

**American Physiological Society
K-12 Minority Outreach Fellowship Report**

Jessica A. Clark, PhD
Washington University School of Medicine
April 23, 2008

Outreach Visits

Ventana Vista Elementary School, Tucson, AZ

Mrs. Dianna Clark's class, 4th grade

September 10, 2007

(0% Native American, 13% Hispanic, 11% Asian, 4% Black, 72% White)

Activity #1: What is a scientist? (15 minutes)

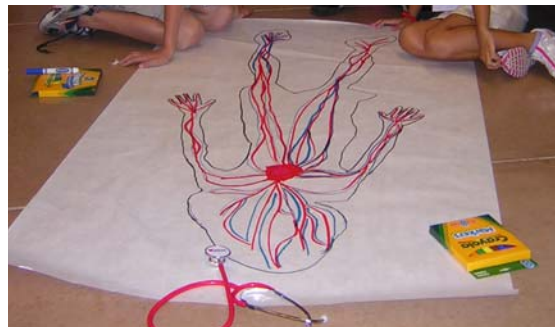
Since many children and teachers visualize scientists as middle-aged white males with wild hair, glasses and a lab coat, holding test tubes and working inside a laboratory, this activity was done to break these common stereotypic perceptions. I wanted to show the students that scientists are people from all walks of life and a variety of racial and ethnic backgrounds. First, I asked for a volunteer to become a scientist. Students then helped me make them look like a scientist. I had a bag full of the typical responses (lab coat, glasses, test tubes, crazy hair, notebook, etc.) which could be pulled out as they were described. Afterwards, I introduced myself as a physiologist and talked about how their views of a scientist may be influenced by distinct cultural behaviors and personal science experiences. This led into a discussion about what physiology is and career opportunities in the sciences.



Activity #2: Your Beating Heart and the Effects of Exercise (60 minutes)

This activity taught students about the cardiovascular system by having them a) draw a life-size body with a heart, lungs, arteries, and veins, b) listen to their heart beat with a stethoscope, and c) design an experiment to test how heart rate changes after exercise. I first introduced the circulatory system by having students form teams of 3. Each team drew a life-size outline of one student's body on butcher paper.

Each team was then given a stethoscope and after showing them how to use it, the students listened to their own hearts and each other's hearts. Next, we discussed as a large group what the heart does and why its function is important. I used a Powerpoint presentation to show them figures of the heart and the circulatory system. Students then drew a heart, lungs, arteries, and veins on their butcher paper bodies. I made sure that students did not get the misconception that blood in veins is blue.



For the next part of the activity, I wrote the word "pulse" on the board and asked students to define the term. We discussed what the pulse is, how pulse can determine heart rate, and how you can measure your pulse. Students then conducted an experiment to determine how heart rate changes during different types of activities. I asked the students to develop a hypothesis for what will happen to their heart rate following lying down, walking, and jumping jacks and recorded their predictions. Students then practiced taking their pulse and recorded trial data. For each activity, students conducted 3 trials. When all the teams were done, we tabulated data on chart paper and had the students come up with conclusions about the effect of different activities on

heart rate. After talking about whether the data supported the hypotheses, we discussed the following questions: Does everyone have the same heart rate at rest? After different activities? What does this mean? Why does heart rate differ between the 3 activities? Why is this important? Lastly, we had a 10 minute open discussion about what they learned and any questions they had about physiology, science in general, college, and careers.

Canyon View Elementary School, Tucson, AZ

Ms. Peggy Clemans' class, 2nd grade

September 10, 2007

(2% Native American, 12% Hispanic, 12% Asian, 3% Black, 71% White)

Activity #1: What is a scientist? (15 minutes)

Please see description on page 1.

