Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2007 Volume V: Health and the Human Machine

Cardiac Arrest! Using Forensics to Investigate Cardiovascular Anatomy and Function

Curriculum Unit 07.05.08
by Wendy Decter, M.D.

Introduction

This unit is designed for an eleventh and twelfth grade Forensic Science class but can be readily adapted to high school biology, anatomy and physiology, health, or middle school science classes. With curricular changes in biology leading to a dearth of study of human anatomy and physiology in high school, students often do not have the conceptual basis required to understand causes of death and autopsy reports in our mock crime scenarios and case studies. Making science relevant for students is always a challenge and the reasoning behind removing the most relevant subject, study of oneself, from biology courses, remains a mystery to me. Teaching Forensic Science allows me to bring some study of anatomy and physiology back to high school science.

Forensic science is the application of knowledge acquired in many scientific disciplines to matters of law. Forensic comes from the Latin word *forensis* , which means public. Information is made public in order for members of society to determine if and how laws have been violated. In the analysis of evidence, the principles and technology of chemistry are pre-eminent. Physics, biology, anatomy, physiology, geology, anthropology, psychology, and pathology, to name a few disciplines, are all applied to the analysis of a crime scene and the testimony of witnesses. Lessons can be developed for just about any discipline based on a mock "crime". I have often used the same laboratory exercise in my chemistry classes as in my forensics class. Students seem to become more engaged if they are using their data to solve a crime, so one lab serves to illustrate both double replacement reactions and ABO blood typing to match "blood" found at a crime scene with that of a suspect. Adding a "crime" scenario can be an effective way to increase relevancy and pique students' interest in *any* discipline of science.

Forensics inquiries encourage students to use deductive reasoning and make decisions based on analyses of data that they have collected. Indeed, it is the essence of scientific inquiry, which is being so heavily touted by education experts today.

The anatomy and physiology of the human cardiovascular system will be studied in this unit. The path of circulation of blood in humans through the atria, ventricles, valves, arteries and veins can be somewhat confusing to students at any grade level, including medical students. Students will first have to explore the

normal anatomy and physiology of the cardiovascular system in order to find the cause of its failure in our "victim". Cardiac arrest is a general term for a cessation of the function of the heart. It can be a primary event, as with an arrhythmia, or the end result of loss of blood, trauma, asphyxiation or other mechanisms. Students will be presented with the details of a "suspicious death" ruled a "cardiac arrest" by an inexperienced medical examiner.

By using their knowledge of the cardiovascular system they will be encouraged and guided to ask the proper questions and look for clues as to the specific cause of death of Mr. A.V. Korotkoff. By using an inquiry-based approach and adding the interest of the possibility of a "murder" students will acquire knowledge of how one of the major organ systems of their own bodies works. They will also be learning and using all of the skills necessary for scientific inquiry.

Justification

The Trends in International Mathematics and Science Study (TIMSS) collects educational achievement data at the fourth and eighth grade levels from countries around the world in order to provide information about students' performance. It is an achievement test administered to students as well as extensive background information collected from schools regarding methodology and content. The test items in 2003 were specifically designed to assess inquiry-based learning and "higher order thinking" skills. TIMSS data is useful to assess our educational policies and compare them to those of the fifty other participating countries. Studies were conducted in 1995, 1997, 2003, and the next will be completed in 2007. In the 2003 study, the United States 8th graders ranked 9th after Singapore, China, Korea, Hong Kong, Estonia, Japan, Hungary and the Netherlands.

How have our curriculae and methods left us so far behind in achievement in the most essential subjects for mastering our world? It will be interesting to see if we have closed the gap when the 2007 results are published next year.

Since 1996 the National Science Education Standards have placed an emphasis on inquiry and process. It is no longer a matter of teaching our students groups of interrelated facts. We must teach them how to investigate, a process which they intuitively knew before they ever entered school. In fact in the 2003 TIMSS our 4th graders were ranked 6th, behind Singapore, China, Japan, Hong Kong, and England. What is happening in science teaching in our schools between 4th and 8th grade. Do we change over to a fact-based "listen and learn" model? Are we more able to capitalize on younger children's' natural curiosity? Inquiry learning is NOT new. It is what babies do. Watch your world, try something, if it "sort of" works, modify it, if it doesn't work, try something else. This how children learn naturally and it is also the essence of the scientific method. We have to reteach this most natural method of discovering the world to our students or prevent them from losing the wonder of it in the first place.

The NSES standards A and E speak to teaching science as inquiry and having students acquire understanding of science and technology. Inquiry means asking questions, but not just any questions. Questions must lead to hypotheses. Students will have to develop their own ways of testing these hypotheses. Observations during these tests lead to more questions. A model starts to take shape and can be tested. Ones' methods can be evaluated and revised. Students take initiative and responsibility for learning. They are doing science.

