the beat
goes on

a comprehensive look
at heart structure,
function, and health
The DESTINY Traveling Science Learning Program developed *The Beat Goes On: A Comprehensive Look at Heart Structure, Function, and Health* with support from the National Center for Research Resources of the National Institutes of Health through a Science Education Partnership Award (Fed. Grant #1 R25 RR016306) to Dr. Amber Vogel, Director of Widening Horizons in Science Education (WHISE) at the University of North Carolina at Chapel Hill. The contents of this module are the responsibility of the authors, and do not necessarily represent the official views of NCRR or NIH. Additional support for dissemination of the module, through teacher professional development and materials for hands-on learning in classrooms, was provided by Medtronic, Inc.

The DESTINY Traveling Science Learning Program (www.moreheadplanetarium.org/go/destiny) is a science education outreach initiative of Morehead Planetarium and Science Center at UNC-Chapel Hill that serves pre-college teachers and schools across North Carolina. DESTINY develops and delivers a standards-based, hands-on curriculum and teacher professional development with a team of educators and a fleet of vehicles that travel throughout the state.

DESTINY has been supported in part by the State of North Carolina; grants from GlaxoSmithKline, the Howard Hughes Medical Institute, and the National Aeronautics and Space Administration; and a Science Education Partnership Award from the National Center of Research Resources, part of the National Institutes of Health. Additional support has come from Bio-Rad, IBM, Medtronic, and New England BioLabs.

© 2007, 2008 The University of North Carolina at Chapel Hill, through its Morehead Planetarium and Science Center. The University of North Carolina at Chapel Hill grants teachers permission to reproduce materials from this curriculum guide for classroom use only, without alteration, provided all copies contain the following statement: “© The University of North Carolina at Chapel Hill, through its Morehead Planetarium and Science Center. This work is reproduced solely for classroom use with the permission of The University of North Carolina at Chapel Hill, through its Morehead Planetarium and Science Center. No other use is permitted without the express prior written permission of Morehead Planetarium and Science Center of The University of North Carolina at Chapel Hill. To request permission, contact The DESTINY Program (Morehead Planetarium and Science Center’s outreach initiative at UNC-Chapel Hill), CB# 7448, Morehead Planetarium and Science Center Annex, UNC-Chapel Hill, Chapel Hill, NC 27599-7448.”
LOCATION OF FIGURES

Figure 1: Size and Location of the Heart .............18
Figure 2: Evolution of the Heart .........................19
Figure 3: Coronary Arteries ...............................20
Figure 4: Coronary Artery Disease
and Treatment ..................................................23
Figure 5: External View of the Heart ..............36
Figure 6: Internal View of the Heart ................37
Figure 7: Heart Regulation .................................38
Figure 8: Internal View of the Heart
(Diagram 1) WORKSHEET .....................40
Figure 9: Internal View of the Heart
(Diagram 2) WORKSHEET ............................41
Figure 10: Heart Regulation WORKSHEET .......42
Figure 11: Flow of Blood through
the Heart WORKSHEET .................................51
Figure 12: Waveforms in an EKG ........................59
KEY TERMS

**aerobic exercise** — exercise that can improve functional ability and possibly reduce symptoms of heart disease.

**angina** — discomfort or pressure, usually in the chest (may also be felt in the neck, jaw, or arms), caused by a temporarily inadequate blood supply to the heart muscle.

**angiography** — technique of inserting a catheter for an X-ray examining the blood vessels connected to the heart.

**angioplasty** — surgical procedure that can open the artery with a balloon and then, if indicated, install a stent (a scaffold-like device) to help keep the vessel open.

**angiotensin-converting enzyme inhibitors (ACE inhibitors)** — a group of drugs used to treat high blood pressure and heart failure. ACE inhibitors block a specific enzyme (ACE or angiotensin-converting enzyme) that retains salt in the kidney and can cause heart and blood pressure problems.

**angiotensin II receptor blockers (ARBs)** — group of drugs used to treat high blood pressure

**anticoagulant** — blood thinner; medication that prevents blood from clotting; used for people at risk for stroke or blood clots

**aorta** — major artery that transports oxygenated blood away from the heart to the body

**aortic valve** — last valve through which blood passes before it enter the aorta

**arrhythmia** — abnormal or irregular heart beat. (See bradycardia and tachycardia.)

**arteries** — vessels that carry blood away from the heart.

**atria** — upper chambers of the heart that receive blood from the veins

**atherosclerosis** — commonest form of arteriosclerosis or “hardening of the arteries.” A complicated disease in which a buildup of fatty deposits within the walls of the arteries restricts, and sometimes blocks completely, the flow of blood to the body’s vital organs.

**atrioventricular (AV) node** — group of special cells located near the center of the heart (atrioventricular junction) that helps to regulate the heart rhythm. Here, the electrical current slows for a moment before going on to the ventricles.

**atrial fibrillation (AF)** — irregular heart rhythm in which many impulses begin and spread through the atria; resulting rhythm is disorganized, rapid, and irregular, and the atria are not able to fully empty their contents into the ventricles.

**atrium** — two upper chambers of the heart known as the left and right divided by a muscular wall (septum); The atrium contracts before the ventricle to allow optimal filling of the ventricle.

**beta-blocker** — drug that slows heart rate, lowers blood pressure, and controls angina

**bicuspid valve** — valve with two leaflets (cusps)

**blood pressure** - the pressure the blood exerts against the inner walls of the blood vessels. (See diastolic and systolic.)

**body mass index (BMI)** — number that reflects body weight adjusted for height.

**bradycardia** — slow heart rate of less than 60 beats per minute.

**bundle branch** — part of the electrical pathway of the heart that delivers electrical impulses to the ventricles

**bundle of His** — electrical impulses normally start in the sinoatrial or SA node and travel to the atrioventricular or AV node; the impulse then goes to the bundle of His. The bundle divides or branches into a right bundle and a left bundle. The bundles take the impulse through the ventricles (bottom chambers) to cause them to contract. Named after Wilhelm His (1863-1934), the Swiss doctor and researcher who discovered them in 1893.

**bypass surgery** — surgeons take a segment of a healthy blood vessel from another part of the body and make a detour around the blocked part of the coronary artery.
**calcium channel blocker** — drug that reduces spasm of blood vessels, lowers blood pressure, and controls angina; acts by selectively blocking the uptake of calcium by the cells.

**capillary** — minute blood vessel connecting arterioles with venules.

**cardiac cycle** — sequence of events encompassing one complete contraction and relaxation of the heart’s atria and ventricles.

**cardiac catheterization** — procedure to diagnose heart disease. A catheter is guided into the heart, a contrast dye is injected, and X-rays of the coronary arteries, heart chambers, and valves are taken.

**cardiologist** — a doctor that specializes in the treatment of heart disease.

**cardiomyopathy** — refers to a disease originating in the cardiac muscle itself, as opposed to cardiac valves or arteries. The cause of cardiomyopathy is frequently unknown.

- dilated cardiomyopathy, commonest of three subtypes, can result from inflammation of the heart muscle due to a viral infection, or possibly an autoimmune process resulting in the body producing antibodies against its own heart muscle cells.
- hypertrophic cardiomyopathy can be an inherited condition resulting in an abnormal increase in size of the heart muscle; can develop at any point in life.
- restrictive cardiomyopathy, the least common form of cardiomyopathy, is a condition where the heart is unable to fill with blood because of stiffness.

**cardiac muscle** — specialized heart muscle; cardiac muscle is myogenic, meaning that it stimulates its own contraction without a requisite electrical impulse coming from the central nervous system.

**cardiovascular disease** — disease of the heart and blood vessels.

**chordae tendinae** — literally means “heart strings”; thin chords that provide support to the tricuspid and mitral valves of the heart, helping them to open and shut properly.

**catheter** — tube placed in the heart’s pulmonary artery in order to diagnose heart conditions.

**cholesterol** — fatty substance made by the body and found in some foods. Cholesterol is deposited in the arteries in coronary artery disease. (See LDL and HDL.)

**congestive heart failure (CHF)** — condition in which the heart muscle weakens and can’t pump blood efficiently throughout the body.

**congenital heart defect** — heart defect present at birth.

**coronary arteries** — network of blood vessels that branch from the aorta and supply the heart muscle with oxygen-rich blood.

**clot busters** — type of medicine given in the hospital through the veins (intravenous) to break up blood clots.

**C–reactive protein** — used as an indicator for heart disease, C-reactive protein is a test that measures the concentration of a protein in serum that indicates acute inflammation.

**defibrillator** — medical device used in the defibrillation of the heart. It consists of a central unit and a set of two electrodes. The central unit provides a source of power and control. The two electrodes are placed directly on or in the patient. The device is designed to deliver an electric shock to the patient, in an effort to stop ventricular fibrillation.

**diastolic** — the pressure when the ventricles are relaxed and the heart is filling.

**diuretic** — drug that enables the kidneys to rid the body of excess fluid; commonly referred to as a “water pill.”

**dorsal** — pertaining to back; posterior.

**echocardiogram (echo)** — imaging procedure that creates a moving picture of the heart’s valves and chambers using high frequency sound waves.

**electrocardiogram (EKG)** — a clinical procedure used for tracing the electrical activity of heart. When electrical currents are generated by the heart, they spread throughout the body and can be detected on the body’s surface and recorded by an electrocardiogram onto graph paper.
**exercise stress test** — provides information about how the heart responds to stress; usually involves walking on a treadmill or pedaling a stationary bike at increasing levels of difficulty, while the electrocardiogram, heart rate, and blood pressure are monitored.

**fibrin** — insoluble protein involved in blood clotting. When an injury occurs, fibrin is deposited around the wound in the form of a mesh, which dries and hardens, so that bleeding stops. Fibrin is developed in the blood from a soluble protein, fibrinogen.

**HDL** — high density lipoproteins; act as scavengers of cholesterol. HDL is known as “good” cholesterol because it deposits cholesterol in the liver, where it is excreted by the body. High HDL is thought to protect against coronary artery disease.

**heart attack (myocardial infarction)** — permanent damage to the heart muscle caused by a lack of blood supply to the heart for an extended time period.

**heart valves** — four valves in the heart (tricuspid and mitral valves, which lie between the atria and ventricles; and pulmonic and aortic valves, which lie between the ventricles and blood vessels leaving the heart) that help to maintain one-way blood flow through the heart.

**hypertension** — high blood pressure.

**hypotension** — low blood pressure.

**incompetent valves** — valve deformities that seriously hamper cardiac function by allowing backflow of blood.

**infarction** — tissue death due to the lack of oxygen rich blood.

**interatrial septum** — the wall of tissue that separates the right and left atria of the heart.

**interventricular septum** — the stout wall separating the lower chambers (the ventricles) of the heart from one another.

**LDL** — low density lipoproteins; deliver cholesterol and triglycerides to body cells for food storage; responsible for depositing cholesterol into the lining of the artery. Known as “bad” cholesterol because high LDL is linked to coronary artery disease.

**mitral valve** — valve lying between the left atrium and left ventricle (main pumping chamber of the heart); allows blood to flow from the left atrium into the left ventricle and then prevents the back flow of blood into the left atrium during ventricular contraction.

**myocardial infarction** — see heart attack.

**obesity** — condition of a person being overweight, and usually defined as having a body mass index (BMI) of 25 or higher.

**obstruction defect** (stenoses) — one of the valves or ventricles is narrowed to such a degree that it partially or completely blocks the flow of blood.

**pacemaker cells** — group of cells located in the SA node create rhythmical impulses and directly control the heart rate.

**patent ductus arteriosus** — defect that allows blood in the pulmonary artery and aorta to mix. Before birth, the ductus arteriosus is an open pathway between these two arteries; normally closes a few hours after birth.

**peripheral vascular disease** — refers to diseases of blood vessels outside the heart and brain. It’s often a narrowing of vessels that carry blood to the legs, arms, stomach or kidneys

**plasminogen activator (t-PA)** — anti-clotting agent that human cells naturally produce.

**platelets** — irregular cell fragments produced in the bone marrow and circulated in the blood and are involved in clotting.

**pulmonary circulation** — part of the cardiovascular system that carries oxygen-depleted blood away from the heart to the lungs, and returns oxygenated blood back to the heart.

**pulmonary vein** — transports oxygen-rich blood from the lungs to the left atrium; the only veins in the post-fetal human body that carry oxygenated blood.

**pulmonary valve (pulmonic valve)** — last valve through which the blood passes before it enters the pulmonary artery that lies between the right atrium and from the right ventricle.
**pulse rate** — number of heartbeats per minute. The resting pulse rate for an average adult is between 60-80 beats per minute.

**risk factors (for heart disease)** — traits that are linked to people’s development of coronary artery disease.

**septum** — muscular wall separating the right and left sides of the heart

**septal defects** — lets blood flow between the heart’s right and left chambers; also called “a hole in the heart.”

**sinoatrial node** — (also called SA node, SAN, or sinus node) is the impulse generating (pacemaker) tissue located in the right atrium of the heart.

**semilunar valve** — either of two valves, one located at the opening of the aorta and the other at the opening of the pulmonary artery. Each consists of three crescent-shaped cusps and serves to prevent blood from flowing back into the ventricles.

**statin** — group of drugs found to be effective in lowering cholesterol levels.

**stent** — small, stainless-steel mesh tube inserted after angioplasty; acts as a scaffold to provide support inside the coronary artery.

**stenosis** — narrowing or restriction of a blood vessel or valve; reduces blood flow.

**stroke** — sudden loss of brain function when blood flow to the brain decreases.

**stroke volume** — volume of blood ejected from a ventricle with each heartbeat.

**sudden cardiac arrest (SCA)** — results from an abrupt, unexpected stoppage of heart function that can cause abnormalities in the heart’s electrical system. Differs from a heart attack, which is caused by a blocked vessel leading to loss of blood supply to a portion of the heart muscle. People may experience SCA during a heart attack. A previous heart attack is a predictor of risk for future SCA.

**systemic circulation** — part of the cardiovascular system that carries oxygenated blood away from the heart to the body, and returns oxygen-depleted blood back to the heart.

**systolic** — the pressure in the arteries at the peak of ventricular contraction.

**tachycardia** — rapid heart rate, over 100 beats per minute.

**tricuspid valve** — valve separating the right atrium from the right ventricle; prevents blood from flowing back into the right atrium during contraction of the ventricle.