Activity #2: Dissecting Owl Pellets (45 minutes)

This activity taught students about digestion and the gastrointestinal tract by dissecting owl pellets. First, I showed the class an owl pellet and asked them if they knew what it was. As a large group, we observed the pellet and wrote down what we know about it (color, texture, size, etc.). I then asked students to predict what they thought was inside the pellet and how we could find out. I talked to them briefly about what regurgitation is and why owls do it. We talked about the basic anatomy of the digestive tract and the basic functions of the digestive system. After showing students how to fill out the report sheet (see below), students got with a partner and were given a pellet, black construction paper, wooden picks, magnifying glass, and bone charts. Each team observed and drew the outside of the pellet before dissecting. Once all the hair and bones were separated out, students used bone charts to identify the animals that were within their owl pellet. Once all teams were finished dissecting, we discussed their discoveries and recorded results on the board. Students were asked to make conclusions based on the data and answer the following questions: What do we know about what owls eat? Were your predictions accurate? Was there anything in your data that surprised you? Students were allowed to keep the bones if they wanted to.



Example of what was included on lab report:

We predict we will find these things in our pellet _____

Here is a sketch of the outside of our pellet:

Our pellet feels like _____

Our pellet looks like _____

Our pellet is _____ long and _____ wide.

Here is a sketch of the inside of our pellet:

Here is what we found inside _____

Details we see are _____

Now we know that owls _____

Our predictions were _____

Mountainair Elementary School, Mountainair, NM

(1% Native American, 68% Hispanic, 0% Asian, 3% Black, 28% White)

Ms. Jen Chavez's class, 4th grade

Ms. Marla Zamora's class, 4th/5th grade

Ms. Joan Page's class, 5th grade

September 13, 2007

Activity #1: What is a scientist? (15 minutes)

Please see description on page 1.



Activity #2: Your Beating Heart and the Effects of Exercise (30 minutes)

This activity taught students about the cardiovascular system by having them listen to their heart beat with a stethoscope and design an experiment to test how heart rate changes after exercise. Students in all three classes had just covered the cardiovascular system in science class, so I started the activity by doing a fun quiz on their knowledge. We discussed as a large group what the heart does and why its function is important. I then had students divide into pairs and gave each pair a stethoscope. After demonstrating how to use the stethoscopes, the students were allowed to listen to their own hearts and each other's hearts.



For the next part of the activity, I wrote the word “pulse” on the board and asked students to define the term. We discussed what the pulse is, how pulse can determine heart rate, and how you can measure your pulse. Students then conducted an experiment to determine how heart rate changes during different types of activities. I asked the students to develop a hypothesis for what will happen to their heart rate following lying down, walking, and jumping jacks and recorded their predictions. Students then practiced taking their pulse and

recorded trial data. For each activity, students conducted 3 trials. When all the teams were done, we tabulated data on chart paper and had the students come up with conclusions about the effect

of different activities on heart rate. After talking about whether the data supported the hypotheses, we discussed the following questions: Does everyone have the same heart rate at rest? After different activities? What does this mean? Why does heart rate differ between the 3 activities? Why is this important? Lastly, we had a 10 minute open discussion about what they learned and any questions they had about physiology, science in general, college, and careers.

Metro Academic & Classical High School, St. Louis, MO

Ms. Kerry Zimmerman's classes, 11th/12th grade Anatomy & Physiology
PhUn Week, November 5, 2008

(0% Native American, 0% Hispanic, 4% Asian, 49% Black, 46% White)

Activity #1: ECG and Heart Sounds (with Alecia Riley from ADInstruments)(80 min)

This activity allowed students to record and analyze their own electrocardiograms (ECG), and examine the relationship between the ECG and heart sounds. I started the session by giving a 15 min Powerpoint lecture about cardiovascular physiology, specifically discussing the heart, its electrical activity, and the cardiac cycle. Students then split into 4 groups (we had 4 units from ADI) and I briefly showed them how to use the computer software and hook up the ECG leads to their bodies. Students worked together through the following experiments (see below for lab handout): 1) ECG in a resting volunteer, 2) ECG recorded from several other volunteers to identify similarities and differences between people, 3)



Using a stethoscope to listen to the heart and an event marker to determine the relationship between heart sounds and the ECG being recorded at the same time, and 4) Digitally recording the heart sounds with a phonocardiogram while the ECG is being recorded. Once all groups were finished working through the experiments, we gathered as a large group and discussed their findings about the correlation between heart sounds and the ECG in terms of



the cardiac cycle.