Students bring their own perspectives and talents to the problems they are investigating so that each student may not be doing exactly the same thing as other students in the class (nor should they be). They must prepare and share their findings with other students so that they teach and learn from each other. Collaboration and communication skills are learned. As students explore they will tend to bring other disciplines into play in their questions and their experiments. They may have to use mathematics, their artistic skills, and they will certainly be practicing their reading and writing skills. The science room should look like a hive of activity with the teacher carefully observing and remaining as quiet as possible. Giving answers spoils the fun.

Relevancy is a most important issue in the teaching of science but once the students are in charge of their own learning it is already relevant to them. While pure science is a joy to some, it is applied science that usually brings home the message to students. I believe this is the basis for the extreme popularity of the forensic science television shows. The science behind the action is made accessible and understandable to the audience. We as high school and middle school science teachers can "cash in" on this tremendous appeal

by creating "crimes" for students to solve. They will be using scientific inquiry daily and instinctually.

As a teacher in an inner city school where students are distracted by the events of their owns lives it is important to create engaging lessons. Crime, hunger, poverty, pregnancy, unstable living arrangements, foster care, and jobs are just a few of the obstacles our students face. It is always challenging to find a way to make science relevant. In my opinion is seems easier to relate a theme from history or a novel to students' day-to-day concerns than it is to make atomic theory relevant. It is more important to me that students learn a method of evaluating their world than the principles of Dalton's Theory. They have to make decisions, every second of every day. Hopefully, they will use the skills they acquire in science class to observe, think, test, and decide based on data, in their lives, whether dealing with influential peers or making decisions for their families' health in the future.

Objectives

As a result of participating in this learning unit students will be able to

1. Make careful and precise observations of a phenomenon or problem
2. Consider a hypothesis or possible solution to the problem using inductive reasoning, past experience, and creativity
3. Design a method for testing a hypothesis
4. Evaluate evidence obtained from testing
5. Draw a conclusion based on evidence
6. Name and locate the atria, ventricles, septum, valves, vena cavae, aorta, major arteries, major veins, parts of the conduction system, coronary arteries, cardiac veins
7. Demonstrate the path of the flow of blood through the heart, lungs, and periphery
8. Compare and contrast the structure of the walls of arteries, veins, and capillaries
9. Relate blood pressure to peripheral resistance
10. Relate oxygenation of tissues to cardiovascular structure and function

11. Draw a schematic model of the cardiovascular system
12. Predict the outcome of failure at various points in the schematic model
13. Solve the "crime" using acquired knowledge of the cardiovascular system
14. Write a persuasive essay defending the conclusions and present this argument to the "jury"

Strategies

Students will develop their own scientific investigations into the cause of death in the form of soliciting information from the coroner and examining evidence in ways they have previously learned in forensics class. They will have to decide what questions to ask the coroner and how to use the information they receive.

Students will be given a detailed scenario of a possible crime scene. Physical "evidence" taken from the scene will be supplied, such as fibers, hairs, possible "blood" stains, found objects, along with sketches and measurements. A man is found dead at home, but so far the "coroner" can only say that the cause of death is cardiac arrest. But the plot will thicken. The teacher plays the role of the coroner, giving out only bits of information, which will drive the details of further investigation. Through directed discussion, the "coroner" discovers that her CSI's need to know what goes right in the cardiovascular system before they can determine what went wrong.

The first lessons are devoted to learning about the anatomy of the cardiovascular system. Several types of media will be employed. There are many excellent videos and interactive websites illustrating the structure and function of the cardiovascular system. Students will explore these as a group and individually. Students will conduct independent research centered on specific questions and then produce a large schematic drawing of the anatomy of the heart and the path of blood circulation. This schematic will be used over the course of the unit. As the "coroner" releases more information from the "autopsy" the students will focus on particular areas of the anatomical schematic that have been disrupted and predict the functional outcomes leading up to the "victim's" cardiac arrest.

After establishing a basic knowledge of the anatomy we will trace the path of blood by playing "The Heart Game". Each student becomes a part of the heart (atria, ventricles, valves), the aorta, the vena cavae, the right and left lung, the brain and the feet. All other students become oxygenated or deoxygenated blood cells. Students wear signs with their "parts" drawn and labeled. "Circulating" red blood cells carry red or blue cardboard "cells" to indicate whether or not they are "oxygenated". It is the job of the "heart" to direct the flow of blood correctly. The "lungs" must exchange the blue cells for red cells. The "brain" and "feet" must use the oxygen and exchange the "red" cells for "blue" cells. This is performed "at rest" and then while "exercising". All the while the "valves" are calling out "lub" and "dub" at the right time. It's very interesting to see if the heart can keep up with the demand for oxygen! Roles are traded so that all students get to "circulate" and be part of the heart.

