cuff around the upper arm.

4. Close the valve of the rubber bulb and squeeze the bulb a few times so the cuff will remain in place.

5. Hang the gauge on the cuff or place it in plain sight on the table.

6. Place the stethoscope in you ears and put its diaphragm over the area of the brachial artery. If you place the cuff on the arm there are two hoses that come out near the patients bend in the elbow, try placing the stethoscope just under the cuff and between the hoses.

APPENDIX M

7. Pump up the pressure cuff to a pressure of about 10 mm Hg above what you think will be the systolic pressure of your partner. **DO NOT** exceed 180 mm Hg, you could end up hurting your partner. The pumped up cuff will cut off the blood flow through the brachial artery.

8. As you watch the pressure gauge and hold the stethoscope over the artery slowly release pressure from the cuff by **slightly** opening the valve of the pressure bulb.

9. As the pressure in the cuff decreases blood will begin to flow through the artery and you should hear a loud beat or thumping of the pulse. When you hear the first sounds, record the number the needle on the pressure gauge is pointing to.

10. Continue to let the air out. The sounds should get louder and then suddenly become muffled and blend together. Take your second reading on the pressure gauge.

11. Repeat the entire process two more times (allowing the partner's arm to rest between) and then do it three times on the other arm. Average the readings for each arm and then record your final results.

12. Switch the roles with your partner so they have a chance to experience this activity too and follow the same procedures.

13. Have your partner (the latest one who was the "guinea pig") exercise by running in place for two minutes (same as for the pulse lab) and then take their blood pressure as you did before. ONLY do this one time.

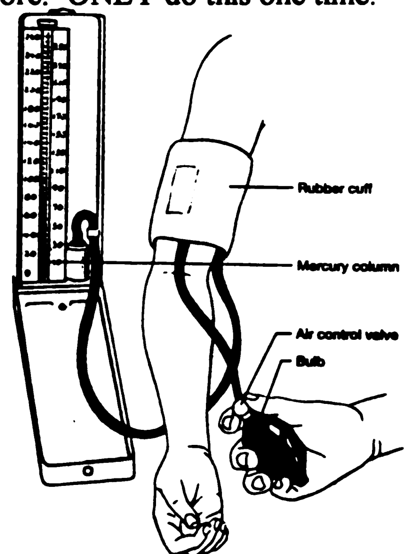

Figure 7: A Sphygmomanometer

Reference: Hole, John W., et al. (1996) Human Anatomy & Physiology. William C. Brown, Dubuque, IA.

APPENDIX M

ARTERIAL BLOOD PRESSURE QUESTIONS

1. Do you find a great difference in the average blood pressure readings of each arm? Why?
2. What effect did exercise have on your blood pressure?
3. What is the relationship between blood pressure and the pulse rate?
4. Class wise is there a big difference between males and females? Athletes and non-athletes? Smokers and non-smokers?
5. What does the blood pressure ratio mean?
6. Explain what is happening in the heart during the top number in the ratio.
7. Explain what is happening in the heart during the bottom number in the ratio.
8. What does an electrocardiogram (ECG) show? Explain the relationship between and ECG and a person's blood pressure if possible.

APPENDIX N

APPENDIX N

CIRCULATORY GROUP RESEARCH QUESTIONS

1. Different organs/tissues need oxygen and nutrients at different times depending on the activity of the person: exercising, digesting, sleeping, problem-solving. Explain how the circulatory system adjusts to the activities.

2. As blood circulates through the body it is either flowing away from the heart, exchanging substances with tissue spaces and /or cells, or flowing back toward the heart. Describe the similarities and differences in the blood vessels and some reasons why they are structured the way they are.

3. The heart has four valves that help the heart pump blood. Describe each valve, tell what its specific function is, and how it works. Then explain what causes a heart murmur.

4. The heart itself is made of living tissue and must, therefore, have its own circulation system. Explain why this cardiac circulation must be different from circulation to the rest of the body, explain how it is different, and explain what happens when excessive blockages occur. Also, explain what medical treatments or cures are possible to correct the blockage(s).

5. Heartbeat must be controlled so we can react to changes in the different levels of activity. Describe the conduction system of the heart and explain how it controls the cyclic pumping action (muscle contractions) of the heart chambers. If the heart action stops, explain how a defibrillator can restore it

6. Electrocardiograms are used to detect "electrical events" during a cardiac cycle. Explain what the ECG pattern means and tell what is happening in the heart at each lettered peak or valley. Then demonstrate an ECG that depicts: ventricular fibrillation, tachycardia, and bradycardia.

APPENDIX O

APPENDIX O

PRE/POST TEST

Please respond to each of the following questions using as much terminology and knowledge that you have. Thank you.

1. Describe the function of the circulatory system.

2. A. Describe the makeup of blood and what each component does?

   B. Describe how blood types differ and why. (Be sure to name as many as possible, too.)

   C. Explain how the environment can influence the perpetuation of a certain phenotype of a given blood disorder with in a certain population.

   D. How long do red blood cells live for and why?

   E. Where are blood cells made? And how is their production regulated?

   F. What happens to red blood cells (the"stuff"that makes them up) when they die?

   G. Do red blood cells have a nucleus? Do they go through mitosis or meiosis?

   H. Describe and diagram the process of mitosis and meiosis.

3. A. Describe the structure or anatomy of the heart.

   B. Explain how the heartbeat is controlled.

4. A. What are the different blood vessel types and how can they be identified?

   B. Describe the pathway blood takes as it moves through the circulatory system?

APPENDIX O

5. A. What is blood pressure?

   B. How do you measure it and what does the ratio mean?

   C. How does ones respiration rate, pulse rate and blood pressure all relate?

6. A. Describe how the blood carries food and oxygen to the cells in your body.

   B. Describe how the food and oxygen enter your cells and what the cell does with the food and oxygen.

   C. Describe what happens to the cellular wastes that the blood cells carry.

7. Construct a concept map of the circulatory system and include how it is related to other body systems like:

digestion	muscle
endocrine	lymphatic
respiratory	skeletal
renal (urinary)	