**triglycerides** — chemical form in which most fat exists in food as well as in the body. They’re also present in blood plasma and, in association with cholesterol, form the plasma lipids.

**thrombosis** — formation of a clot or thrombus inside a blood vessel, obstructing the flow of blood through the circulatory system.

**veins** — vessels that carry blood away from the tissues towards the heart.

**ventricles** — lower, pumping chambers of the heart. The heart has two ventricles (right and left).

**venae cavae** — veins that return the blood from the body into the heart; empty into the right atrium.

**SOURCES**


The Key Components of the 5E Model

<table>
<thead>
<tr>
<th>PHASE</th>
<th>WHAT THE TEACHER DOES THAT IS</th>
<th>Consistent with the 5E Model</th>
<th>Inconsistent with the 5E Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGAGE</td>
<td></td>
<td>• Creates interest</td>
<td>• Explains concepts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Generates curiosity</td>
<td>• Provides definitions and answers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Raises questions</td>
<td>• States conclusions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Elicits responses that uncover what students know or think about the concept/subject</td>
<td>• Provides premature answers to students' questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Lectures</td>
</tr>
<tr>
<td>EXPLORE</td>
<td></td>
<td>• Encourages students to work together without direct instruction from teacher</td>
<td>• Provides answers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Observes and listens to students as they interact</td>
<td>• Tells or explains how to work through the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Asks probing questions to redirect students' investigations when necessary</td>
<td>• Tells students they are wrong</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provides time for students to puzzle through problems</td>
<td>• Gives information or facts that solve the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Acts as a consultant for students</td>
<td>• Leads students step-by-step to a solution</td>
</tr>
<tr>
<td>EXPLAIN</td>
<td></td>
<td>• Encourages students to explain concepts and definitions in their own words</td>
<td>• Accepts explanations that have no justification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Asks for justification (evidence) and clarification from students</td>
<td>• Neglects to solicit students' explanations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Formally provides definitions, explanations, and new labels</td>
<td>• Introduces unrelated concepts or skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Uses students' previous experiences as the basis for explaining concepts</td>
<td></td>
</tr>
<tr>
<td>ELABORATE</td>
<td></td>
<td>• Expects students to use formal labels, definitions and explanations provided previously</td>
<td>• Provides definitive answers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Encourages students to apply or extend concepts and skills in new situations</td>
<td>• Tells students they are wrong</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reminds students of alternative explanations</td>
<td>• Lectures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Refers students to existing data and evidence and asks &quot;What do you already know?&quot;&quot;Why do you think . . . ?&quot;</td>
<td>• Leads students step-by-step to a solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Explains how to work through the problem</td>
</tr>
<tr>
<td>EVALUATE</td>
<td></td>
<td>• Observes students as they apply new concepts and skills</td>
<td>• Tests vocabulary words, terms and isolated facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Assesses students' knowledge and/or skills</td>
<td>• Introduces new ideas or concepts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Looks for evidence that students have changed their thinking or behaviors</td>
<td>• Creates ambiguity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Allows students to assess their own learning and group process skills</td>
<td>• Promotes open-ended discussion unrelated to concept or skill</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Asks open-ended questions, such as &quot;Why do you think . . . ?&quot;&quot;What evidence do you have?&quot;&quot;What do you know about x?&quot;&quot;How would you explain x?&quot;</td>
<td></td>
</tr>
</tbody>
</table>

(Trowbridge & Bybee, 1990), adapted by Biological Sciences Curriculum Study
### North Carolina Standard Course of Study for Biology — Grades 9-12

**Highlighted sections are objectives addressed in The Beat Goes On**

**Strands:** Nature of Science, Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives. The strands provide the context for teaching of the content Goals and Objectives.

**Competency Goal 1:**
The learner will develop abilities necessary to do and understand scientific inquiry.

**Objectives**

1.01 Identify biological questions and problems that can be answered through scientific investigations.
   - Create testable hypotheses
   - Identify variables
   - Use a control or comparison group when appropriate
   - Select and use appropriate measurement tools
   - Collect and record data
   - Organize data into charts and graphs
   - Analyze and interpret data
   - Communicate findings

1.02 Design and conduct scientific investigations to answer biological questions.
   - Create testable hypotheses
   - Identify variables
   - Use a control or comparison group when appropriate
   - Select and use appropriate measurement tools
   - Collect and record data
   - Organize data into charts and graphs
   - Analyze and interpret data
   - Communicate findings

1.03 Formulate and revise scientific explanations and models of biological phenomena using logic and evidence to:
   - Explain observations
   - Make inferences and predictions
   - Explain the relationship between evidence and explanation

1.04 Apply safety procedures in the laboratory and in field studies:
   - Recognize and avoid potential hazards
   - Safely manipulate materials and equipment needed for scientific investigations

1.05 Analyze reports of scientific investigations from an informed, scientifically literate viewpoint including considerations of:
   - Appropriate sample
   - Adequacy of experimental controls
   - Replication of findings
   - Alternative interpretations of the data

**Competency Goal 2:**
The learner will develop an understanding of the physical, chemical and cellular basis of life.

**Objectives**

2.01 Compare and contrast the structure and functions of the following organic molecules:
   - Carbohydrates
   - Proteins
   - Lipids
   - Nucleic acids

2.02 Investigate and describe the structure and functions of cells including:
   - Cell organelles
   - Cell specialization
   - Communication among cells within an organism

2.03 Investigate and analyze the cell as a living system including:
   - Maintenance of homeostasis
   - Movement of materials into and out of cells
   - Energy use and release in biochemical reactions
2.04 Investigate and describe the structure and function of enzymes and explain their importance in biological systems.

2.05 Investigate and analyze the bioenergetic reactions:
   - Aerobic respiration
   - Anaerobic respiration
   - Photosynthesis

**Competency Goal 3:**
The learner will develop an understanding of the continuity of life and the changes of organisms over time.

**Objectives**

3.01 Analyze the molecular basis of heredity including:
   - DNA replication
   - Protein synthesis (transcription, translation)
   - Gene regulation

3.02 Compare and contrast the characteristics of asexual and sexual reproduction.

3.03 Interpret and predict patterns of inheritance.
   - Dominant, recessive and intermediate traits
   - Multiple alleles
   - Polygenic inheritance
   - Sex-linked traits
   - Independent assortment
   - Test cross
   - Pedigrees
   - Punnett squares

3.04 Assess the impact of advances in genomics on individuals and society.
   - Human genome project
   - Applications of biotechnology

3.05 Examine the development of the theory of evolution by natural selection, including:
   - Development of the theory
   - The origin and history of life
   - Fossil and biochemical evidence
   - Mechanisms of evolution
   - Applications (pesticide and antibiotic resistance)

**Competency Goal 4:**
The learner will develop an understanding of the unity and diversity of life.

**Objectives**

4.01 Analyze the classification of organisms according to their evolutionary relationships.
   - The historical development and changing nature of classification systems
   - Similarities and differences between eukaryotic and prokaryotic organisms
   - Similarities and differences among the eukaryotic kingdoms: protists, fungi, plants, animals
   - Classify organisms using keys

4.02 Analyze the processes by which organisms representative of the following groups accomplish essential life functions, including:
   - Unicellular protists, annelid worms, insects, amphibians, mammals, non vascular plants, gymnosperms and angiosperms
   - Transport, excretion, respiration, regulation, nutrition, synthesis, reproduction, and growth and development

4.03 Assess, describe and explain adaptations affecting survival and reproductive success.
   - Structural adaptations in plants and animals (form to function)
   - Disease-causing viruses and microorganisms
   - Co-evolution
### 4.04 Analyze and explain the interactive role of internal and external factors in health and disease:
- Genetics
- Immune response
- Nutrition
- Parasites
- Toxins

### 4.05 Analyze the broad patterns of animal behavior as adaptations to the environment.
- Innate behavior
- Learned behavior
- Social behavior

---

**Competency Goal 5:**

The learner will develop an understanding of the ecological relationships among organisms.

#### Objectives

5.01 Investigate and analyze the interrelationships among organisms, populations, communities, and ecosystems.
- Techniques of field ecology
- Abiotic and biotic factors
- Carrying capacity

5.02 Analyze the flow of energy and the cycling of matter in the ecosystem.
- Relationship of the carbon cycle to photosynthesis and respiration
- Trophic levels — direction and efficiency of energy transfer

5.03 Assess human population and its impact on local ecosystems and global environments.
- Historic and potential changes in population
- Factors associated with those changes
- Climate change
- Resource use
- Sustainable practices/stewardship
The Beat Goes On
Correlation to the National Science Education Standards

<table>
<thead>
<tr>
<th>The Beat Goes On Correlation</th>
<th>The Teaching Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each activity in the module provides short-term objectives for students. There is a conceptual flow of activities and a timeline to help teachers plan for teaching the module. Use of this module helps teachers to update their curriculum in response to student interest in the topic. The module's focus is active, collaborative, and inquiry-based learning.</td>
<td>Standard A: Teachers of science plan an inquiry-based science program for their students. In doing this, teachers • develop a framework of yearlong and short-term goals for students. • select science content and adapt and design curriculum to meet the interests, knowledge, understanding, abilities, and experiences of students. • select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.</td>
</tr>
<tr>
<td>Student inquiry is encouraged by all activities in the module. The module promotes discourse among students, and challenges students to accept responsibility for their learning. The use of the 5E instructional model with collaborative learning is an effective way of responding to diversity in student backgrounds and learning styles.</td>
<td>Standard B: Teachers of science guide and facilitate learning. In doing this, teachers • focus and support inquiries while interacting with students. • orchestrate discourse among students about scientific ideas. • challenge students to accept and share responsibility for their own learning. • recognize and respond to student diversity and encourage all students to participate fully in science learning. • encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.</td>
</tr>
<tr>
<td>There are a variety of assessment components provided in module. Answers are provided to help teachers analyze student feedback.</td>
<td>Standard C: Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers • use multiple methods and systematically gather data about student understanding and ability. • analyze assessment data to guide teaching.</td>
</tr>
<tr>
<td>The answers provided for teachers model respect for the diverse ideas, skills, and experiences of all students. Students work collaboratively in teams to complete activities in the module. Discussion activities in this module model the rules of scientific discourse.</td>
<td>Standard E: Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers • display and demand respect for the diverse ideas, skills, and experiences of all students. • structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse. • model and emphasize the skills, attitudes, and values of scientific inquiry.</td>
</tr>
</tbody>
</table>
The Beat Goes On
Correlation to the National Science Education Standards

<table>
<thead>
<tr>
<th>The Beat Goes On activity</th>
<th>The Content Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-lab Activities</td>
<td>Standard A (Science as Inquiry): As a result of activities in grades 9-12, all students should develop 1. abilities necessary to do scientific inquiry. • Identify questions and concepts that guide scientific investigations • Use technology and mathematics to improve investigations and communications • Formulate and revise scientific explanations and models using logic and evidence • Recognize and analyze alternative explanations and models • Communicate and defend a scientific argument 2. understanding about scientific inquiry.</td>
</tr>
<tr>
<td>Wet-lab Activities</td>
<td>Standard C (Life Science): As a result of their activities in grades 9-12, all students should develop understanding of 1. the cell. • Cells store and use information to guide their functions • Cells can differentiate, and complex multicellular organisms are formed as a highly organized arrangement of differentiated cells 2. the molecular basis of heredity. • In all organisms, DNA carries the instructions for specifying organism characteristics • Changes in DNA occur spontaneously at low rates</td>
</tr>
<tr>
<td>Introduction</td>
<td>3. the behavior of organisms. • Organisms have behavioral responses to internal changes and external stimuli.</td>
</tr>
<tr>
<td>Post-lab Activities</td>
<td>Standard E (Science and Technology): As a result of activities in grades 9-12, all students should develop understanding of 1. abilities of technological design. 2. science and technology. • Scientists in different disciplines ask questions, use different methods of investigation, and accept different types of evidence to support these explanations • Science often advances with the introduction of new technologies • Creativity, imagination, and good knowledge base are all required in the work of science and engineering • Science and technology are pursued for different purposes</td>
</tr>
<tr>
<td>Additional Activities</td>
<td>Standard F (Science in Personal and Social Perspectives): As a result of activities in grades 9-12, all students should develop understanding of 1. personal and community health. 5. human-induced hazards. 6. science and technology in local, national, and global challenges.</td>
</tr>
<tr>
<td>All</td>
<td>Standard G (History and Nature of Science): As a result of activities in grades 9-12, all students should develop understanding of 1. science as a human endeavor. 2. nature of scientific knowledge. 3. historical perspectives.</td>
</tr>
</tbody>
</table>
INTRODUCTION

The Beat Goes On focuses on the cardiovascular system and diseases of the heart, including cardiovascular disease, sudden cardiac arrest, and congenital heart and blood vessel diseases. Students will learn heart structure and function and become familiar with treatments for various heart conditions. Activities in this module will enable students to fulfill the following objectives:

1. To understand the biology of the cardiovascular system:
   a. describe the location of the heart in the body, become familiar with its major anatomical areas and their functions, and trace the pathway of blood through the heart;
   b. explain the operation of heart valves and define heart sounds and murmurs;
   c. identify the structures of the intrinsic conduction system of the heart and describe the pathway of electrical impulses.

2. To understand and explain what kinds of information can be gained from an electrocardiogram (EKG).

3. To identify genetic and environmental factors that influence an individual’s likelihood of developing cardiovascular disease or experiencing sudden cardiac arrest.

4. To explore the wide array of current treatments available for various heart conditions.

5. To analyze the relationships between stimulants, heart rate, and heart function.

6. To examine the magnitude of heart-related health conditions from a social, economic, and political perspective.

THE HEART: A STARRING ROLE

The ancient Egyptians believed the heart was the center of emotion and intellect, and a sense of the heart’s emotional as well as physical centrality to our lives still holds true. In our everyday conversation, we evoke this physiological force to describe emotional and intellectual states, as these well-known phrases indicate: have a heart (to be merciful), have a change of heart (to reconsider), know something by heart (to memorize), be light-hearted (to be joyful), have a heavy heart (to be somber), have your heart in the right place (to mean well), cry your heart out (to grieve), set your heart on something (to desire), get to the heart of the matter (to get to the main point).