Subsequent lessons deal with the maintenance of blood pressure, the role of the coronary arteries, and the pacemakers of the heart, and oxygen exchange.

Students will construct a large poster of their biomechanical models of the cardiovascular system within a specific rubric. They will use their biomechanical schematics to predict the results of interruption in various areas of their models. They can start to form their hypotheses of how the cardiac arrest occurred or continue to question the coroner. As the coroner supplies more information the specific cause of the cardiac arrest will become clear. Students will have to decide if a crime was committed. They will then tackle the final project, a persuasive essay and presentation to the jury, defending their argument as to what happened, with facts and evidence.

I have designed this unit to take into account different learning styles and different abilities. The "Heart Game" is directed at tactile-kinesthetic learners in particular. The game can be played both at the beginning and end of the unit so that students can see how they have mastered the subject matter as their travels as blood cells become much smoother. This game can be modified for students of any grade by making the path of the blood cells more or less complex. The "blood cells" can travel only through the left and right sides of the heart and through the lungs for a simpler route for younger students or it can travel through the atria, ventricles, valves, to the brain, lungs, kidneys and feet, or other organs for a more complex route.

Students who have difficulty with writing or verbal expression have the opportunity to demonstrate their knowledge by creating the schematic drawing. Reading and writing in the sciences are extremely important and I have included practice in the form of a persuasive essay. Presentation skills are also practiced in this unit.

Classroom Activities

Lesson 1

The goal of this lesson is to set the stage for the investigation of the cardiovascular system by investigating the suspicious death of Mr. A. V. Korotkoff. It is essentially a guided discussion and brainstorming session in which students will have to come up with questions and then do research to answer their own questions.

Students are presented with the following scenario:

Mrs. Purkinje Korotkoff returned home from work at approximately 4:00 pm on Monday. When she entered the bedroom she found Mr. A. V. Korotkoff fully clothed lying on his back on the neatly made bed. She first thought that he was sleeping but on closer look saw that his color was "awful". She realized he was dead and called 911. Inspector Decter arrived with the police within minutes. Mrs. Korotkoff was relatively calm as she told the inspector that her husband had gotten a ride to work with his friend, Ivan Intima, this morning because Ivan wanted to show Mr. Korotkoff his new, bright yellow, extremely fast, Lotus Elise. She had left for her 7:00 to 3:00 shift as a nurse a few minutes after they "took off" and had just returned home. She told Inspector Decter that her husband was healthy and had not seemed different at all this morning. Inspector Decter asked the officers to secure the scene as she found this to be a puzzling and suspicious death.

The bedroom was neat and clean without signs of a struggle. Mr. Korotkoff was on his back with his head partly on the pillow on his side of the bed. His shoes were on. There were no obvious wounds nor was there any blood. The officers found some black fibers on his shoes and pants cuffs.

Mr. Intima was questioned and told Inspector Decter that he had picked up Mr. Korotkoff to drive him to work in his new sports car as they had agreed the previous day. He was eager to show off its speed and handling on the curves of the highway. After a few minutes Mr. Korotkoff told Ivan that he didn't feel well and asked him to drive him back home. Ivan, not wanting to be late for his own job, drove very fast back to Mr. Korotkoff's house and dropped him off. In fact there were skid marks approaching the driveway of the Korotkoff's house. Ivan then went to work and appeared shocked to hear that his friend was dead. Officers inspected the Lotus for evidence and found some brown hairs on the passenger seat head rest and some blonde hairs on the passenger seat.

After the scene was documented and evidence collected, Mr. Korotkoff's body

was examined downtown by the coroner, Jay Newcomer. It was his first week on the

job. His preliminary report indicated that the toxicology screen was negative and the

cause of death was cardiac arrest. The approximate time of death was given as 7:00

a.m. Inspector Decter's instincts told her that something was amiss, but she would

have to wait for more information from Newcomer, when he performed the autopsy.

After reading and studying the scenario the teacher will ask the class the essential question, "What does cardiac arrest mean?" Cardiac arrest is a general term which means that the heart has stopped its' function. Through guided discussion students will come up with a list of more specific causes of cardiac arrest such as heart attack, arrhythmia, trauma, blunt or sharp, or poisoning. As this point the teacher will indicate that as a group we need to know how the anatomy and physiology of the cardiovascular system so that we can know what kind of questions to ask the coroner and the witnesses and what other kind of information we need to find out about Mr. Korotkoff and the circumstances of his death.

Goal

The goal of this lesson is to initiate discussion of the possible causes of cardiac arrest and have that discussion lead the students into investigation of the cardiovascular system.