Since this visit was during PhUn Week, we spent the last few minutes of class talking about physiology in general and passing out the goodies!

I have modified the content in the following Laboratory Handout (see following page) to be appropriate for use in a high school anatomy and physiology classroom. The handout contains background information on cardiac physiology, a description of how to attach the ECG leads, and a brief description of the experiments they were to work through using the LabTutor software.

ECG and Heart Sounds

Introduction

The beating of the heart is associated with both electrical activity and sound. The pattern of electrical activity recorded at the body surface is called the **electrocardiogram** or **ECG**. The aim of this laboratory is for you to record and analyze an ECG from a volunteer, and to examine the relationship between the ECG and the characteristic sounds of the heart.

Background

The heart is a dual pump that circulates blood around the body and through the lungs. Blood enters the atrial chambers of the heart at a low pressure and leaves the ventricles at a higher pressure. The high arterial pressure provides the energy to force blood through the circulatory system. Figure 1 shows a schematic of the organization of the human heart and the circulatory system.

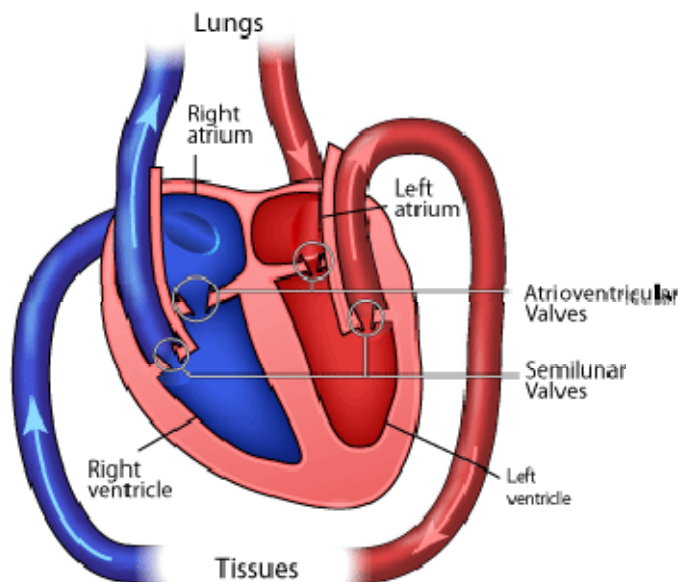


Figure 1. A schematic diagram of the human heart and circulatory system.

Blood returning from the body arrives at the right side of the heart and is pumped through the lungs. Oxygen is picked up and carbon dioxide is released. This oxygenated blood then arrives at the left side of the heart, from where it is pumped back to the body.

ECG and Heart Sounds

The electrical activity of the heart

Cardiac contractions are not dependent upon a nerve supply. However, innervation by the parasympathetic (vagus) and sympathetic nerves does modify the basic cardiac rhythm. Thus the central nervous system can affect this rhythm.

A group of specialized muscle cells, the sinoatrial (SA) node, acts as the pacemaker for the heart (Figure 2). These cells rhythmically produce electrical impulses that spread through the muscle fibers of the atria. The resulting contraction pushes blood into the ventricles. The only electrical connection between the atria and the ventricles is via the atrioventricular (AV) node. The electrical signal spreads slowly through the AV node, thus allowing atrial contraction to contribute to ventricular filling, and then rapidly through the AV bundle and Purkinje fibers to excite both ventricles.

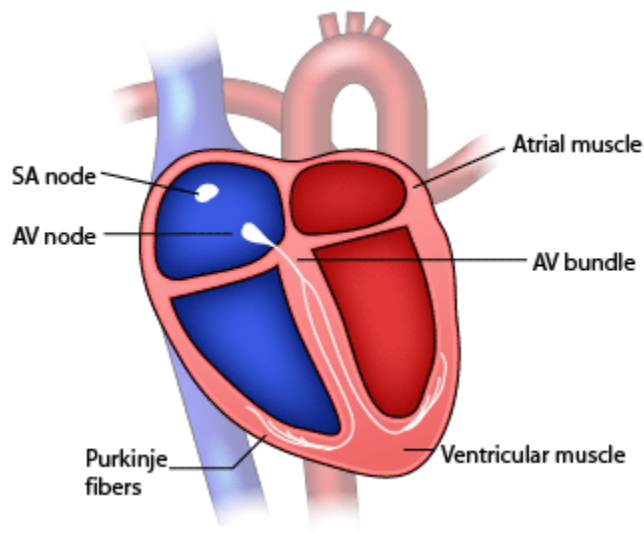


Figure 2. Components of the human heart involved in conduction.