Whether we live in the heartland, receive the Military Order of the Purple Heart, read about the Tin Man’s quest for a heart, bite into an artichoke heart, or hear Celine Dion sing “My Heart Will Go On,” we will likely understand that the imagery being used is intended to represent something that is central and also valuable. But it is also important that each of us understands what
a heart really is, and the significant role it plays in human physiology.

About three weeks after conception, the human heart begins to beat with the child’s own blood. And during an average lifetime, “the beat goes on” more than two and a half billion times without stopping for rest. About the size of a person’s fist, the human heart is located within the chest cavity, with the lungs on each side and the apex (the more pointed part) of the heart resting on the diaphragm. A membrane—the pericardium—covers the heart, protecting and anchoring it. A lubricating fluid within the pericardium enables the heart to beat easily within its environment.

The heart is the primary organ of the body’s circulatory system. This system uses blood to carry oxygen, nutrients, hormones, cell waste, and other substances throughout the body. With each beat, the heart provides a driving force that enables the blood to do this important work.

**EVOLUTION OF THE HEART**

With two atria and two ventricles, the four-chambered human heart is a marvel of evolution, having taken millions of years to become amazingly efficient.

Fish have hearts with two chambers—one atrium and one ventricle. The muscular atrium of the fish heart receives deoxygenated blood from the body through the sinus venosus, and pumps the blood into the ventricle. The blood

**FIGURE 1: SIZE AND LOCATION OF THE HEART**
FIGURE 2: EVOLUTION OF THE HEART

**FISH**
Two-chambered heart
1 atrium, 1 ventricle
single circulation

**AMPHIBIANS/REPTILES**
Three-chambered heart
2 atria, 1 ventricle
double circulation

**MAMMALS**
Four-chambered heart
2 atria, 2 ventricles
double circulation

Gill capillaries

Lung capillaries

Body capillaries

Ventricle (oxygenated and deoxygenated blood are mixed)

Atrium

Body capillaries

Ventricles (oxygenated and deoxygenated blood are kept separate)
then travels through a muscular vessel known as the aorta, which sends the blood through the gills where it receives a fresh supply of oxygen and continues flowing throughout the body. This is called “single circulation.”

The hearts of amphibians and reptiles have three chambers. (The exception is the crocodile, which has a four-chambered heart.) These chambers allow blood from the heart to travel first to the lungs to be oxygenated, and then back again. This process, referred to as “double circulation,” allows blood to be pumped back to the heart before going out to the body. Double circulation, which pumps blood more vigorously and with more pressure than does single circulation, was critical for the development of life on land.

Birds and mammals have four-chambered hearts with two atria and two ventricles. The four-chambered heart prevents the mixing of oxygenated and deoxygenated blood. This allows blood that leaves the heart to have much more oxygen, which is needed for the fast-paced lifestyles of these warm-blooded animals.

**HEART STRUCTURE**

The human heart functions as a double pump that has four chambers or cavities: two atria (receiving chambers) and two ventricles (pumping chambers). Two septa divide the heart longitudinally. The interatrial septum separates the right atrium from the left atrium, and the interventricular septum separates the right ventricle from the left ventricle.

The right side of the heart functions in pulmonary circulation. The superior and inferior vena cava receive oxygen-poor blood from the veins. Blood then enters the right...
atrium of the heart and, after its contraction, travels to the right ventricle, which pumps it through the pulmonary trunk. The pulmonary trunk splits into the right and left pulmonary arteries, which carry the blood to the lungs where oxygen is picked up and carbon dioxide is released.

The left side of the heart (left atrium) receives oxygen-rich blood back from the lungs by way of the four pulmonary veins. The atria contract, and the blood enters the left ventricle, which pumps blood out through the aorta and to the arteries throughout the body. This is referred to as “systemic circulation.”

The coronary arteries, which branch from the aorta and encircle the heart, bathe the heart’s chambers with an almost continuous supply of blood. If the myocardium—a thick layer of muscle surrounding the heart—does not receive an adequate supply of blood, the heart beats rapidly and the shortened relaxation periods (times when the atria and ventricles fill up with blood again) that result prevent the flow of blood to the heart tissue. A symptom of this may be crushing chest pains called angina. A prolonged problem with blood flow may result in an infarct, an area of dead tissue in the heart wall. This is commonly referred to as a heart attack or coronary. Technically, it is referred to as a myocardial infarction.

HEART VALVES

The heart has four valves that allow blood to flow in only one direction through the chambers of the heart. Blood flows by way of the atria through the ventricles and out of the aorta leaving the heart. Each set of valves functions at different times. (See “Figure 6: Internal View of the Heart” for a pictorial view.)

The AV valves (atrioventricular) prevent back flow into the atrium when the ventricles are contracting. They are located on both sides of the heart, between the atrial and ventricular chambers. The AV valves open when the heart relaxes and close when the ventricles are contracting. The left AV valve consists of two cusps, or flaps, of endocardium, and is called the bicuspid or mitral valve. The right AV valve has three cusps anchored by tiny white cords—the chordae tendineae (heart strings)—and is called the tricuspid valve.

The pulmonary valve and the aortic valve are the semilunar valves (so called because of their crescent shape). They are closed when the heart relaxes and forced open when the ventricles contract. The semilunar valves guard the bases of the two large arteries (one to the lungs, and one to the rest of the body) leaving the ventricular chambers. Each has three cusps that fit together when the valve is closed. Contraction of the ventricles forces blood out of the heart and causes the cusps to be forced open and flattened against the artery walls. When the ventricles relax, the blood begins to flow backwards toward the heart. The cusps fill with blood, which then closes the valves and prevents back flow of blood into the heart.

An incompetent, or “leaky,” valve forces the heart to re-pump the same blood. A malformed valve, which can seriously compromise the heart, can be replaced with a valve taken from a pig or with a synthetic valve.

HEART SOUNDS

The cardiac cycle is the time occurring from one heartbeat to the next. It has two distinct sounds, which can be heard using a stethoscope. They are often described by the syllables “lub” and “dup,” creating the sequence “lub-dup and pause, lub-dup and pause,” and so on.

The lub sound created by closing the AV valves is a longer and louder sound than the dup sound. The dup sound occurs when the semilunar valves close at the end of the systole. (Systolic refers to heart contraction. Diastolic refers to heart relaxation.)

When it meets obstacles in its path, the normally smooth flow of blood becomes turbulent and it generates an unusual sound called a heart murmur. Heart murmurs are fairly common in young children and some elderly people with perfectly healthy hearts, possibly because they may have relatively thin heart walls which have a tendency to vibrate rushing blood.
Heart murmurs may indicate a problem with a defective valve that does not close tightly (is incompetent) and makes a swishing sound that can be heard after the valve has supposedly closed, as the blood flows back through the partially open valves. If blood flows turbulently through narrowed (stenosed) valves, other distinct sounds can be heard.

**REGULATION OF HEART ACTIVITY**

Two systems regulate heart activity. First, the nerves of the autonomic nervous system act like “brakes” and “accelerators” to decrease or increase the heart rate, depending on which division is activated. Second, the intrinsic conduction system, or nodal system, made of heart tissue enforces a contraction rate of approximately 75 beats per minute and causes heart muscle depolarization in only one direction, from the atria to the ventricles.

The sinoatrial (SA) node, also called the “pacemaker,” is located in the right atrium. It is a tiny mass with a huge job, that of starting each heartbeat and setting the pace for the whole heart. The atrioventricular (AV) node is located at the junction of the atria and ventricles. It receives impulses from the SA node which result in contraction of the atria. The AV node delays the impulses briefly to allow the atria sufficient time to finish contracting, then passes the impulse through the (AV) bundle (Bundle of His). The right and left bundle branches are located in the interventricular septum and receive impulses from the AV bundle.

Purkinje fibers are spread within the muscle of the ventricle walls. These fibers receive impulses from the AV bundle, resulting in a squeezing contraction of the ventricles that begins at the apex and moves toward the atria. This contraction results in blood being ejected into the large arteries (pulmonary and aortic arteries) which transport blood away from the heart.

**Electrocardiography** is a clinical procedure used for tracing the electrical activity of the heart. Electrical currents generated by the heart spread throughout the body. They can be detected on the body’s surface and recorded on an electrocardiogram (EKG).

A typical EKG has three recognizable waves. (See “Figure 12: Waveforms in an EKG” for a pictorial view.) The **P wave** is small and signals the depolarization of the atria immediately before they contract. The large **QRS complex**, which precedes the contraction of the ventricles and has a complicated shape, results from the depolarization of the ventricles. The **T wave** results from current flowing during the repolarization of the ventricles. (The repolarization of the atria is usually hidden by the large QRS complex.)

Abnormalities in the shape of the waves or their timing may indicate that something is wrong with the heart’s intrinsic conduction system. They may also indicate a heart attack, past or present. Other information can be gained from an EKG: fibrillation—a rapid, uncoordinated shuddering of the heart caused by lack of adequate blood to the heart muscle; heart block—damage to the AV node that can result in partial or total release of the ventricles from the control of the SA node; tachycardia—a rapid heart rate over 100 beats per minute; bradycardia—a slow heart rate of less than 60 beats per minute.

**SUDDEN CARDIAC ARREST**

Cardiovascular disease remains the number one cause of death for adults in the US. While the overall number of individuals dying from cardiovascular disease has declined somewhat over the past years, the proportion of deaths attributed to sudden cardiac events has increased. Sudden cardiac arrest (SCA) kills more Americans than do lung cancer, breast cancer, and HIV/AIDS combined.

SCA is an abrupt loss of heart function caused by abnormalities in the heart’s electrical conduction system. The average response time to an emergency call is 6 to 12 minutes, and an estimated 95 percent of people who suffer SCA die before reaching the hospital. SCA victims range from young children to the elderly.

**Ventricular arrhythmias** are associated with SCA. In these cases, the heart beats more rapidly than it should (ventricular
FIGURE 4: CORONARY ARTERY DISEASE AND TREATMENT

The inside walls of arteries are normally smooth and flexible to allow easy blood flow. However, plaques (fatty deposits) may build up inside the arterial wall, hardening and narrowing the artery and reducing or even stopping the flow of blood.

There are several ways to treat coronary artery disease. Medications and lifestyle changes can usually help prevent progression in patients who have coronary artery narrowings that limit blood flow. A patient who has a coronary narrowing can be treated with balloon angioplasty and stenting. For a patient with coronary artery narrowings or blockages in multiple locations, coronary artery bypass graft surgery is the recommended treatment.

ANGIOPLASTY AND STENTING

Balloon angioplasty uses a balloon-tipped catheter to push the plaque back against the arterial wall and improve blood flow. During this procedure a small wire-mesh metal tube, called a stent, is often implanted in the artery. The stent supports the damaged arterial wall and reduces the chance that the vessel will close again after angioplasty.

CORONARY ARTERY BYPASS GRAFT SURGERY

In this procedure, a part of a healthy artery or vein from the leg, chest, or arm is used to create a detour or bypass around the blocked portion of the coronary artery.

SOURCE: AMERICAN HEART ASSOCIATION (www.americanheart.org)
PHOTO COURTESY OF NATIONAL INSTITUTES OF HEALTH
tachycardia), or it may beat chaotically (ventricular fibrillation). The only way to restart a heart in SCA is to use a defibrillator, which delivers an electrical shock to the heart and restores its normal rate. In addition to external defibrillators, there are implantable cardiovascular defibrillators (ICD) that can be placed surgically under the skin of the chest. With wires that attach to the heart, ICDs are able to detect a life-threatening arrhythmia and send an appropriate electrical impulse that brings the heart back into its normal rhythm.

Though some people may experience SCA during a heart attack, SCAs differ from heart attacks, which result from a lack of blood flow that leads to destruction of heart muscle. The leading cause of heart attacks is coronary artery disease. In coronary artery disease, plaques (accumulations of cholesterol, fat, and other substances) develop inside the blood vessels. As the plaques grow, the vessels become narrower and allow less blood to flow through. Blood clots can occur, as can complete blockage of the vessels, and, ultimately, heart attack. Having experienced a heart attack is a predictor of future risk for SCA.

CARDIOMYOPATHY

Cardiomyopathy is a disease originating in the cardiac muscle itself, rather than in the cardiac valves or arteries. Cardiomyopathy has often been associated with sudden death in athletes under the age of 30. While SCA may result from the cardiac muscle functioning improperly, the cause of cardiomyopathy is frequently unknown.

Dilated cardiomyopathy, the most common of three subtypes, can result from inflammation of the heart muscle due to a viral infection, or possibly an autoimmune process resulting in the body producing antibodies against its own heart-muscle cells. Hypertrophic cardiomyopathy can be an inherited condition that results in an abnormal increase in size of the heart muscle; this can develop at any point in life. Restrictive cardiomyopathy, the least common form of cardiomyopathy, is a condition in which the heart is unable to fill with blood because of stiffness.

Diagnostic evaluations for cardiomyopathy may include a chest X-ray and electrocardiogram (EKG), which might reveal an enlarged heart, fluid in the lungs, or abnormal electrical impulses in the heart. An echocardiogram (ECHO) is a test for early diagnosis of cardiomyopathy. In this test, a picture of the heart is produced by bouncing a series of sound waves off it. These pictures are helpful in determining the thickness of the heart muscle, the size of the heart’s chambers, and the anatomy and function of the heart’s pumping action.

Cardiac catheterization may also be helpful in assessing cardiomyopathy. A tube, or catheter, is placed directly into the chambers of the heart so that a type of “dye” can be injected. An X-ray process tracks the “dye” and assesses the structure of the heart, while pressure monitors are able to assess whether the heart is functioning properly.

Treatment of cardiomyopathy depends on the type it is (dilated, hypertrophic, or restrictive) and on the presence of symptoms. Medications that improve pumping action and regulate heart rhythm may be used to treat the inherited form of hypertrophic cardiomyopathy. Surgery may be indicated for some patients who do not respond well to medication. It is generally recommended that individuals who have the inherited form of hypertrophic cardiomyopathy be discouraged from participating in competitive sports or strenuous exercise.