Objectives

1. Make careful and precise observations of a phenomenon or problem

2. Consider a hypothesis or possible solution to the problem using inductive reasoning, past experience, and creativity

3. Design a method for testing a hypothesis

4. Evaluate evidence obtained from testing

5. Draw a conclusion based on evidence

Materials

Copies of the above scenario, paper and pencil are needed for this lesson.

Anticipatory Set

The death scenario serves as the anticipatory set for this lesson.

Procedure

The procedure is the carefully lead class discussion. At the end of this discussion students will have been able to list the parts of the cardiovascular system that they will need to investigate in order to determine what went wrong with Mr. Korotkoff's heart. The list should include the anatomy of the heart and major vessels, the

function of the heart as muscular pump, the nature of blood itself, the path of the blood, the working of the electrical system of the heart, the maintenance of blood pressure, and the process of oxygenation of tissues including the heart itself. The class should be able to generate it's own list of learning objectives 6 through 10 (above). The class will then be separated into groups and each group given a topic for research and presentation to the class.

Closure

The lesson closes with a compilation of a set of questions the students want answered, such as, "Did Mr. Korotkoff take any medication when his friend dropped him off?",

"What time did Mr. Intima and Mr. Korotkoff leave for work?", or "What was Mr. Korotkoff's medical history?", "What color hair does Mrs. Korotkoff have?", and "What did the crime lab determine the black fibers from Mr. Korotkoff's pants to be?". These questions are only limited by students' imaginations and are usually extremely thoughtful and pointed.

Assessment

Assessment will be based on the level of class participation in this discussion.

Homework

1. Why is our victim named Korotkoff?
2. What is the meaning of his wife's unusual first name?
3. Is there any significance to any of the other names in this story?
4. What is the difference between a coroner and a medical examiner? What are the educational requirements for each position?

Lesson 2

The second lesson of this unit consists of a web research project. There are so many excellent websites with animations and three-dimensional views of the cardiovascular system now. Teachers may also have access to plastic models of the chest or heart. The class is divided into groups and each group has a set of questions for its particular topic. Each group will be responsible for a clear presentation of information to the group as a whole. The teacher is responsible for ensuring the information is correct and complete.

Additionally, more information will be given about the "case". Students will be formulating, testing with new evidence, and reformulating hypotheses as to what happened to Mr. Korotkoff throughout this and subsequent lessons.

Goal

The goal of lesson 2 is to have students research information about the normal structure and function of the cardiovascular system and share the information with each other. This will give them the basis to predict what might happen if normal structure and function are disrupted and compare their predictions to evidence from the case.

Objectives

1. Name and locate the atria, ventricles, septum, valves, vena cavae, aorta, major arteries, major veins, parts of the conduction system, coronary arteries, cardiac veins
2. Demonstrate the path of the flow of blood through the heart, lungs, and periphery
3. Compare and contrast the structure of the walls of arteries, veins, and capillaries
4. Relate blood pressure to peripheral resistance
5. Relate oxygenation of tissues to cardiovascular structure and function

Materials

Access to the internet is needed for this lesson. Students should preferably work in small groups in the computer lab or library-media center if possible. Anatomy and physiology books and atlases should be available as well.

Anticipatory set

Answers to the homework questions from Lesson 1 will be discussed and used to lead into this lesson. Korotkoff sounds are the sounds that one hears through the stethoscope when measuring blood pressure with a sphygmomanometer. Purkinje is the name of conductive fibers in the heart. Intima alludes to the inner layer of blood vessels.

Procedure

A set of questions is given to each group. Students are encouraged to start with the websites listed below in the student resource section of the bibliography. They are encouraged to play the animations, work through the tutorials, and thoroughly research their questions. They will have time to put together a presentation for the class. Students can pick one website animation or picture to show with their presentation as a visual aid. Teachers will determine the number of class periods devoted to group research. Some teachers may want to have students do independent research on some topics and present the other topics to the class.

Group 1-Anatomy of the Heart and Great Vessels

1. Name and locate the atria, ventricles, septum, valves, vena cavae, aorta, coronary arteries and cardiac veins, and the pericardium.

2. Why is the thickness of the right side of the heart less than that of the left side of the heart?
3. What accounts for the flow of blood in ONE direction?
4. Compare and contrast arteries, arterioles, capillaries, venules, and veins as related to their structure and function.
5. Describe the location and orientation of the heart within the chest.

Group 2- The Path of Blood Flow

1. What is meant by pulmonary and systemic circuits?
2. Trace the path of blood through the heart and major vessels, the pulmonary circuit, the systemic circuit, and the coronary arteries and veins (cardiac circuit).
3. Describe the relationship between pressure, flow and resistance in the pulmonary and systemic circuits. What is the average amount of blood in a human being?