ECG and Heart Sounds

The cardiac cycle involves a sequential contraction of the atria and the ventricles. The combined electrical activity of the different myocardial cells produces electrical currents that spread through the body fluids. These currents are large enough to be detected by recording electrodes placed on the skin (Figure 3).

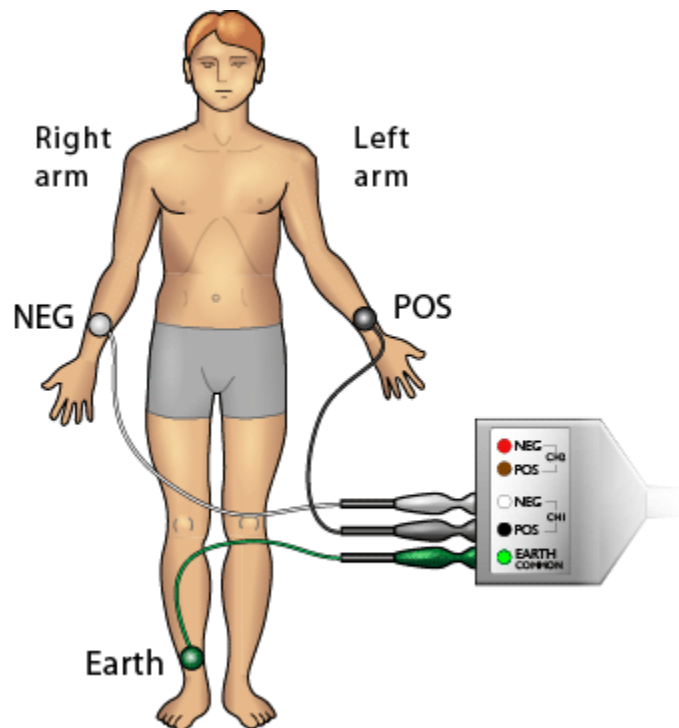


Figure 3. Standard method for connecting the electrodes to a volunteer.

ECG and Heart Sounds

The regular pattern of peaks during one cardiac cycle is shown in Figure 4.

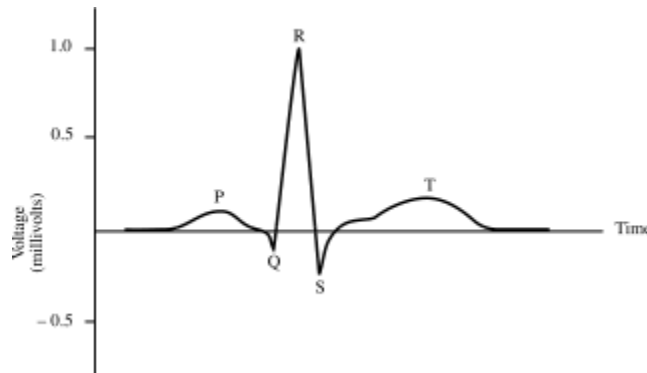


Figure 4. One cardiac cycle showing the P wave, QRS complex and T wave.

The components of the ECG can be correlated with the electrical activity of the atrial and ventricular muscle:

- The P-wave is produced by electrical activation of the atria.
- The QRS complex is produced by electrical activation of the ventricles; atrial electrical relaxation also occurs during this time, but its contribution is insignificant.
- The T-wave is produced by ventricular electrical relaxation.