CONGENITAL HEART AND BLOOD-VESSEL DEFECTS

The sudden deaths of young athletes, which we fairly often learn about in sports broadcasts or read about at news sites, focus public attention on cardiovascular disease and overall heart health, because they raise the question, “Why has this happened to an apparently healthy individual?” We want to know the answers because they may help us understand how to guard our own health.

For some athletes, intake of powerful, non-prescription drugs has caused serious heart problems. For instance, a practice among
some amateur and professional athletics is the use of anabolic steroids to enhance performance. Case studies have linked anabolic steroids with increased left ventricular mass, cardiomyopathy, and sudden death. A well-known case is that of Len Bias, a college basketball player who suffered a fatal cardiac arrhythmia, the result of a cocaine overdose, fewer than 48 hours after being selected by the Boston Celtics in the 1986 NBA Draft.

But there are many other causes of heart problems, including congenital heart defects—conditions that occur when the heart or blood vessels do not develop normally before birth. These kinds of defects are present in almost one percent of live births. Scientists are not always sure why these defects occur. Viral infections such as German measles (rubella) have been associated with malformations of the baby’s heart as it develops. Conditions such as Down’s syndrome can affect many organs, including the heart. Many congenital cardiovascular defects have a hereditary basis. Some prescription drugs, certain over-the-counter medications, alcohol, and “street drugs” may also increase the risk of congenital heart defects.

Some heart defects either obstruct blood flow in the heart or vessels near it, or they may cause blood to flow through the heart abnormally. One of the most common types of congenital heart defects is patent ductus arteriosus (PDA), a defect that allows blood in the pulmonary artery and aorta to mix. The ductus arteriosus is an open pathway before birth, between these two arteries. It normally closes a few hours after birth, but may not close in premature infants. A septal defect (also called “a hole in the heart”) lets blood flow between the heart’s right and left chambers and obstruction defects (stenoses) narrow the vessel or partially block blood flow.

Symptoms of cardiomyopathy may include decreased exercise tolerance, shortness of breath, dizziness, or fainting. Because some at-risk individuals may exhibit none of these symptoms, it is important for physicians to ask about the presence of congenital heart disease or sudden death in the family history for both athletes and non-athletes alike.

REFERENCES


SUMMARY OF ACTIVITIES

PRE-LAB
Students listen to a simulated radio broadcast of a basketball game during which a player suffers a sudden cardiac arrest. They then attend a “Healthy Heart Expo” to become more familiar with heart structure and function. Heart models, diagrams, and animations help students to learn more about heart structure and function, heart sounds, heart regulation, and heart health in general.

WET LAB
Students have an opportunity to use an EKG sensor to make a five-second graphical recording of their hearts’ electrical events. From these recordings, students identify the five deflections (P, Q, R, S, and T waveforms) produced. Students use these to determine the time associated with each. Students will determine the heart rate from the EKG of a person at rest, after mild exercise, in different body positions and note any changes in EKG readings which result from mild stimulants. Students will also determine the direction of electrical activity for the QRS complex.

POST-LAB
These activities include analysis of the EKG graph of their heart’s electrical activity to determine the time intervals between EKG events. Students will then calculate their heart rate based on their EKG reading. They will also analyze EKG tracings from several patients and describe unique attributes of each recording. It is also suggested that students observe the Discovery video, “Heart Attack,” and discuss related questions. “Rescue 911” provides scenarios that enable students to speculate on diagnoses and possible treatments for patients with medical emergencies. The Quiz Game provides teachers an opportunity to evaluate their students’ knowledge of the heart.

ADDITIONAL ACTIVITIES
The activities listed below give students other opportunities to better understand heart structure and function:

Create a Pamphlet on a Heart-Related Topic: Instructional scoring rubric provided.

Feel the Pulse: An activity for measuring heart rate.

Pump It Up: An activity for calculating stroke volume.

Stat!: An activity for using tables to record, organize, and analyze vital information related to heart health.

INTERDISCIPLINARY ACTIVITIES

Finding Inner Peace: Discussion, writing, and research activities related to possible health benefits of meditation.

A Discovery-Based Approach to Understanding Clinical Trials: Teacher’s guide, discussion questions, glossary, and FAQ.


The Tell-Tale Heart: The complete text of Poe’s short story and a worksheet for guided reading.
CONNECTION TO OTHER MODULES

*The Beat Goes On* focuses on cardiovascular disease. Students explore heart structure, heart sounds, and procedures used in the treatment of heart conditions. Using an EKG sensor students make a five-second graphical recording of the heart’s electrical events in order to determine the time between intervals and calculate their heart rate based on their EKG recording.

This module is connected to the others listed below since they are all health related. No specific sequence is required.

This module along with the two additional wet-lab activities mentioned below provides students with first-hand experience of common techniques used by molecular biologists. Molecular biology examines nucleotide and amino acid sequences of DNA and proteins from different species.

**WEIGH TO GO!**

This DESTINY module is a discovery-based module that promotes awareness of the obesity epidemic at global and individual levels. Students are encouraged to explore the connections between obesity, diabetes, high blood pressure, and high cholesterol. Like *The Beat Goes On*, this module examines the genetics and biochemistry of specific health conditions.

**BIOLOGICAL BODYGUARDS**

This DESTINY module examines the vital role that the body’s immune system plays in the fight against illness and the prevention of disease.

**MYSTERY OF THE CROOKED CELL**

This module developed by Boston University School of Medicine’s CityLab enables students to examine the genetic basis for sickle cell anemia. Students observe functional differences in the normal hemoglobin and sickle cell hemoglobin which result from a point mutation that changes the DNA.

**SEQUENCE OF MODULES**

*The Beat Goes On* is connected to the others described above by their shared emphasis on health topics. No specific sequence is required.
## THE BEAT GOES ON IMPLEMENTATION PLAN — PRE-LAB

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated Time</th>
<th>Materials/Equipment</th>
<th>Purpose/Objectives/Essential Questions</th>
</tr>
</thead>
</table>
| Engagement          | 5 minutes      | Audio of radio broadcast of a simulated basketball game                              | Purpose:  
To help students better understand the biology of the cardiovascular system and the types of equipment used for diagnosis and treatment of various heart conditions.  
Objectives:  
• To learn the basic structure and function of the heart.  
• To learn how to read and analyze an EKG (ECG).  
• To become familiar with various problems associated with the heart.  
• To become familiar with several types of treatment for heart problems.  
Essential Questions:  
How is the structure of the heart related to its function?  
What kind of information can be obtained from an EKG? |
| Exploration         | 30 minutes     | Video clip of the heart (circulation, valves, heart regulation)  
Heart model  
Copies of diagrams, songs  
Magnetic diagrams with labels  
Stethoscope             |                                                                                                                                                                                                                                   |
| Explanation/Elaboration | 40 minutes  | Heart to Heart Questions  
Pamphlets on heart-related topics                          |                                                                                                                                                                                                                                   |
| Evaluation          | 10 minutes     | Evaluation questions                                                             |                                                                                                                                                                                                                                   |

### Alignment with NC Competency Goals

<table>
<thead>
<tr>
<th>Biology</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1 Objectives</td>
<td>1.01, 1.02, 1.03</td>
</tr>
<tr>
<td>Goal 2 Objectives</td>
<td>2.02</td>
</tr>
<tr>
<td>Goal 3 Objectives</td>
<td>3.04</td>
</tr>
<tr>
<td>Goal 4 Objectives</td>
<td>4.02, 4.04</td>
</tr>
</tbody>
</table>
THE BEAT GOES ON PRE-LAB ACTIVITIES:
UTILIZING THE 5E INSTRUCTIONAL MODEL

ENGAGEMENT
In the pre-lab activities, students listen to an audio tape of a Carolina basketball game. The tape ends with questions regarding the status of one of the players, Latonya Smith, who was rushed to the hospital due to an apparent cardiac event. What happened to Latonya? Could she have taken drugs, or steroids? Did she pass the athletic physical? Were there any signs of a problem with her heart?

Materials needed:
CD with the audio of the Basketball game
CD Player/ Computer with speakers

EXPLORATION
To get answers to their questions, students attend a Healthy Heart Expo to learn more about the heart. As students arrive at the “Healthy Heart Expo”, they are welcomed by health care professionals and encouraged to become more familiar with heart structure and function. Heart models, diagrams and animations provide information on heart structure and function, heart sounds, heart regulation and heart health in general.

Materials needed at teacher station:
Video clip of the heart (circulation, valves, heart regulation): HHMI: Of Hearts and Hypertension, Blazing Genetic Trails; Lecture One, Chapter 2: Normal Heart Structure and Function 8:44-11:11.

Materials needed at student stations:
Heart model
Copies of diagrams of the heart (external, internal, regulation of heart beat)
Magnetic diagrams with labels
Stethoscope

EXPLANATION/ELABORATION
When students return to class after their visit to the Healthy Heart Expo, they share with their classmates information gained from the brochures that were available to them at the Expo.

Assign each student or group of students a brochure on one heart related topic from the list provided. Explain to students that they will become the experts on that topic and will share their knowledge with the rest of the class.

• Presentation should be about 2-3 minutes.
• Encourage students to use good presentation skills.
• Students may use diagrams from the pre-lab to aid in their explanations.

Materials needed:
Brochures on heart-related topics.

EVALUATION
A variety of evaluation activities are provided. The magnetic diagrams used in the exploration activity provide a quick check to see that students know the structure of the heart. The “Flow of Blood” activity requires that students trace the flow of blood through the heart and indicate what is happening at each step.

Materials needed:
Diagram showing blood flow through the heart
Corresponding answer sheet
ENGAGEMENT ACTIVITY: LISTENING TO A SIMULATED BASKETBALL GAME

OVERVIEW
Students listen to an audio recording of a radio broadcast of a simulated basketball game. During this game a fictional player collapses on court.

In this fictional scenario, Latonya Smith is a good student and conditioned athlete who was recruited to play for UNC’s women’s basketball team, a championship contender. Her team has a fifteen-point lead when she suddenly collapses on the floor.

The team’s medical personnel rush to her aid. A portable defibrillator is brought on court, and Latonya is taken to hospital for observation and treatment.

Though the game ends with a win for Latonya’s team, there are also many questions. What happened to this player? Was she on drugs or steroids? Did she pass the physical allowing her to play a sport? Were there any signs of a problem before she passed out?

GAME BROADCAST SCRIPT

*The basketball-game announcer says:*

What an exciting game! Carolina has the lead. They are up by 15 points now. These Tar Heel fans are really looking for a win tonight. Can’t you just feel the excitement in this place?

What is happening out there on the floor? It looks like we’ve got a player down. Yes, that’s Latonya Smith. She has passed out. This looks serious. The coaches and the sports medical personnel are rushing to her aid. Oh my, they have a portable defibrillator. Could this be some kind of cardiac event?

This crowd is in disbelief!!! Latonya is one of Carolina’s leading scorers!! She is a conditioned athlete. She is motivated. She has that drive and enthusiasm we all admire. Latonya is a great student!! She was recruited to play basketball for Carolina. She is one of the reasons this team is a championship contender!!!

The medics are taking Latonya off the floor on a gurney. She is on her way to the hospital. I have just been informed that there is a group of cardiac specialists awaiting her arrival.

The game continues!! But this event has really diminished the excitement. What a blow to this Carolina team. Now they are struggling to maintain the lead. Oh no, they are losing their momentum. It’s going to be a close game.

That’s the final buzzer. The game is over with Carolina up by one point.

There are a lot of questions on everyone’s mind. What happened to Latonya? Could she have taken drugs, or steroids? Did she pass the athletic physical? Were there any signs of a problem with her heart?

MATERIALS NEEDED
DESTINY-provided CD with game “broadcast”
Computer with CD and audio capabilities.

OPTIONAL MATERIALS
LCD projector enabling presentation of the visual element of the CD.
EXPLORATION ACTIVITY: HEALTHY HEART EXPO
TEACHER’S GUIDE

ACTIVITY SCENARIO
Students attend a “Healthy Heart Expo” to learn more about the heart.

As students arrive at the “Healthy Heart Expo,” they are welcomed by health care professionals and encouraged to become more familiar with heart structure and function. Heart models, diagrams, and animations provide information on heart structure and function, heart sounds, heart regulation, and heart health in general.

To get an idea of how hard their heart works, students are asked to try clenching and unclenching their fist and to see how long they can keep it up. They quickly find that their hand and arm soon begin to ache. That ache signals that the muscles are overworked. Yet the heart keeps that pace 24 hours a day, every day, year after year. In an average lifetime the heart beats tirelessly more than two and a half billion times without resting pumping 1,800 gallons of blood a day.

HEART STRUCTURE:
GETTING TO THE HEART OF THINGS
Provide students a model of the heart that opens up, and ask them to work cooperatively with their group members making sure each person in the group can identify the following structures and their functions:

- Right atrium
- Left atrium
- Right ventricle
- Left ventricle
- Vena cava
- Pulmonary arteries
- Pulmonary veins
- AV valves (tricuspid and bicuspid)
- Semi lunar valves (pulmonary valve and the aortic valve)

Show the video clip of blood flow through the heart: HHMI: Of Hearts and Hypertension, Blazing Genetic Trails; Lecture One, Chapter 2: Normal Heart Structure and Function 8:44-11:11.

BLOOD FLOW THROUGH THE HEART
1. Right atrium receives impure blood by way of the superior and inferior vena cava.
2. Right ventricle pumps impure blood to the lungs.
3. Pulmonary arteries transport blood to the lungs.
4. Pulmonary veins transport oxygenated blood back to the left atrium.
5. Left atrium receives oxygenated blood from the lungs.
6. Left ventricle pumps blood through the aortic valve.
7. Aorta transports blood throughout the body.

Using the magnetic diagrams of the heart ask students to use blue arrows to show pulmonary circulation and the red arrows to show systemic circulation.

HEART SOUNDS
Show the video clip “Heart Valves and Sounds” from HHMI: Of Hearts and Hypertension, Blazing Genetic Trails (Lecture One, Chapter 4: Heart Valves and Heart Sounds; 18:00-21:43).

Ask students to locate the heart valves on their model of the heart and to label them using their magnetic diagram.

Provide students a stethoscope to listen to heart sounds (“lub dup” sounds).