Group 3- The Conduction System and Heart Sounds

1. Describe the intrinsic conducting system of the heart including the location and function of the SA node, AV node, bundle of His, bundle branches, and Purkinje fibers.
2. Relate the ECG waves to what is happening in the heart's conductions system.
3. Describe some changes that may be seen in the ECG of an abnormal heart.
4. Relate the first and second heart sounds (S1 and S2) to the events of the cardiac cycle.
5. What are heart murmurs?

Group 4- Causes of Cardiac Arrest

1. Describe what happens during a "heart attack". How can a heart attack cause death?
2. What is an arrhythmia? Describe several types of arrhythmias and how they can lead to death.
3. How can blunt trauma to the chest affect the cardiovascular system?
4. How can sharp trauma affect the cardiovascular system?

The questions for each group can be tailored for the depth of discussion of the cardiovascular system. Math can be added in by having students compute the cardiac output. The end-diastolic volume of the ventricle (when it is full) minus the end-systolic volume of the ventricle (when it is "empty") is equal to the stroke volume. The stroke volume multiplied by the heart rate equals the cardiac output (in liters/min). Different conditions affect the cardiac output. Chemistry and biochemistry can be introduced by talking about hemoglobin and the role of iron in the oxygenation and deoxygenation of the blood. Students should be given adequate time to master their topics and prepare their presentations for their classmates. It is the teacher's role to tie together the threads of the groups' presentation into a coherent whole.

Closure

Each lesson will close with some additional evidence, physical or testimonial, from the case. Students should rethink their hypotheses about the cause of death in relation to the presentations and new evidence. We now learn that Coroner Newcomer has noticed that there is lividity on the buttocks and backs of the thighs and the feet. He has also noticed a slanted linear bruise across the middle of the chest about 8 cm wide and 16 cm long. Mrs. Korotkoff tells Inspector Decter that her husband had been hit in the chest with a softball during practice before his regular Thursday evening game (Mr. Intima was the pitcher). She claimed that at the time he seemed fine and did not seek any treatment, nor did he mention it to her at all over the weekend. Newcomer seemed confused because the bruise looked more "strap-like" than rounded and was probably more recent. He has not yet been able to perform an autopsy because he is "up to his elbows in dead bodies". The trace lab has identified the black fibers on Mr. Korotkoff's shoes and cuffs as being consistent with the carpet fibers of a 2007 Lotus Elise automobile.

Assessment

Students will be assessed on their participation in their groups' research and presentation. Written answers to the questions will be turned in as well. They will also be assessed on their participation in discussions relating cardiovascular anatomy and physiology to the specifics of the "case".

Homework

Students will be working on this lesson at home as well as in school to ensure that they are prepared to participate maximally in the group work.

Lesson 3

The Heart Game provides a kinesthetic method for demonstrating and understanding circulation and is fun. It is a game I made up many years ago when I was a student teacher. It can be modified for any student group from elementary to high school or college by adding or removing organs or parts of the circulatory system to make the path of blood flow more or less complicated.

Goal

The goal of Lesson 3, "The Heart Game", is to solidify students' understanding of the path of circulation of blood.

Objectives

Demonstrate the path of the flow of blood through the heart, lungs, and periphery

Materials

Materials needed for this lesson are a large space where the class can move around without bumping into desks or other objects, construction paper, markers, string, and imagination.

Anticipatory Set

Students are asked to think about what it might be like to be a red blood cell speeding along a person's circulatory system. Is it like the water slides at Lake Compounce? Did they watch *The Magic School Bus* when they were younger? One might want to get a copy of the old movie *Fantastic Voyage* to show during this unit.

Procedure

Teachers will make signs or pictures out of construction paper for the brain, left and right lungs, feet, left and right atria, and left and right ventricles. For high school classes I will also make signs for the superior and inferior vena cavae, the aorta, and the pulmonary artery. To make the path of circulation even more complex one can include the valves and through in any other organ systems like the kidneys or digestive tract. One student is picked to be each part of the circulatory system and wears their sign/picture around their neck with string or yarn to have their hands free. (Teachers can enlist their colleagues in the art department for help in making the construction paper organs or cells.)The rest of the class is given red blood cells made out of red or blue construction paper, symbolizing oxygenated or deoxygenated blood. It is important to make sure that students understand that venous blood is not actually blue, but that the colors red and blue are a convention to indicate oxygenated or deoxygenated blood in drawings and cartoons. This was a misconception I have had to clear up with several classes.