Heart valves and heart sounds

Each side of the heart is provided with two valves, which convert the rhythmic contractions into a unidirectional pumping. The valves close automatically whenever there is a pressure difference across the valve that would cause backflow of blood. Closure gives rise to audible vibrations (heart sounds). Atrioventricular (AV) valves between the atrium and ventricle on each side of the heart prevent backflow from ventricle to atrium. Semilunar valves are located between the ventricle and the artery on each side of the heart, and prevent backflow of blood from the aorta and pulmonary artery into the respective ventricle.

The closure of these valves is responsible for the characteristic sound produced by the heart, usually referred to as a 'lub-dup' sound. The lower-pitched 'lub' sound occurs during the early phase of ventricular contraction. This is produced by closing of the atrioventricular (mitral and tricuspid) valves. These valves prevent blood from flowing back into the atria. When the ventricles relax, the blood pressure drops below that in the artery, and the semilunar valves (aortic and pulmonary) close, producing the higher-pitched 'dup' sound. Malfunctions of these valves often produce an audible murmur, which can be detected with a stethoscope.

ECG and Heart Sounds

The cardiac cycle

The sequence of events in the heart during one cardiac cycle is summarized in Figure 6. During ventricular diastole blood is returning to the heart. Deoxygenated blood from the periphery enters the right atrium and flows into the right ventricle through its open AV valve. Oxygenated blood from the lungs enters the left atrium and flows into the left ventricle through its open AV valve. Filling of the ventricles is completed when the atria contract (atrial systole). Atrial contraction is followed by contraction of the ventricles (ventricular systole). Initially, as the ventricles begin to contract the pressure in them rises and exceeds that in the atria. This closes the AV valves. But, until the pressure in the left ventricle exceeds that in the aorta (and in the right ventricle exceeds that in the pulmonary artery), the volume of the ventricles can not change. This is the so-called isovolumic phase of ventricular contraction. Finally, when the pressure in the left ventricle exceeds that in the aorta (and the pressure in the right ventricle exceeds that in the pulmonary artery), the aortic and pulmonary valves open and blood is ejected into the aorta and pulmonary arteries. As the ventricular muscle relaxes, pressures in the ventricles fall below those in the aorta and pulmonary artery, and the aortic and pulmonary valves close. Ventricular pressure continues to fall and once it has fallen below that in the atria, the AV valves open and ventricular filling begins again.

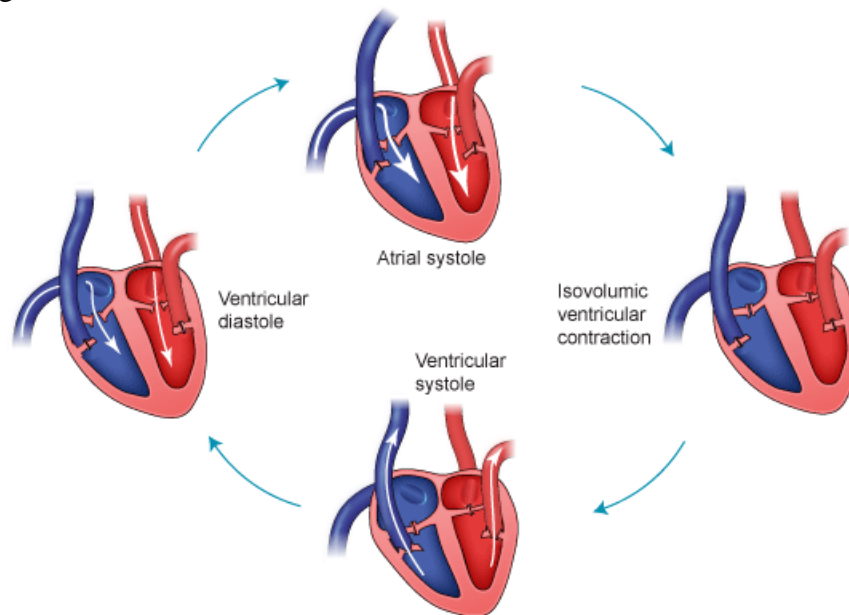


Figure 6. The cardiac cycle.