Provide information indicating what causes these sounds:

1. Closing of the AV valves (lub), longer and louder sound.
2. Closing of the semi lunar valves (dup), short and sharp sound.
REGULATION OF THE HEART BEAT

Show the video clip about the regulation of heart beat (HHMI’s Of Hearts and Hypertension, Blazing Genetic Trails; Lecture One, Chapter 5: The Mechanism of Heart Contraction; 27:23-32:40).

Provide students a diagram showing regulation of heart beat.

Students use their magnetic diagrams to label the SA node, the AV node, Purkinge fibers, and use the red magnetic arrows to show the direction of the electrical impulse.

Students should be prepared to answer the following questions:

a. How does this diagram relate to the readings on an EKG (PQRST)?

b. What kinds of information can be gained from an EKG?
MAGNETIC DIAGRAMS AND STATION SHEETS
INSTRUCTIONS FOR STUDENTS

HEART STRUCTURES
A. Examine the model and diagram of the heart at your station. Work cooperatively with your group members making sure that each person in your group can identify the following structures and their function.

- **Right atrium** — chamber that receives deoxygenated blood from the vena cava
- **Left atrium** — chamber that receives oxygenated blood from the lungs by way of the pulmonary veins
- **Right ventricle** — thick walled chamber that pumps out oxygen-poor blood by way of the pulmonary arteries
- **Left ventricle** — thick-walled chamber that pumps out well-oxygenated blood by way of the aorta
- **Pulmonary arteries** — transport deoxygenated blood to the lungs from the right ventricle
- **Pulmonary veins** — transport oxygen-rich blood back from the lungs to the left atrium
- **Vena cava** — transports deoxygenated blood to the right atrium of the heart
- **Aorta** — transports oxygenated blood from the left ventricle to all organs of the body by its branching arteries

B. Use your magnetic diagram titled “Figure 8: INTERNAL VIEW OF THE HEART (Diagram 1)” to practice labeling these heart structures. Remove the heart labels and place them back into the bag. Use the arrows to show the flow of blood through the heart on the magnetic diagrams.

HEART VALVES
C. Locate the four valves that allow blood to flow in only one direction through the chambers of the heart.

- **1-2. AV (atrioventricular) valves** — prevent back flow into the atria when the ventricles are contracting. They open when the heart relaxes and close when the ventricles are contracting. The **left AV valve** consists of two cusps and is called the bicuspid or mitral valve. The **right AV valve** has three cusps anchored by tiny white cords, the chordae tendineae (heart strings); is called the tricuspid valve.

- **3-4. Semilunar valves** — the pulmonary valve and the aortic valve, which are closed when the heart relaxes and forced open when the ventricles contract. **Semilunar valves** get their names from their function, which is to prevent back flow of blood into the heart from the bases of the two large arteries leaving the ventricular chambers. Each has three cusps, which fit together when the valve is closed.

D. Use your magnetic diagram titled “Figure 9: INTERNAL VIEW OF THE HEART (Diagram 2)” to practice labeling the valves of the heart.

HEART SOUNDS
E. Using the stethoscope at your station, listen to your partner’s heart beat and your own. Be sure to clean the ear pieces of the stethoscope with alcohol prep pads before the next person uses the stethoscope.

- **Cardiac cycle** — the time occurring from one heartbeat to the next. The cardiac cycle has two distinct sounds, often described by the syllables “lub” and “dup,” which create the sequence lub-dup and pause, lub-dup and pause, and so on. The lub sound is created by closing the AV valves (longer and louder sound than the dup sound). The dup sound occurs when the semilunar valves close at the end of the systole. Systolic refers to heart contraction as compared to diastolic which refers to heart relaxation.

REGULATION OF HEART ACTIVITY
F. At your station, study the diagram showing regulation of heart beat. There are two systems that regulate heart activity.

- **1. Nerves of the automatic nervous system** act like “brakes” and “accelerators” to decrease or increase the heart rate, depending on which division is activated.
2. **Intrinsic conduction system or nodal system**, which is made of heart tissue, enforces a contraction rate of approximately 75 beats per minute on the heart and causes heart muscle depolarization in only one direction, from the atria to the ventricles.

*Sinoatrial (SA) node* — also called the pacemaker, is located in the right atrium; a tiny mass with a huge job, that of starting each heartbeat and setting the pace for the whole heart.

*Atrioventricular (AV) node* — located at the junction of the atria and ventricles and receives impulses from the SA node which result in contraction of the atria. The AV node delays the impulses briefly to allow the atria sufficient time to finish contracting, then passes the impulse through the (AV) bundle (bundle of His). Right and left bundle branches are located in the interventricular septum and receive impulses from the AV bundle.

*Purkinje fibers* — spread within the muscle of the ventricle walls. These fibers receive impulses from the AV bundle, resulting in a squeezing contraction of the ventricles that begins at the apex and moves towards the atria. This contraction results in blood being ejected into the large arteries (pulmonary and aortic arteries), which transports blood away from the heart.

**ELECTROCARDIOGRAM (EKG)**

Electrocardiography is a clinical procedure used for tracing the electrical activity of heart. When electrical currents are generated by the heart, they spread throughout the body and can be detected on the body’s surface and recorded on an electrocardiogram (EKG).

A typical EKG has three recognizable waves:

*The P wave* is small and signals the depolarization of the atria immediately before they contract.

*The large QRS complex* precedes the contraction of the ventricles, has a complicated shape, and results from the depolarization of the ventricles.

*The T wave* results from current flowing during the repolarization of the ventricles (the repolarization of the atria is usually hidden by the large QRS complex).

Abnormalities in the shape of the waves or their timing may indicate that something is wrong with the heart’s intrinsic conduction system (for example, a past or present heart attack).

Other information that can be gained from an EKG:

- **Fibrillation** — rapid uncoordinated shuddering of the heart caused by lack of adequate blood supply to the heart muscle.
- **Heart block** — damage to the AV node can result in partial or total release of the ventricles from the control of the SA node.
- **Tachycardia** — rapid heart rate over 100 beats per minute.
- **Bradycardia** — a slow heart rate of less than 60 beats per minute.

G. Use your magnetic diagrams to label the SA node, AV node, and Purkinge fibers.

H. Observe the direction of the arrows that show the direction of the electrical impulse.

I. Be prepared to answer the following questions:

- How does this diagram relate to the readings on an EKG (PQRST)?
- What kinds of information can be gained from an EKG?
FIGURE 5: EXTERNAL VIEW OF THE HEART

- Aortic arch
- Superior vena cava
- Right atrium
- Right pulmonary artery
- Right pulmonary veins
- Inferior vena cava
- Right ventricle
- Left pulmonary artery
- Left pulmonary veins
- Left atrium
- Left ventricle
FIGURE 6: INTERNAL VIEW OF THE HEART

- Aorta
- Aortic semilunar valve
- Right pulmonary artery
- Vena cava
- Right pulmonary veins
- Right atrium
- Tricuspid valve
- Right ventricle
- Bicuspid (mitral) valve
- Left atrium
- Left pulmonary veins
- Left ventricle
- Pulmonary semilunar valve
- Septum
- Left pulmonary artery
- Aorta
- Right pulmonary artery
FIGURE 7: HEART REGULATION

The heart muscle is myogenic, which means it can contract and relax on its own rather than having to rely on conscious or reflex nervous stimuli. A look at how the heart’s rhythmic contractions occur:

1. The sinoatrial node, often called the pacemaker, produces a wave of electrical stimulation that initiates atria contraction.

2. The wave spreads out over the atrial walls, causing them to contract.

3. The wave moves to the atroventricular node, which is the only location where the electrical wave can move from the atria to the ventricles.

4. After a short delay (about 0.1 seconds), the atroventricular node passes on the electrical wave through the Purkinje fibers, causing the ventricular walls to contract.
### Exploration Activity: Labels for Magnetic Diagrams

<table>
<thead>
<tr>
<th>Right atrium</th>
<th>Right ventricle</th>
<th>Pulmonary arteries</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>Left ventricle</td>
<td>Pulmonary veins</td>
<td>Vena cava</td>
</tr>
<tr>
<td>Left AV or bicuspid</td>
<td>Right AV or tricuspid</td>
<td>Pulmonary</td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>SA node</td>
<td>AV node</td>
<td>Purkinje fibers</td>
</tr>
</tbody>
</table>

### Diagram:

- [Diagram representation of heart chambers and blood vessels]

<table>
<thead>
<tr>
<th>Right atrium</th>
<th>Right ventricle</th>
<th>Pulmonary arteries</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>Left ventricle</td>
<td>Pulmonary veins</td>
<td>Vena cava</td>
</tr>
<tr>
<td>Left AV or bicuspid</td>
<td>Right AV or tricuspid</td>
<td>Pulmonary</td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>SA node</td>
<td>AV node</td>
<td>Purkinje fibers</td>
</tr>
</tbody>
</table>

- [Diagram representation of heart chambers and blood vessels]

<table>
<thead>
<tr>
<th>Right atrium</th>
<th>Right ventricle</th>
<th>Pulmonary arteries</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>Left ventricle</td>
<td>Pulmonary veins</td>
<td>Vena cava</td>
</tr>
<tr>
<td>Left AV or bicuspid</td>
<td>Right AV or tricuspid</td>
<td>Pulmonary</td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>SA node</td>
<td>AV node</td>
<td>Purkinje fibers</td>
</tr>
</tbody>
</table>

- [Diagram representation of heart chambers and blood vessels]

<table>
<thead>
<tr>
<th>Right atrium</th>
<th>Right ventricle</th>
<th>Pulmonary arteries</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>Left ventricle</td>
<td>Pulmonary veins</td>
<td>Vena cava</td>
</tr>
<tr>
<td>Left AV or bicuspid</td>
<td>Right AV or tricuspid</td>
<td>Pulmonary</td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>SA node</td>
<td>AV node</td>
<td>Purkinje fibers</td>
</tr>
</tbody>
</table>

- [Diagram representation of heart chambers and blood vessels]

<table>
<thead>
<tr>
<th>Right atrium</th>
<th>Right ventricle</th>
<th>Pulmonary arteries</th>
<th>Aorta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrium</td>
<td>Left ventricle</td>
<td>Pulmonary veins</td>
<td>Vena cava</td>
</tr>
<tr>
<td>Left AV or bicuspid</td>
<td>Right AV or tricuspid</td>
<td>Pulmonary</td>
<td></td>
</tr>
<tr>
<td>Aortic</td>
<td>SA node</td>
<td>AV node</td>
<td>Purkinje fibers</td>
</tr>
</tbody>
</table>

- [Diagram representation of heart chambers and blood vessels]
FIGURE 8: INTERNAL VIEW OF THE HEART (Diagram 1)

A. 

B. 

C. 

D. 

E. 

F. 

G. 

H. 

FIGURE 9: INTERNAL VIEW OF THE HEART (Diagram 2)

A. 

B. 

C. 

D. 
FIGURE 10: HEART REGULATION

Movement of electrical stimulation

A. 

B. 

C.
EXPLANATION/ELABORATION ACTIVITY: HEART TO HEART
TEACHER’S GUIDE

Students will have a “Heart to Heart” talk with health care professionals they meet at the Healthy Heart Expo. They will get answers to questions and concerns they have regarding heart health. Assign each student or group of students a brochure on one of these heart-related topics:

- What is a Heart Attack? (Myocardial Infarction)
- What is Angina?
- What is Congestive Heart Failure? Living with Heart Failure
- What is Atrial Fibrillation? Arrhythmias (Tachycardia / Bradycardia)
- What is Metabolic Syndrome?
- Cardiac Medications and How They Work
- Congenital Heart Defects
- Cardiomyopathy / Athletes
- What is Bacterial Endocarditis?
- Cholesterol-Lowering Drugs (statins)
- Heart Transplants
- Surgery and Other Treatments
- New Frontiers in Treating Heart Disease/ Stem Cell Research
- Stroke, TIA
- Rheumatic Heart Disease
- Women and Heart Disease
- What is Echocardiography?
- Numbers that Count for a Healthy Heart
- How Do Cocaine, Marijuana, and other Drugs Affect the Heart?

Explain to students that they will become the experts on that topic and will share their knowledge with the rest of the class.

- Each presentation should be about 2-3 minutes long.
- Encourage students to use good presentation skills.
- Students may use diagrams from the pre-lab to aid in their explanation.
HEART TO HEART
QUESTIONS FOR THE CLASS

1. Why is cardiovascular disease such an important consideration today?

2. How does cardiovascular disease differ from sudden cardiac arrest (SCA)?

3. How does heredity affect one’s chances of getting heart disease?

4. What are the most important controllable risk factors for heart disease?

5. How does the rate of heart disease compare in men and women?

6. How do incidents of heart disease compare in Caucasians and minorities?

7. At what age does one develop heart disease?

8. What happens during a heart attack?

9. What are the symptoms of a heart attack?

10. What is heart failure?

11. What are some common medicines used to treat heart failure?

12. What is angina? How does it differ from a heart attack?
13. What are three main ways to restore blood flow?

14. What are congenital heart defects?

15. What is cardiomyopathy?

16. What are the events of the cardiac cycle?

17. What is the controlling system to regulate heart activity?

18. How are the following used in treating heart disease?
   Pacemaker
   Defibrillator (portable)
   Catheter
   Heart valve
   Coronary bypass surgery
   Cardiac stent

18. What are some of the new frontiers in treating heart disease?

19. How do cocaine, marijuana, and other drugs affect the heart?

20. Is it possible to die from a broken heart?
1. Why is cardiovascular disease such an important consideration today?

Cardiovascular disease (CVD) is the number-one killer of American males and females among all racial groups.

Almost 1 million Americans die of CVD each year, which adds up to 43% of all deaths. According to the American Heart Association, approximately every 33 seconds an American will suffer some type of coronary event and almost every minute someone will die from it.

CVD costs the nation $274 billion each year, including health expenditures and lost productivity.

2. How does cardiovascular disease differ from sudden cardiac arrest (SCA)?

Sudden cardiac arrest (SCA) results from an abrupt and unexpected stoppage of heart function, which can cause abnormalities in the heart’s electrical system. It is not a heart attack, which is caused by a blocked vessel leading to loss of blood supply to a portion of the heart muscle; however, some people may experience SCA during a heart attack. Having experienced a previous heart attack is a predictor of future risk for SCA.