The students are placed with the "head" and "feet" at opposite ends of the room. Each has a supply of deoxygenated (blue) red blood cells. The heart parts position themselves correctly. The red and blue blood cells line up and need to start circulating CORRECTLY. If they are deoxygenated they have to get to the right heart to be sent to the lungs and if they are oxygenated they have to get to the systemic circulation to bring oxygen to the brain and the feet. The brain and the feet take the oxygenated blood (red construction paper cells) and give the circulating students deoxygenated blood (blue construction paper cells). The students who are the parts of the heart must guide the circulating "blood" along the correct path. When they get to the lungs they exchange their blue cells for red cells, to take back into circulation. Meanwhile the brain and feet might be getting faint or crampy! The body may start exercising so that the heart has to circulate the blood faster! Traffic may be held up in an area and a CLOT might start to form! If some students are playing the roles of the valves they must yell "lub" and "dub" at the correct times. The teacher collects the "used" blood and returns red construction paper cells to the lungs and blue construction paper cells to the organs. Students exchange places so that all get to be a part of the heart or organ and all get to circulate. This game is always a hit with students and teachers alike.

Closure

The class can discuss their experience with the heart game and ask and answer questions about the path of blood circulation.

Inspector Decter also delivers more information regarding the suspicious death of Mr. A.V. Korotkoff.

Apparently, the brown hairs found on Mr. Intima's passenger seat headrest are consistent with hairs from Mr. Korotkoff's head and the blonde hairs found on the passenger seat appear to be consistent with blond hairs taken from Mrs. Korotkoff. Additionally, the inspector has learned that Mrs. Korotkoff works in the office of Dr. Archie Orta, a leading cardiologist. She denies having been in the Lotus and suggests that her blond hair was on her husband's shirt because they hugged and kissed before he left for work. Coroner Newcomer will be doing the autopsy tomorrow and Inspector Decter plans to attend.

Assessment

Students are assessed on their observed participation in the exercise.

Homework

Students are to continue to refine their thoughts on the cause of death of Mr. Korotkoff and formulate further questions. They are also to study all notes and materials obtained thus far in the unit in preparation for drawing their schematic diagrams of the circulatory system.

Lesson 4

Goal

The goal of Lesson 4 is to provide an alternate assessment (as opposed to a written examination) of students' understanding of the anatomy and physiology of the cardiovascular system.

Objective

11. Draw a schematic model of the cardiovascular system

12. Predict the outcome of failure at various points in the schematic model

Materials

Students will need poster board, pencils, erasers markers, colored pencils, construction paper, scissors, glue, rulers, and other art supplies.

Anticipatory Set

Students will have been studying the information they obtained from their own and their classmates' presentations and class discussions.

Procedure

Students will draw a large, clear schematic drawing of the circulatory system. This is a graphic linear drawing with symbols depicting the parts of the circulatory system and path of blood flow, not an anatomical drawing with perspective. It is rather like a road map or circuit drawing to diagram the flow of blood through the parts of the heart. It should be clearly labeled and easy to follow. It should be neat and colorful. Depictions of the following MUST be included: the right and left atria, the right and left ventricles, the aorta, the pulmonary artery, the pulmonary vein, the superior vena cava, the inferior vena cava, the triuspid valve, the mitral valve, the pulmonary valve, the aortic valve, the path of the pulmonary circuit, the path of the systemic circuit, the path of the cardiac circuit, a depiction of the electrical system (SA node, AV node, bundle of His, bundle

branches, purkinje fibers, internodal pathways). The student will pick THREE possible problems that can occur in the cardiovascular system, indicate these on their schematic, and give a brief explanation of the results of disruption of the system at that point.

Closure

Inspector Decter finds out that Mr. Korotkoff did not want to worry his wife but did see

Dr. Orta on Friday during her lunch break, because he had a little discomfort from the softball injury. Dr. Orta took an x ray of his chest. Mrs. Korotkoff found the x ray and the doctor's interpretation when she came back to the office. There was a suspicion of a slight widening of the mediastinum and Dr. Orta wanted Mr. Korotkoff to have a follow-up MRI on Monday to take a closer look at the heart and great vessels. Inspector Decter tells Mr. Newcomer to be very careful and exact when he opens Mr. Korotkoff's chest for the autopsy, which unfortunately has to be postponed one more day.

Assessment

The schematic drawings will be assessed on completeness, accuracy and clarity, lack of error, and creativity.

Homework

Students will research the significance of and possible causes of "widening of the mediastinum." They will continue to try to solve the "case" of Mr. Korotkoff's suspicious death.

Lesson 5

By this time students have come up with multiple theories and hypotheses as to Mr. Korotkoff's cause of death and whether or not a crime has been committed. Depending on the teachers' or courses' focus, forensic science labs such as hair and fiber identification can be added to the unit. Students also could be asked to describe how the scene should have been documented and evidence collected, preserved and transported. They should answer questions as to the significance of the pattern of livor mortis on the body and how the coroner determined the approximate time of death.