ECG and Heart Sounds

The temporal relationship between the electrical activity of the heart, the heart sounds, and the cardiac cycle are depicted in Figure 7.

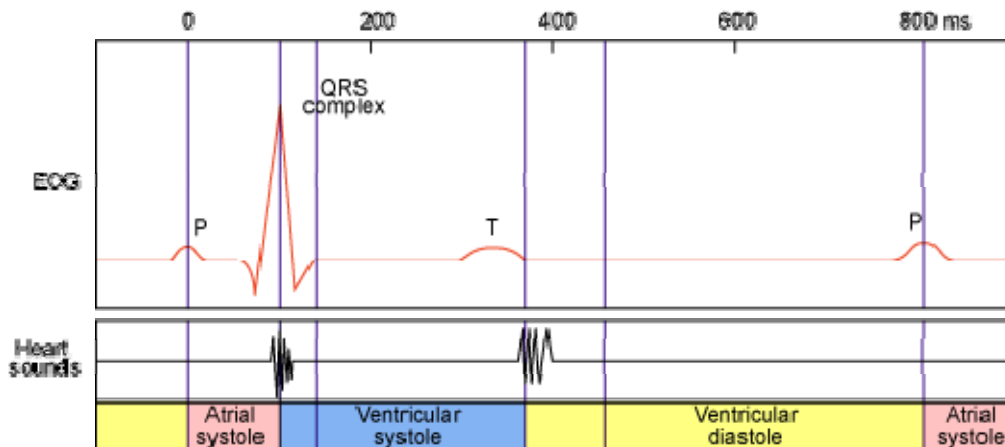


Figure 7. Relationship between ECG and heart sounds.

ECG and Heart Sounds

What you will do in the laboratory

1. **ECG in a resting volunteer.** You will record the ECG, analyze the signal and observe the effects of slight movement on the signal.
2. **ECG recorded from several other volunteers.** You will identify and discuss similarities and differences in the ECGs of the different participants.
3. **ECG and heart sounds.** You will use a stethoscope to listen to the heart and an event marker to determine the relationship between what you are hearing and the ECG being recorded at the same time.
4. **ECG and phonocardiography.** You will also record the heart sounds (phonocardiogram) together with the ECG.

Metro Academic & Classical High School, St. Louis, MO

Ms. Kerry Zimmerman's classes, 11th/12th grade Anatomy & Physiology

PhUn Week, November 7, 2008

(0% Native American, 0% Hispanic, 4% Asian, 49% Black, 46% White)

Activity #1: Careers in Physiology Presentation (30 minutes)

This activity was a Powerpoint presentation about potential careers in physiology. Based on the slides that were provided on the PhUn Week website, I talked to the students about the wide range of career paths and research focuses within the field of physiological sciences. I wanted to make sure they had real-life examples of actual people doing research, so I chose 3 physiologists and presented their story about how they got to be where they are today. I also spent time talking about my own career path and my research projects. To ensure that the students were aware of opportunities available through APS, I highlighted minority programs, the career website, EB, etc. In addition, I came prepared with information regarding summer research internships at institutions in the St. Louis area. The last 10 min of class were used to answer questions. I brought business cards to give them so they could contact me whenever they had a question about research, physiology, college, etc.

Additional Outreach Activities I Participated In During 2007-2008:

Washington University School of Medicine Young Scientist Program (2006-present)

-Brings underprivileged students from the city school district into a research lab for the summer

Washington University School of Medicine Teacher-Researcher Program (2006-present)

-Partners high school science teachers with grad students or postdocs to conduct research for 10 weeks in the summer and develop new science curriculum

St. Louis Academy of Science, Greater St. Louis Science Fair (May 2007)

-Elementary school judge (4th and 5th grade)

St. Louis Academy of Science, Greater St. Louis Science Fair Honor's Division (March 1, 2008)

-High school honor's division judge

Briar Crest Elementary School Science Night (March 7, 2008)

-Had a table with hands-on demonstration of listening to your heart beat with stethoscopes and seeing what the electrical activity of your heart looks like (thanks to ADInstruments, I was able to bring the equipment to do the ECG lab). Students were able to hook their parents up to the ECG machine or each other. They performed brief experiments to observe variation in the shape of the ECG trace between people.