3. How does heredity affect one’s chances of getting heart disease?

Heredity is an uncontrollable risk factor that does play an important role in developing heart disease. Many “disease genes” are currently being identified that may predispose people to heart disease. The identification of these genes offers new diagnostic tools and potential approaches to treatment.

4. What are the most important controllable risk factors for heart disease?

Controllable risk factors include smoking, high cholesterol levels, blood pressure that is not in the normal range, lack of physical activity, diabetes, and being overweight.

Smoking — Smoking is the single most preventable cause of death in the United States. Smokers have more than twice the risk of heart attack than non-smokers. The nicotine and carbon dioxide in tobacco smoke reduce the amount of oxygen in the blood. They also damage blood vessels walls, causing plaque to build up, and may cause blood clots to form. Smoking reduces the HDL (good cholesterol). Smoking may also disturb the heart rhythm in people who have chest pain or those who have already had a heart attack.

High cholesterol levels — People can reduce their risk of heart disease and blood vessel disease by lowering their cholesterol level. Total blood cholesterol above 200mg/dl, LDL cholesterol above 130HDL mg/dl, and HDL below 35 mg/dl are indicators of problematic cholesterol.

Blood Pressure — High blood pressure (systolic 140mmHg or higher and/or a diastolic pressure above 90mm Hg for an extended period of time) causes the heart to work harder than normal and the arteries are consequently more prone to injury. High blood pressure also hurts arteries and arterioles because over time they become scarred, hardened and less elastic which probably speeds atherosclerosis.

Lack of physical activity — People who are sedentary have twice the risk of heart disease as those who are physically active. For most healthy people 30-60 minutes of physical activity daily is recommended for good heart health.

Diabetes — People with diabetes tend to have LDL particles that stick to arteries and damage their walls more easily. Glucose latches onto lipoproteins. Sugar-coated LDL remains in the blood stream longer and may lead to plaques. People with diabetes tend to have low HDL and high triglyceride levels, both of which boosts the risk of heart and artery disease.

Overweight — Being overweight can be a contributing factor in heart disease because too much fat can act like a poison which spews out substances that contribute to diabetes, heart disease, high blood pressure, stroke and cancer. Fat cells produce a hormone called aldosterone which increases blood pressure.

5. How does the rate of heart disease compare in men and women?

Cardiovascular disease is the leading cause of death
for both men and women, but it kills more women overall—nearly 500,000 each year, more than the next seven causes of death combined and nearly twice as many as cancer.

Women are far less likely than men to get basic medical care that could significantly reduce their risk of cardiovascular disease.

6. How do incidents of heart disease compare in Caucasians and minorities?

Blacks are 2.5 times more likely and Hispanics are 1.7 times more likely to be hospitalized for congestive heart failure. Minorities are more likely to die of heart disease because of economic status, education, and lack of adequate health care.

7. At what age does one develop heart disease?

Studies have shown that the signs of heart disease begin developing in childhood. Lowering levels of elevated blood cholesterol in children and adolescents is beneficial.

8. What happens during a heart attack?

If a blood clot totally blocks an artery that feeds the heart, the heart muscle becomes “starved” for oxygen. Within a short time, death of heart muscle cells occurs, causing permanent damage. This is called a myocardial infarction (MI), or heart attack.

Healing of the heart muscle begins soon after a heart attack and takes about eight weeks. Just like a skin wound, the heart’s wound heals and a scar will form in the damaged area. But, the new scar tissue does not contract or pump as well as healthy heart muscle tissue. So, the heart’s pumping ability is lessened after a heart attack. The amount of lost pumping ability depends on the size and location of the scar.

9. What are the symptoms of a heart attack?

- Discomfort, pressure, heaviness, or pain in the chest, arm or below the breastbone; discomfort radiating to the back, jaw, throat, or arm
- Fullness, indigestion, or choking feeling (may feel like heartburn)
- Sweating, nausea, vomiting or dizziness.
- Extreme weakness, anxiety or shortness of breath
- Rapid or irregular heartbeats

During a heart attack, symptoms last 30 minutes or longer and are not relieved by rest or oral medications (medications taken by mouth).

Some people have a heart attack without having any symptoms (a "silent" myocardial infarction). A silent MI can occur in any person, though it is more common among diabetics.

10. What is heart failure?

Heart failure means the pumping power of the heart is weaker than normal; as a result, the heart cannot pump oxygen and nutrients to meet the body’s needs. Symptoms of heart failure can include:

- a. congested lungs
- b. fluid and water retention
- c. dizziness, fatigue, and weakness
- d. rapid or irregular heartbeats

11. What are some common medicines used to treat heart failure?

Angiotensin converting enzyme (ACE) inhibitor — group of drugs used to treat high blood pressure and heart failure. ACE inhibitors block a specific enzyme that retains salt in the kidney and can cause heart and blood pressure problems.

Angiotensin II receptor blockers — group of drugs used to treat high blood pressure.

Beta-blockers — drugs that slow heart rate, lower blood pressure, and control angina.

Diuretics— commonly known as “water pills”; help the body get rid of unwanted water and salt through urine which makes it easier for the heart to pump and maintain blood pressure.

Digitalis — used to treat congestive heart failure and rhythm problems.

Nitroglycerin — relieves chest pain by dilating blood vessels so that more oxygen rich blood is available to the heart. Nitroglycerin can be administered under the tongue or by way of a patch on the skin (known as a transdermal patch).

Statins — cholesterol-reducing drugs.

Aspirin — has been found to be an effective daily treatment in preventing blood platelets from clotting.
12. What is angina? How does it differ from a heart attack?

When the heart beats very rapidly, the myocardium, a layer of the heart which consists of thick bundles of cardiac muscle, may not receive an adequate blood supply. Rapid heart beats result in shortened relaxation periods. When blood is able to flow to the heart tissue, the result is crushing chest pain called angina. Prolonged angina may result in an area of dead tissue in the heart wall caused by a blocking of local blood circulation, called an infarct. This is commonly referred to as a “heart attack.”

13. List three main ways to restore blood flow to the heart.

Clot-busting drugs (thrombolytics) — dissolve clots immediately (for example, t-PA).

Angioplasty — surgical procedure that can open the artery with a balloon and then, if indicated, install a stent (a scaffold-like device) that helps to keep the vessel open.

Cardiac bypass surgery — provides an alternative route around a blockage, using a blood vessel taken from the patient’s calf or elsewhere in the body.

14. What are congenital heart defects?

Congenital refers to conditions that occur when the heart or blood vessels do not develop normally before birth. These kinds of defects are present in almost one percent of live births. Scientists are not always sure why these defects occur. Viral infections such as German measles (rubella) have been associated with malformations as the baby’s heart develops.

15. What is cardiomyopathy?

Cardiomyopathy refers to a disease originating in the cardiac muscle itself, rather than in the cardiac valves or arteries. The cause of cardiomyopathy is frequently unknown.

Dilated cardiomyopathy is the more common of three subtypes and can result from inflammation of the heart muscle due to a viral infection, or possibly an autoimmune process resulting in the body producing antibodies against its own heart muscle cells.

Hypertrophic cardiomyopathy can be an inherited condition resulting in an abnormal increase in size of the heart muscle and can develop at any point in life.

Restrictive cardiomyopathy, the least common form of cardiomyopathy, is a condition where the heart is unable to fill with blood because of stiffness.

16. What are the events of the cardiac cycle?

Cardiac cycle is the time occurring from one heartbeat to the next in the cardiac cycle. Heart sounds can be heard through a stethoscope.

The cardiac cycle has two distinct sounds, often described by the syllables “lub” and “dup,” which create the sequence lub-dup and pause, lub-dup and pause, and so on.

The lub sound is created by closing the AV valves (longer and louder sound than the dup sound). The dup sound occurs when the semilunar valves close at the end of the systole. Systolic refers to heart contraction as compared to diastolic which refers to heart relaxation.

17. What is the controlling system to regulate heart activity?

There are two types of controlling systems which regulate heart activity.

Nerves of the automatic nervous system act like “brakes” and “accelerators” to decrease or increase the heart rate depending on which division is activated.

The intrinsic conduction system or nodal system is made of heart tissue. This specialized tissue found nowhere else in the body is a cross between muscle and nervous tissue. This tissue enforces a contraction rate of approximately 75 beats per minute on the heart and causes heart muscle depolarization in only one direction, from the atria to the ventricles.

18. How are the following used in treating heart disease?

Pacemaker — artificial pacemaker that can substitute
for a defective natural pacemaker or conduction pathway; used to regulate heart beat by emitting a series of rhythmic electrical discharges.

Defibrillators (portable) — electrical device that helps reestablish normal contraction rhythms in a malfunctioning heart.

Catheter — tube used in a surgical procedure which can be used to open an artery.

Artificial heart valve — replaces defective heart valve.

EKG — tests the electrical activity of the heart. Abnormalities in the shape of the waves or their timing may indicate that something may be wrong with the heart’s intrinsic conduction system. It may indicate a heart attack, past or present.

Coronary bypass surgery—provides an alternative route around a blockage using a blood vessel from the calf or elsewhere in the body.

A cardiac stent—is a scaffold-like device that helps to keep a blood vessel open.

19. What are some of the new frontiers in treating heart disease?

Heart disease has been one of the primary targets of stem-cell research.

Use of stem cells harvested from a patient’s own bone marrow has been found to improve cardiac function in heart attack patients months, years—and even decades after the attack. Laboratory experiments suggest that stem cells can make heart muscle, blood vessels, nerve cells and other tissues.

Blood vessels are now being bioengineered in the lab from cells taken from the patient. Often patients do not have arteries that are healthy enough to be harvested from one part of the body, and then inserted where they are needed as bypasses around blockages or damaged arteries. Reliable replacements from a person’s own cells would be less likely to trigger an immune system rejection.

Heart medications which target specific races are being developed.

ACE inhibitors tend not to work as well in blacks as whites according to current research. BiDil is a combination of two drugs: hydralazine, which eases blood pressure, and isosorbate dinitrate, which is used for heart pain. These two medications are combined to boost the amounts of nitric oxide in the blood which has several roles in heart health and is a substance that is found in lower levels in blacks.

20 How do cocaine, marijuana, and other drugs affect the heart?

The so-called “recreational drugs,” like marijuana and cocaine, affect how the central nervous system works and can cause fatal arrhythmia (abnormal heartbeats).

Some possibly fatal complications, which can occur even in a first-time user, include chest pain syndromes, heart attacks, strokes, and fatal as well as nonfatal arrhythmias. In addition, the following may occur: inflammation of the heart muscle, inflammation of the inner lining of the heart, blood clots in blood vessels, and enlargement of the heart.

Intravenous (IV) drugs can cause an infection of the heart called endocarditis. A hospital stay plus several weeks of medication are required for treatment. These infections may be fatal because they could lead to heart failure, heart attack, or stroke.

21. Is it possible to die from a broken heart?

Yes, the stress that comes with the loss of a loved one has on occasion triggered a fatal heart attack. Research has found that other emotions can also affect the heart.
EVALUATION ACTIVITY: TRACING THE FLOW OF BLOOD THROUGH THE HEART

TEACHER’S GUIDE

This activity, which can be used as an evaluation exercise, asks students to trace the flow of blood through the heart and indicate what is actually occurring at each step.

After studying the diagram included here (Figure 11), students are provided an answer sheet to write on, which allows the actual diagrams of the heart to be used more than once. A key is provided.
FIGURE 11: FLOW OF BLOOD THROUGH THE HEART

Arrange the following letters in the correct sequence to show blood flow through the heart and briefly describe what is happening in each step.

A
B
C
D
E
F
G
FLOW OF BLOOD THROUGH THE HEART

NAME: ____________________________________________________

Arrange the letters from Figure 11 (“Flow of Blood through the Heart”) in the correct sequence to show blood flow through the heart. Indicate what is happening at each step.

1. ____

____________________________________________________________________________
____________________________________________________________________________

2. ____

____________________________________________________________________________
____________________________________________________________________________

3. ____

____________________________________________________________________________
____________________________________________________________________________

4. ____

____________________________________________________________________________
____________________________________________________________________________

5. ____

____________________________________________________________________________
____________________________________________________________________________

6. ____

____________________________________________________________________________
____________________________________________________________________________

7. ____

____________________________________________________________________________
____________________________________________________________________________
FLOW OF BLOOD THROUGH THE HEART

NAME: ______________________________________________________

Arrange the letters from Figure 11 (“Flow of Blood through the Heart”) in the correct sequence to show blood flow through the heart. Indicate what is happening at each step.

1. **E** The right atrium receives de-oxygenated blood from the vena cava and pumps it to the right ventricle.

2. **A** The right ventricle pumps blood through the pulmonary arteries.

3. **C** The pulmonary arteries pump blood to the lungs.

4. **B** The pulmonary veins transport oxygenated blood back to the heart into the left atrium.

5. **G** The left atrium receives oxygenated blood from the lungs and pumps it into the left ventricle.

6. **F** The left ventricle pumps the oxygenated blood to the aorta.