Students who do their homework should find that a widened mediastinum on x-ray can be indicative of an aortic aneurysm. An aneurysm is a weakness in the wall of a vessel, which can rupture or tear. Since the aorta is the largest blood vessel with blood under relatively high pressure, a tear or rupture of the thoracic aorta is generally fatal.

Up to 15% of all deaths following motor vehicle collisions are due to injury to the thoracic aorta. Many of these patients are dead at the scene from complete aortic tear. But with our modern life support methods and quick transportation to trauma centers patients can survive. Survivors usually have small tears or partial-thickness tears of the aortic wall.

Most blunt aortic injuries occur in the thoracic aorta, that part of the aorta in the chest, rather than in the abdomen. The thoracic descending aorta is at greatest risk from the shearing forces of sudden deceleration. This is because the relatively mobile aortic arch can move against the descending aorta which is fixed by the ligamentum arteriousm. In a sudden deceleration the mobile aortic arch tends to continue its' forward motion while fixed descending aorta stops suddenly, creating a shearing force. Thus the aorta is at greatest risk in frontal or side impacts, and falls from great heights. Other postulated mechanisms for aortic injury are

compression between the sternum and the spine, and sudden increases in intra-aortic pressure at the moment of impact.

Goal

The goal of Lesson 5 is to give students an opportunity to practice writing a persuasive essay. They will use their accumulated knowledge of this unit to formulate and support a hypothesis of the cause of death of Mr. Korotkoff and support their hypothesis with evidence.

Objective

1. Solve the "crime" using acquired knowledge of the cardiovascular system
2. Write a persuasive essay defending the conclusions and present this argument to the "jury"

Materials

No materials other than paper and pen or pencil are needed. Students can use all of their notes from the unit.

Procedure

Students will write a persuasive essay from the point of view of an investigator presenting evidence to a grand jury to see if they can get an indictment for a crime of murder. The structure of the essay is as follows:

1. Introduction-one or two paragraphs summarizing the facts of the case being sure to keep events in sequence
2. Hypothesis as to what/who caused the death of Mr. Korotkoff
3. Evidence- three or more paragraphs, each citing one piece of evidence which supports your hypothesis
4. "Con" side-a paragraph describing one or two pieces of evidence which may conflict with or do not "fit" your hypothesis (you must always be aware of the "other" side)
5. Summary- your views and conclusions based on the arguments you have already presented.
6. References-list references for all sources used

Closure

Mr. Newcomer has finally gotten over his initial fright and has performed the autopsy on Mr. Korotkoff. Inspector Decter observes the bruise on Mr. Korotkoff's chest and muses that it looks like the imprint of a

seatbelt. On opening the chest Mr. Newcomer finds that that Mr. K had an aortic aneurysm, which had ruptured. Inspector Decter confronts Mrs. Korotkoff with this information. He tells her that her hair could not have come from her husbands' shirt as it had skin tags at the root, indicating that it had been pulled. He accuses her of catching her hair behind her husband's limp body when she and her lover, Mr. Intima, carried him from the Lotus to the bedroom. Because she is a cardiac nurse she understood the significance of her husband's x-ray findings and couldn't wait to tell Ivan of her plan. Ivan spent the weekend combing posh rental car agency websites looking for just the right vehicle. Mrs. Korotkoff breaks down crying and admits the truth. The softball to the chest was truly an accident but when she saw her husband's x-ray she suspected he had an asymptomatic aortic aneurysm. She and Ivan figured they would try to cause a tear by having Mr. K experience a sudden deceleration injury in the Lotus Elise. Hence the skid marks near their driveway. Mr. K did die in the car and sat there for a time while the plotters decided what to do and what story to tell. Hence the lividity in the buttocks, thighs and feet, rather than along the whole back of the body.

Hopefully, the students' hypotheses of what happened will mirror Inspector Decter's

solution of the case.

Assessment

Students' persuasive essays will be evaluated according to the guidelines in the procedure. Students will not lose credit for an incorrect conclusion as long as their evidence supports their conclusion.

Bibliography

Deslich, Barbara and John Funkhouser. *Forensic Science for High School.* Dubuque, Iowa: Kendall/Hunt Publishing Co. 2006

A new and excellent general forensics text for high school students. Chapters 1 through 3 especially helpful for an introduction to forensic science.