Science Teaching Forum (July 23-29, 2007, Warrenton, VA)

Summary: My role during the Science Teaching Forum was to help set-up the room for the week's activities, help lead particular inquiry-based activities, and serve as a physiologist-in-residence to answer any questions that arose.

My Reflections: Attending the Science Teaching Forum was a wonderful opportunity to work with middle and high school teachers and learn about inquiry-based curricula. Overall, it was a

great introduction to what goes on in these classrooms, as well as a source of knowledge on how to better prepare for my own lessons in the classroom.

Having physiologists present at the Teaching Forum is an invaluable source to the teachers. Not only can we teach them about physiology, but for the outreach fellows, it is good teaching practice and a chance to get feedback on our presentation skills. Although we were given the materials before hand, I was a little unsure of how the Forum would go and my exact role as a physiologist-in-residence. It might be more effective for the fellows if there were discussions prior to the Forum to divide up teaching the different activities. While we knew what activities we would be doing before hand, it was unclear if we would just be sitting in the back to help out, or if we would actually be given a chance to lead. Although it is great practice to have to teach an unfamiliar topic “on the spot,” for this particular forum I think it would be more effective to be better prepared. If we could plan this more in detail prior to the Forum, we could prepare a brief Powerpoint presentation to introduce the physiology behind the activity, come up with creative ways to discuss the topic, etc. Ultimately, it would have made me feel more prepared and like I was able to contribute something to the Forum.

I liked being included in the teacher emails throughout the year. Although it would’ve required more time on our part, it would have been fun to be more involved with the teachers on their assignments or projects beyond the week of the Forum. Perhaps fellows could have the opportunity to lead one of the online discussions or give more feedback on their labs as they progress and field test them through the year. It is beneficial for the fellows as well as the teachers to explore effective pedagogy and develop new science curricula. Creating more opportunities for us to interact with each other would be exciting and could potentially help foster even more outreach activities in the future.

SACNAS (October 11-14, 2007, Kansas City, MO)

Summary: My role at SACNAS was to help set up the APS booth in the exhibit hall and answer any questions from students or faculty interested in APS programs.



My Reflections: The conference was great and I enjoyed talking to students interested in physiology. Since some students tend to shy away from visiting society booths, I tried to walk around and bring material to them during poster sessions. I think having a K-12 fellow present at SACNAS is important and it would be more effective to have fellows be more involved with the meeting. Would it be possible to sponsor an award at SACNAS like at ABRCMS? Further, I wish I would have been able to interact more with the students beyond chatting with them in the APS booth and walking around the poster hall. There is an amazing mentoring program set up at SACNAS that fellows should take advantage of to maximize mentoring skills and interactions

with students. For example, graduate students can participate as Peer Reviewers for student poster and oral presentations and postdocs can participate as graduate student poster and oral presentation judges. Another idea would be to get involved with the precollege teacher workshops. We could offer a brief session on PhUn Week or other K-12 programs, or have a physiology demonstration or hands-on activity.

What I Have Achieved Through the K-12 Outreach Fellowship

Teaching Skills:

This fellowship has definitely allowed me to expand and improve my communication and teaching skills. I found one of the greatest benefits of this fellowship to have developed a range of pedagogy skills from elementary to high school levels. Specifically, I was able to use technology (Powerpoint) to engage and inform students about physiology and then use hands-on activities to give students the opportunity to be a scientist. For each lesson, I tried to incorporate real-life, age appropriate examples so students could connect with the science. In addition, I was able to develop effective classroom management skills. I realized early on, whether working with 2nd graders or high school students, that if I was unable to manage the classroom there would not be a productive learning environment for the students. I was able to spend time speaking with the teachers so I could better understand how their students learned best. Consequently, I was able to scale my activities for various age levels. Importantly, by visiting several schools across 3 states (Arizona, New Mexico, and Missouri) I was able to teach to diverse populations from rural, suburban, and urban school districts. This not only was an eye-opening experience for myself, but made me a better teacher because I got to interact with students from every walk of life.