7. **D** The aorta transports oxygenated blood to arteries which will carry it throughout the body.
THE BEAT GOES ON IMPLEMENTATION PLAN — WET LAB

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated Time</th>
<th>Materials/Equipment</th>
<th>Purpose/Objectives/ Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard limb lead EKG</td>
<td>60 minutes</td>
<td>Computer Vernier computer interface Logger Pro Vernier sensor Disposable electrode tabs</td>
<td>Purpose: To analyze the heart with an EKG Objectives: • To obtain a graphical representation of the electrical activity of the heart over a period of time. • To learn to recognize the different wave forms seen in an EKG, and associate these wave forms with the heart. • To determine the heart rate by determining the rate of individual wave forms in the EKG. • To record the EKG of a person at rest, after mild exercise, and in different body positions. Note any changes in these EKG readings after a mild stimulant. • To compare wave forms. Essential Questions: What are the different components of the waveforms and how can these components be used to determine heart rate? What is the direction of electrical activity for a QRS complex?</td>
</tr>
<tr>
<td>Alternative limb lead EKG</td>
<td>10 minutes</td>
<td>Same as above</td>
<td></td>
</tr>
</tbody>
</table>

Alignment with NC Competency Goals

<table>
<thead>
<tr>
<th>Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 1</td>
</tr>
<tr>
<td>Objectives 1.01, 1.02, 1.03, 1.04, 1.05</td>
</tr>
<tr>
<td>Goal 3</td>
</tr>
<tr>
<td>Objectives 3.04</td>
</tr>
<tr>
<td>Goal 4</td>
</tr>
<tr>
<td>Objectives 4.02, 4.04</td>
</tr>
</tbody>
</table>
THE BEAT GOES ON WET LAB: OVERVIEW
Adapted from Human Physiology with Vernier

ANALYZING THE HEART WITH EKG
An electrocardiogram (EKG or ECG) is a graphical recording of the electrical events occurring within the heart. In a healthy heart there is a natural pacemaker in the right atrium (the sinoatrial node, SA node) which initiates an electrical sequence. This impulse then passes down natural conduction pathways between the atria to the atrioventricular node (AV node) and from there to both ventricles. This electrical journey creates a unique deflection in the EKG that tells a story about heart function and heart health.

There are five components of a single heart beat: P, Q, R, S and T. The P wave represents the start of the electrical journey as the impulse spreads from the SA node downward from the atria through the AV node to the ventricles. Ventricular activation is represented by the QRS complex. The T wave results from ventricular repolarization, which is recovery of the ventricular muscle tissue to its resting state. By looking at several beats you can calculate the rate for each component.

Doctors and other trained personnel can look at an EKG tracing and see evidence for disorders of the heart, such as: abnormal slowing, speeding, irregular rhythms, injury to muscle tissue (angina) and death of muscle tissue (myocardial infarction). The length of an interval indicates whether an impulse is following its normal pathway. A long interval indicates that an impulse has been slowed or taken a longer route. A short interval indicates an impulse which followed a shorter route.

If a complex is absent, the electrical impulse did not rise normally or was blocked at that part of the heart. Lack of a normal depolarization of the atria leads to an absent P wave. An absent QRS complex after a normal P wave indicates the electrical impulse was blocked before it reached the ventricles. Abnormally shaped complexes result from abnormal speed of the impulse through the muscle tissue, such as in a myocardial infarction where the impulse cannot follow the normal pathway because of tissue death or injury. Electrical patterns may also be changed by metabolic abnormalities and by various medicines.

IN THIS EXPERIMENT
Students will use the EKG sensor to make a five-second graphical recording of your heart's electrical activity. Students will:

identify the five components of the waveforms and use them to determine your heart rate.

record the EKG of a person: at rest, after mild exercise, in different body positions and note changes in EKG readings with mild stimulants.

switch the red and green leads to simulate the change in electrical activity that can occur in a heart attack.

determine the direction of electrical activity for the QRS complex.
HOW THE EKG SENSOR WORKS

Heart muscle cells are polarized at rest. This means the cells have slightly unequal concentrations of ions across their cell membranes. An excess of positive sodium ions on the outside of the membrane causes the outside of the membrane to have a positive charge relative to the inside of the membrane. The inside of the cell is at a potential of about 90 millivolts (mV) less than the outside of the cell membrane. The 90 mV difference is called the resting potential.

The typical cell membrane is relatively impermeable to the entry of sodium. However, stimulation of a muscle cell causes an increase in its permeability to sodium. Sodium ions migrate into the cell through the opening of voltage-gated sodium channels. This causes a change (depolarization) in the electrical field around the cell. This change in cell potential from negative to positive and back is a voltage pulse called the action potential. In muscle cells, the action potential causes a muscle contraction.

Other ions and charged molecules are involved in the depolarization and repolarization of the cardiac muscle. These include potassium, calcium, chlorine, and charged protein molecules. The sum action potential generated during the depolarization and repolarization of the cardiac muscle can be recorded by electrodes at the surface of the skin. A recording of the heart’s electrical activity is called an electrocardiogram (EKG).

The cells of the heart’s conducting system will depolarize spontaneously. This spontaneous depolarization is most apparent in a cluster of cardiac muscle cells embedded in the upper wall of the right atrium. This group of cells is called the pacemaker (also known as the sinoatrial or SA node). Depolarization of the pacemaker generates a current that leads to the depolarization of all other cardiac-muscle cells. The wave of depolarization travels from the right atrium to the left atrium quickly enough that both atria contract at essentially the same time.

The atria and the ventricles are isolated from each other electrically by connective tissue that acts like the insulation on an electric wire. The depolarization of the atria does not directly affect the ventricles.

There is another group of cells in the right atria, called the atrioventricular or AV node, that will conduct the depolarization of the atria down a special bundle of conducting fibers (called the bundle of His) to the ventricles.

In the muscle wall of the ventricles are the Purkinje fibers, which are a special system of muscle fibers that bring depolarization to all parts of the ventricles almost simultaneously. This process causes a small time delay, so there is a short pause after the atria contract and before the ventricles contract. Because the cells of the heart muscle are interconnected, this wave of depolarization, contraction, and repolarization spreads across all of the connected muscle of the heart.

When a portion of the heart is polarized and the adjacent portion is depolarized, an electrical current is created that moves through the body. This current is greatest when one half of the connected portion of the heart is polarized and the adjacent half is not polarized. The current decreases when the ratio of polarized tissue to non-polarized tissue is less than one to one. The changes in these currents can be measured, amplified, and plotted over time. The EKG represents the summation of all the action potentials from the heart, as detected on the surface of the body. It does not measure the mechanical contractions of the heart directly.

The impulse originating at the SA node causes the atria to contract, forcing blood into the ventricles. Shortly after this contraction, the ventricles contract due to the signal conducted to them from the atria. The blood leaves the ventricles through the aorta and...
The polarity of the cardiac-muscle cells returns to normal and the heart cycle starts again.

THE ELECTROCARDIOGRAM

The electrocardiogram (EKG) is a graphic tracing of the heart’s electrical activity. A typical tracing consists of a series of waveforms occurring in a repetitive order. These waveforms arise from a flat baseline called the isoelectric line. Any deflection from the isoelectric line denotes electrical activity.

The five major deflections on a normal EKG are designated by the letters P, Q, R, S, and T. One heart cycle is represented by a group of waveforms beginning with the P wave, followed by the QRS wave complex, and ending with the T wave.

The P wave represents the depolarization of the atria and is associated with their contraction. The QRS wave complex consists of three waves. The first negative deflection is the Q wave and is followed by a positive deflection called the R wave. The complex ends with a negative deflection known as the S wave.

The QRS wave complex denotes depolarization of the ventricles and is associated with their contraction. Atrial repolarization occurs during the depolarization of the ventricles. For this reason, the waveform associated with atrial repolarization is undetectable on an EKG. The last wave is called the T wave, and is usually represented by a positive deflection. The T wave indicates ventricular repolarization.

Electrical energy is also generated by skeletal muscle, and can be seen as muscle artifacts if your arm is moved while the EKG is attached. The sequence from P wave to P wave represents one heart cycle. The number of cycles in a minute is called the heart rate and is typically 70-80 beats per minute at rest.

Some typical times for portions of the EKG are:

- P-R interval 0.12 to 0.20 seconds
- QRS interval less than 0.1 seconds
- Q-T interval less than 0.38 seconds

If your EKG does not correspond to the above numbers, DO NOT BE ALARMED! These numbers represent typical averages and many healthy hearts have
FIGURE 12: WAVEFORMS IN AN EKG

Atrial excitation begins as the SA node sends out an electrical charge. (Blue highlight indicates the spread of the electrical charge.) The charge stimulates both atria before being delayed at the AV node.

The AV node passes the electrical charge along the Purkinje fibers, starting ventricular excitation.

PR interval

The electrical charge spreads along the Purkinje fibers, stimulating both ventricles.

QRS complex

P Wave: Represents atrial depolarization, when the SA node sends an electrical charge toward the AV node.

QRS complex: Corresponds to the electrical wave that causes contraction of the left and right ventricles. This wave is significantly more forceful than that of the atria and involves more muscle mass, thus creating a greater EKG deflection. The QRS complex usually is less than or equal to 0.10 seconds.

T wave: Represents the repolarization of the ventricles. The QRS complex usually obscures the atrial repolarization wave so that it is not usually seen.

P R
Q S
T

Time (sec.)

mV

© 2007, 2008 DESTINY Traveling Science Learning Program • UNC-Chapel Hill • CB# 7448 • Chapel Hill, NC 27599 • moreheadplanetarium.org/go/destiny
data that fall outside of these parameters. To read an EKG effectively takes considerable training and skill. This sensor is NOT intended for medical diagnoses.

This sensor is equipped with circuitry that supports auto-ID. When used with LabPro, Go! Link, EasyLink, or CBL 2, the data-collection software identifies the sensor and uses predefined parameters to configure an experiment appropriate to the recognized sensor.

**CONNECTING THE EKG SENSOR TO A PERSON**

Use three electrode patches per subject. The electrodes can be reused, but they tend to absorb moisture (they are very hygroscopic) and, therefore, reuse is not recommended.

Once opened, the electrodes should be kept refrigerated in a clean, dry, air-tight container for storage. Even with air-tight storage, opened electrode packages cannot be stored from one year to the next.

1. Because the electrical signal produced by the heart and detected at the body’s surface is so small, it is very important that the electrode patch makes good contact with the skin. Scrub the areas of skin where the patches will be attached with a paper towel to remove dead skin and oil.

2. Peel three electrode patches from the backing paper. Firmly place the first electrode on the right wrist.

3. Place a second electrode on the inside of the right elbow.

4. Place a third electrode on the inside of the left elbow.

5. Place each electrode so it is on the inside part of the arm (closer to the body) and the tab on the edge of the electrode patch points down. This way, the wire of the sensor can hang freely without twisting the edge of the electrode patch.

6. Connect the micro alligator clips from the sensor to the tabs on the edges of the electrode patches.

7. Connect the black (or “reference”) alligator clip to the right wrist electrode patch. This is the reference point for the isoelectric line (baseline).

8. Connect the red (or positive) alligator clip to the left elbow electrode patch.

9. Connect the red (or positive) alligator clip to the left elbow electrode patch.

10. There are several different ways to connect the EKG sensor. This simple arrangement is appropriate for the classroom.

**CALIBRATION**

Because you are primarily interested in the shape and periodicity of the signal, the Vernier EKG sensor does not need to be calibrated. You can simply load the appropriate calibration file and experiment file. Any experiments described in Vernier’s booklet can be done using a stored Vernier calibration in volts, as described in the previous section. The sensor is designed to produce a signal between 0 and 5 volts, with 1 volt being the isoelectric line. Deviation from the isoelectric line indicates electrical activity.

*Please note: this activity is intended for educational purposes only. It is not appropriate for making diagnoses of illness or for other medical applications.*
EKG ANALYSIS EXPERIMENT: STUDENT’S GUIDE
ADAPTED FROM HUMAN PHYSIOLOGY WITH VERNIER

OBJECTIVES
In this experiment, you will:

- obtain graphical representation of the electrical activity of the heart over a period of time;
- learn to recognize the different wave forms seen in an EKG, and associate these wave forms with activity of the heart;
- determine the heart rate by determining the rate of individual wave forms in the EKG;
- monitor EKG of a person: at rest, after mild exercise, with different body positions, after mild stimulants;
- determine the axis of the heart;
- compare wave forms generated by alternate EKG lead placements.

Remember that this experiment is for educational purposes only. It is not appropriate for making diagnoses of illness or for other applications.

ELECTRODE POSITIONS: HEART’S AXIS
Different arrangements of electrode patches will change the shape and intensity of the measured signal. Each arrangement is called a “lead.” Each lead reveals unique information based on the lead’s orientation relative to the axis of the heart. (Scrub the areas of the skin where the electrode patches are placed with a paper towel to remove skin oil and moisture.)

STANDARD LIMB LEAD EKG
1. Connect the EKG Sensor to the Vernier computer interface, and open Logger Lite Go Link.

2. Attach three electrode tabs to your arms, as shown in the figure below. Place a single patch on the inside of the right wrist, on the inside of the right upper forearm (distal to the elbow), and on the inside of the left upper forearm (distal to elbow).

3. Connect the EKG clips to the electrode tabs as shown in the figure below. Sit in a relaxed position in a chair, with your forearms resting on your legs or on the arms of the chair. When you are properly positioned, have someone click “Collect” to begin data collection.

4. Observe the EKG on your computer screen or print a copy of your EKG. Record your data and analyses in the tables on your data sheet.

Table 1: Resting EKG
Record the EKG of a person who is at rest. The person whose EKG is being recorded should remain calm and relaxed. Encourage the person to breathe normally.

Table 2: EKG after Mild Exercise
Using the EKG Sensor, record an EKG of a person who is initially at rest. Disconnect the sensor wires from the electrode patches, but leave the patches on the person being monitored. Have the person exercise for three minutes by jogging in place or by “stepping in time.” Reattach the sensor wires to the electrodes on the person when they have finished exercising and record a new EKG. Compare the resting EKG to the EKG after mild exercise.

Table 3: EKG and Different Body Positions
Use body position as your independent variable. Record the resting EKG as before. Then have the person sit, stand, or lie down. Make no other changes. Compare your results with your resting EKG. Note any changes in heart rate, interval times, height of R wave, etc.