Lazaroff, Michael. *The Complete Idiots' Guide to Anatomy and Physiology.* Indianapolis, IN: Alpha Books. 2004

Lee, Dr. Henry C., George M. Taft, and Kimberly A. Taylor. *Forensic Science Today.* Tucson, AZ: Lawyers & Judges Publishing Company, Inc. 2006

New Haven's famous Dr. Lee has written a textbook for high school students, which is concise, complete, and inexpensive. It has an excellent teachers' resource CD-ROM.

http://www.msjensen.gen.umn.edu/webanatomy

This site is an interactive study guide in the form of games, covering all aspects of anatomy and physiology. Especially useful for high school students and teachers

http://www.k12station.com/k12link_library.html?subject=NHS&sub_cat=103536&final=103537

This site gives a comprehensive list of many excellent multimedia presentations of the cardiovascular system geared for high school students.

http://www.medtropolis.com/VBody.asp

Interactive anatomy and physiology website.

http://www.pbs.org/wgbh/nova/heartmap.html

Take a tour through the heart or use the interactive portion of the site. Also addresses pathology and treatment.

http://www.medphys.ucl.ac.uk/teaching/undergrad/projects/2003/group_03/how.html

An explanation of Korotkoff sounds during the measuring of blood pressure.

http://timss.bc.edu/timss2003.html

Extensive information about the Trends in International Mathematics and Science worldwide studies

http://www.trauma.org/archive/thoracic/CHESTaorta.html

Information about trauma to the chest.

Student Resources

http://innerbody.com

An interactive website which shows the anatomy of all of the organ systems. Scroll over parts to read their names.

http://webschoolsolutions.com/patts/systems/heart.htm

An excellent source for information about the cardiovascular system with animation and interactivity for students. It also has many links to other sites.

http://www.texasheartinstitute.org/HIC/Anatomy/anatomy2.cfm

Excellent tutorials about cardiovascular anatomy and physiology, along with information about EKG's, heart sounds.

http://www.gwc.maricopa.edu/class/bio202/cyberheart/cardio.htm

http://www.wits.ac.za/radar/PDF%20files/cardiovascular.pdf

http://filer.case.edu/-dck3/heart/intro.html

http://www.getbodysmart.com/ap/circulatory/menu/circulatory.html

The above four resources are excellent tutorial sites for students.

Teacher resources

www.csn.edu/science/biology/anatomy/anatomy.html

A resource for science teachers in any subject, which includes teaching strategies, activities, and internet resources. This site is useful for students in the upper grades as well.

http://science.nhcmccd.edu/BIOL/ap2.html

A large selection of websites offering dissections and animations in anatomy and physiology, cardiology, digestive system, AIDS, and nutrition.

www.uh.edu/sibs/tutorial/index/htm

Tutorials, websites and other resources from the University of Houston, Texas, for biology, anatomy and physiology, genetics, biochemistry and microbiology.

http://www.youthlearn.org/learning/approach/inquiry.asp

A website with extensive information about developing inquiry-based curricula and projects.

http://www.biology.duke.edu/cibl/

Duke University professor Steve Wainwright's website for the Center for Inquiry Based Learning.

http://www.thirteen.org/edonline/concept2class/inquiry/index.html

PBS website with an interactive workshop on inquiry-based learning.

http://apps.exploratorium.edu/10cool/index.php?cmd=browse&category=10

An amazingly cool website with access to unique and unusual resources for K-12 educators on every scientific subject.

www.accessexcellence.org

An extensive website with resources for Health and Bioscience teachers, including a graphics library, student activities, and up to the minute health information.

Appendix A

National Science Education Standards

LS 5d: The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
UCP 1: Systems, order, and organization
UCP 2: Evidence, models, and explanation
UCP 5: Form and function
SAI 1: Abilities necessary to do scientific inquiry
SAI 2: Understandings about scientific inquiry
ST 1: Abilities of technological design
ST 2: Understandings about science and technology

SPSP 1: Personal and community health
SPSP 3: Natural resources
HNS 2: Nature of scientific knowledge
HNS 3: Historical perspectives

Appendix B

Implementing National Science Education Standards for Inquiry Based Learning Through the Teaching of Forensic Science Science as Inquiry

- Abilities necessary to do scientific inquiry

-- Communicate investigations and explanations.
-- Develop descriptions, explanations, predictions, and models using evidence.
-- Think critically and logically to make the relationships between evidence and explanations.
-- Recognize and analyze alternative explanations and predictions.

Content Standards

- Quality Teaching

-- Deepens educators' content knowledge, provides them with research-based instructional strategies to assist students in meeting rigorous academic standards, and prepares them to use

various types of classroom assessments appropriately. (NSDC)

Teaching Standards

- Teachers of science plan an inquiry-based science program for their students.

-- Work together as colleagues within and across disciplines and grade levels.

- Teachers of science guide and facilitate learning. In doing this, teachers

-- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.
-- Focus and support inquiries while interacting with students.
-- Orchestrate discourse among students about scientific ideas.

- Teachers provide students with the time, space, and resources needed to learn science.

-- Structure the time available so that students are able to engage in extended investigations.
-- Identify and use resources outside the school.