Talking About Careers in Physiology and My Own Path:

Although I have always been active in promoting physiology to students, this fellowship has provided opportunities to get students excited about science at a very early age. It was a rewarding experience to be able to tell students what physiology actually is and see their faces light up when they realized they could be involved with physiology too! In my previous experiences, I spoke to undergrads about career options in physiology and most were trying to decide between graduate and medical school. I really enjoyed giving career talks at the elementary and high school levels because it allowed me to introduce career paths beyond those two tracks.

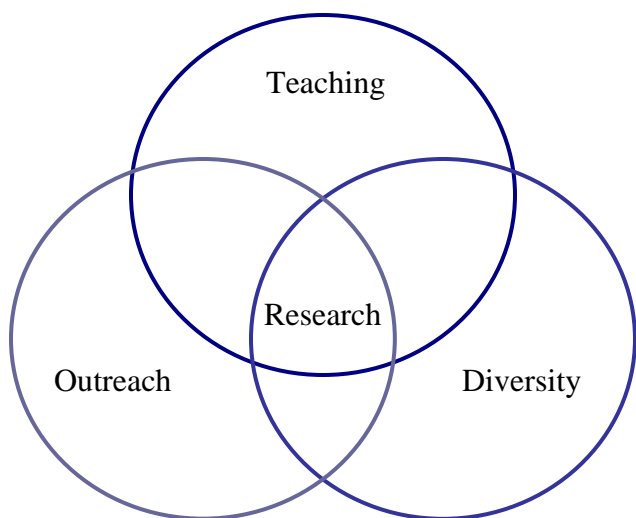
For the elementary students, I spent more time talking about the education process (how to get into college, how many years it takes to get a PhD, etc). One student from Ms. Clemans' 2nd grade class was extremely interested in chemistry and asked me many, many questions about college. After my visit, her parents came in to the class complaining that all she wants to read is science books. At first they were upset because they wanted her to be a lawyer (I know...she's in 2nd grade!), but then became very appreciative of my effort to foster her interests in science. For the high school students, I modified the APS Careers in Physiology Powerpoint (from PhUn Week) so I could show real world examples of what physiologists do and then talk about my own work. This was very effective, although I realized I had to prepare a lot before hand to be able to answer questions about alternative career paths, particular schools or regions in the country that have good physiology programs, or summer opportunities in research labs at my institution. I also used these career talks to demonstrate that I have a very strong interest in helping them get to where they want to be, not just in physiology but science in general. I

brought my business cards and offered to help them find internships in medicine, biomedical research, or anything that may interest them. I was pleased to have several students contact me for information.

How the Fellowship Has Changed My Career Goals and Aspirations:

This fellowship has definitely changed my career goals and has made me rethink my true passions. Before the fellowship, I knew I loved teaching and that working with students was a big component of my future career goals. However, I did not have a lot of experience working with students at the K-12 level. I have realized that my passion is inspiring others and being in the high school classroom in particular has given me much satisfaction because students at that age are so easily excitable about life!

I see my career having three main components: 1) Teaching, 2) Outreach, and 3) Diversity. All three components are intimately connected with each other, and I see Research as



the common thread that will help me be successful in all three. This fellowship has helped me realize that I like using research and the lab as a *tool* to teach and attract students. This has been a shift from my grad school years where I was motivated to do research to satisfy my own scientific curiosity. Therefore, I don't see myself going down the "normal" career path as an academician. Instead, my career goals are to not only teach at the college level and stay involved with research, but to develop education programs to bring science into K-12 schools and the community with particular attention on working with people from disadvantaged backgrounds. I want to

remain active in science outreach and continue efforts in engaging the public in science and research. I feel this is so important in order to breakdown the barriers and misunderstandings about scientists- we need to get out there and allow people to see who we are!

Overall, this fellowship has been an amazing, life changing experience and I am so grateful to APS for allowing me to participate! It has allowed me to immerse myself in science outreach, network with educators all over the country, develop my own professional goals, and most importantly, excite and inspire numerous students and teachers.