Table 4: EKG and Mild Stimulants
Drink a couple of cups of caffecinated coffee or cola. Record an EKG. Compare your results with those at rest and following mild exercise. Note: This might show less effect on people who are accustomed to large amounts of caffeine.
**ALTERNATE LIMB LEAD EKG**

Exchange the red and green EKG clips so that the green clip is now attached to the electrode tab on the left arm and the red clip is on the right arm. Sit in a relaxed position in a chair, with your forearms resting on your legs or on the arms of the chair. When you are properly positioned, have someone click “Collect” to begin data collection. Print or sketch the tracing for alternate limb lead placement only.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Description</th>
<th>Normal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-R interval</td>
<td>Time from beginning of P wave to start of QRS complex.</td>
<td>0.12 to 0.20 seconds</td>
</tr>
<tr>
<td>QRS interval</td>
<td>Time from Q deflection to S deflection.</td>
<td>Less than 0.12 seconds</td>
</tr>
<tr>
<td>Q-T interval</td>
<td>Time from Q deflection to the end of T</td>
<td>0.30 to 0.40 seconds</td>
</tr>
<tr>
<td>R-R interval</td>
<td>Time from R1 to R2</td>
<td>Varies depending on activity</td>
</tr>
</tbody>
</table>

**STANDARD RESTING ELECTROCARDIOGRAM INTERVAL TIMES**

<table>
<thead>
<tr>
<th>Interval</th>
<th>Description</th>
<th>Normal Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR interval</td>
<td>Time from beginning of P wave to end of PR segment</td>
<td></td>
</tr>
<tr>
<td>PR segment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QRS complex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QT interval</td>
<td>Time from beginning of P wave to end of T</td>
<td>0.30 to 0.40 seconds</td>
</tr>
<tr>
<td>ST segment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QT interval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NAME: ____________________________________________________

<table>
<thead>
<tr>
<th>TABLE 1. ANALYSIS OF EKG — AT REST</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVAL</td>
</tr>
<tr>
<td>P-R</td>
</tr>
<tr>
<td>QRS</td>
</tr>
<tr>
<td>Q-T</td>
</tr>
<tr>
<td>R-R</td>
</tr>
</tbody>
</table>

Heart Rate (bpm) = 60 sec./R2-R1 ____________

<table>
<thead>
<tr>
<th>TABLE 2. ANALYSIS OF EKG — AFTER MILD EXERCISE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVAL</td>
</tr>
<tr>
<td>P-R</td>
</tr>
<tr>
<td>QRS</td>
</tr>
<tr>
<td>Q-T</td>
</tr>
<tr>
<td>R-R</td>
</tr>
</tbody>
</table>

Heart Rate (bpm) = 60 sec./R2-R1 ____________

<table>
<thead>
<tr>
<th>TABLE 3. ANALYSIS OF EKG — WITH DIFFERENT BODY POSITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVAL</td>
</tr>
<tr>
<td>P-R</td>
</tr>
<tr>
<td>QRS</td>
</tr>
<tr>
<td>Q-T</td>
</tr>
<tr>
<td>R-R</td>
</tr>
</tbody>
</table>

Sitting Heart Rate (bpm) = 60 sec./R2-R1 ____________
Standing Heart Rate (bpm) = 60 sec./R2-R1 ____________
Lying Down Heart Rate (bpm) = 60 sec./R2-R1 ____________

<table>
<thead>
<tr>
<th>TABLE 4. ANALYSIS OF EKG — AFTER MILD STIMULANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVAL</td>
</tr>
<tr>
<td>P-R</td>
</tr>
<tr>
<td>QRS</td>
</tr>
<tr>
<td>Q-T</td>
</tr>
<tr>
<td>R-R</td>
</tr>
</tbody>
</table>

Heart Rate (bpm) = 60 sec./R2-R1 ____________
## Equipment Needed for *The Beat Goes On* Wet Lab

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Catalog Number</th>
<th>Item</th>
<th>Unit</th>
<th>Price</th>
<th>Minimum Purchase</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REQUIRED EQUIPMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vernier</td>
<td>EKG-BTA</td>
<td>EKG Sensor with 100 disposable electrodes</td>
<td>1</td>
<td>$144.00</td>
<td>1</td>
<td>$144.00</td>
</tr>
<tr>
<td>Vernier</td>
<td>Go-LINK</td>
<td>Go! Link</td>
<td>1</td>
<td>$59.00</td>
<td>1</td>
<td>$59.00</td>
</tr>
</tbody>
</table>
| **EQUIPMENT TOTAL**                                                                                         |       |       |       |       | **$203.00**
| **REQUIRED CONSUMABLES**                                                                                     |       |       |       |       |       |
| Vernier  | ELEC           | Disposable electrodes                   | 1 pkg. of 100 | $10.00 |                  | $10.00 |
| Staples or drug store | ELEC | Alcohol prep pads for cleaning stethoscopes | 1 box of 100 | $5.00 |                  | $5.00 |
| **CONSUMABLES TOTAL**                                                                                        |       |       |       |       | **$15.00**

**Vendor information:** Vernier, 13879 S.W. Millikan Way, Beaverton, OR 97005-2886; 503-277-299; orders@vernier.com
## THE BEAT GOES ON IMPLEMENTATION PLAN — POST-LAB

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated Time</th>
<th>Materials/Equipment</th>
<th>Purpose/Objectives/Essential Questions</th>
</tr>
</thead>
</table>
| **EKG and heart rate data analysis**          | 30 minutes     | Data Sheet  Results of EKG  Sample data with standard and alternative limb lead placements | **Purpose:** To analyze the heart activity.  
**Objectives:**  
- To learn to recognize the different wave forms seen in an EKG, and associate these wave forms with the heart.  
- To determine the heart rate by determining the rate of individual wave forms in the EKG.  
- To record the EKG of a person at rest, after mild exercise, and in different body positions. Note any changes in these EKG readings after a mild stimulant.  
- To compare wave forms generated by alternative EKG lead placements  
- To analyze EKG tracings from patients.  
**Essential Questions:**  
What are the different components of waveforms and how can they be used to determine heart rate?  
How can we use EKG tracings to recognize heart problems?  
What is the direction of electrical activity for a QRS complex? |
| **Analysis of EKG tracings from patients**    | 30 minutes     | EKG tracings from patients                                |                                                                                                           |
| **Inside Look: Heart Attack video and questions** | 26 minutes    | Video: Inside Look: Heart Attack  This VHS video can be ordered online from www.teachersdiscovery.com for $59.95. The catalog number is SBV182G7. | **Essential Questions:**  
What are the different components of waveforms and how can they be used to determine heart rate?  
How can we use EKG tracings to recognize heart problems?  
What is the direction of electrical activity for a QRS complex? |
| **Rescue 911 Activity**                      | 20 minutes     | Copies of activity                                       |                                                                                                           |
| **The Beat Goes On quiz game**               | 60 minutes     | CD                                                       |                                                                                                           |

## Alignment with NC Competency Goals

### Biology

<table>
<thead>
<tr>
<th>Goal 1</th>
<th>Objectives 1.01, 1.02, 1.03, 1.05</th>
<th>Goal 3</th>
<th>Objectives 3.04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal 2</td>
<td>Objectives 2.02</td>
<td>Goal 4</td>
<td>Objectives 4.02, 4.04</td>
</tr>
</tbody>
</table>
DATA ANALYSIS: INTERPRETING AN EKG

Adapted from Human Physiology with Vernier

1. A positive deflection indicates electrical activity moving toward the green EKG lead. Examine the two major deflections of a single QRS complex (R wave and S wave) in your EKG tracing. Using this data, answer the following two questions:

• Does ventricular depolarization proceed from right to left or left to right? ________________________________

• How does your tracing from Part II confirm your answer? ________________________________

2. Health-care professionals ask the following questions when interpreting an EKG:

• Can all components be identified in each beat?

• Are the intervals between each component and each complex consistent?

• Are there clear abnormalities of any of the wave components?

Using these questions as guides, analyze each of the following three-beat EKG tracings and record your conclusions in the table provided.

Indicate presence or absence of the P wave, and whether other intervals and/or shapes are normal or abnormal. The first analysis (A) is done for you.
<table>
<thead>
<tr>
<th>EKG</th>
<th>Beat</th>
<th>P Wave</th>
<th>PR Interval</th>
<th>QRS Interval</th>
<th>QRS Shape</th>
<th>T Wave Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A.</td>
<td>1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>B.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DATA ANALYSIS: INTERPRETING AN EKG
Adapted from Human Physiology with Vernier

1. The initial deflection of the QRS complex in Part I of the experiment is positive, with the next deflection negative. This indicates that the initial depolarization then proceeds to the left, as shown by the negative S wave.

In Part II, the leads are switched. The initial QRS wave is negative because its depolarization is moving toward the right side of the body, this time away from the green lead. This confirms the finding in Part I of the experiment.

2. Following are details about each of the tracings presented on the Data Analysis worksheet.

   A. Second-degree heart block. This is a term given to the sudden dropping of a ventricular beat (QRS complex). A normal P wave is generated, but at periodic intervals the impulse fails to reach the ventricles. This can be caused by scarring in conduction pathways or the acute injury which occurs in myocardial infarction. If this condition persists, implantation of an artificial pacemaker may be considered.

   B. Atrial fibrillation. There are no P waves seen in this tracing, indicating that the sinoatrial node is not generating electrical impulses. Instead, electrical impulses are flowing in random directions all over the atria and random impulses make their way through the atrial ventricular node down to the ventricles. This results in an irregular heartbeat, but the ventricles are contracting normally. This is a common condition at all ages, but is even more common in the elderly. Since electrical activity in the atria is flowing in random directions, the atria are not contracting. This reduces the efficiency of the heart, because blood must flow passively from the atria to the ventricles. The lack of contraction of the atria leads to a stagnation of blood along its walls and a higher incidence of blood in many of these patients. Others may be treated by electrical cardioversion, where a shock is administered to the heart, causing depolarization of all of the muscle, allowing the sinoatrial node to resume its role as a natural pacemaker.

   C. Ischemia. In this tracing, the T wave is inverted as a result of abnormal repolarization of ventricular tissue. This most commonly occurs when heart muscle is not being properly supplied with blood and hence oxygen. This is the pattern often seen in patients with angina (chest pain), where partial blockages in the coronary arteries result in temporary muscle pain. After treatment with nitroglycerin or other medication the T wave will normalize.

   D. First-degree heart block. The prolonged P-R interval is caused by abnormalities in the pathway from the sinoatrial node to the ventricles. This commonly occurs in the vicinity of the atrioventricular node. This condition is usually benign.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D.</td>
<td>1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY**

- X: Present
- : Absent
- Nml: Normal
- Abn: Abnormal
- Abs.: Absence
AN INSIDE LOOK: HEART ATTACK
INFORMATION FOR TEACHERS

DESCRIPTION OF THIS RESOURCE

*An Inside Look: Heart Attack* is a video examining what happens when a heart attack occurs in 45-year-old Jon Palmer’s body. The cardiovascular system is challenged by cholesterol deposits and cannot do its job of keeping oxygen-rich blood pumping.

On the following page of this curriculum guide you will find two worksheets that you can copy for your students. Both worksheets enable your students to watch and listen actively, finding and recording answers to the questions provided as they view *An Inside Look*. Choose the worksheet that you feel best meets your students’ needs.

You may wish to discuss the questions before you begin showing the video. You may also wish to stop the video at points where you feel your students would benefit from a short discussion or explanation of vocabulary and topics that may arise.

This VHS video is 26 minutes long.

ANSWER KEY

This is the answer key to the first worksheet provided:
1-c; 2-a; 3-c; 4-b; 5-a; 6-b; 7-a: 8-c; 9-b; 10-c.

The second worksheet does not include a key.

ORDERING INFORMATION

*An Inside Look: Heart Attack* can be ordered online from www.teachersdiscovery.com for $59.95. The catalog number is SBV182G7.
AN INSIDE LOOK: HEART ATTACK

NAME: ____________________________________________________

1. Every day the heart pumps about 1,800 gallons of blood through _______ miles of blood vessels.
   a. 7,500  b. 600,000  c. 75,000

2. What does the heart supply to the other organs?
   a. oxygen  b. nitrogen  c. hydrogen

3. How many elastic muscle cells does the human heart have?
   a. 6  b. 20,000  c. 50 million

4. ___________ is found in our liver.
   a. glucose  b. cholesterol  c. gingivitis

5. The heart is the only organ in the body that has its own power supply, generating ____________.
   a. electric impulses  b. high cholesterol  c. mass production

6. Cholesterol is found in the human body and in the fats in foods from ____________.
   a. protists  b. animals  c. plants

7. The beginning of a heart attack may feel like you have ____________.
   a. indigestion  b. a toothache  c. diarrhea

8. ____________ is the most primitive hormone and has the most powerful reaction when your body is in crisis.
   a. cortisone  b. intermiden  c. adrenaline

9. Heart cells can be replaced after a heart attack.
   a. true  b. false

10. ____________ health habits (such as eating a fatty diet, getting little or no exercise, and smoking) can lead to a heart attack.
    a. Moderate  b. Great  c. Poor

SOURCE: TEACHER'S DISCOVERY: Science Division (888) 977-2436
AN INSIDE LOOK: HEART ATTACK

NAME: ____________________________________________________

1. What are “controllable risks”?

2. What are the primary controllable factors that put one at risk for developing heart disease?

3. What are the primary uncontrollable factors that put one at risk for developing heart disease?

4. What happens to the heart during a heart attack?

5. What are the symptoms of a heart attack?

6. What happens to heart muscle as a result of a heart attack?

7. What types of lifestyle choices will encourage good cardiovascular and general health?
CARDIOLOGY CASE STUDIES

In your group, diagnose and suggest possible treatments for your patient based upon the information provided and what you have learned in class.

Your group will present to the class your recommendations for your assigned patient and ask for additional feedback.

CASE 1: CAROL
A middle-aged woman is admitted to the coronary unit with a possible heart attack (myocardial infarction). She called her doctor earlier in the day to complain of indigestion. How would you go about diagnosing and treating her?

CASE 2: SUSAN
A 14-year-old girl is undergoing a physical examination before being allowed to run track. When you listen to her heart with a stethoscope it has a swishing sound. What are your diagnosis, prognosis, and possible treatments?

CASE 3: JOHN
A man in his 40s is having angina due to a blood clot that lodges in the left coronary artery. What are possible treatments?

CASE 4: CHRISTINA
A 45-year-old Hispanic female was diagnosed with type II diabetes five years ago. She has higher than average blood pressure and high cholesterol levels and is overweight. Christina was recently discharged from the hospital where she was recuperating from a heart attack. What is her diagnosis and possible treatment?

CASE 5: ALTON
A 16-year-old Caucasian male has recently felt more tired than usual, as well as dizzy and light headed on several occasions. He passed out in class a few days ago, and just yesterday had some chest pain. Alton appears to have an unusually slow heart rhythm. What steps should be taken to possibly diagnose and treat his problem?

CASE 6: CHARLES
An African American male in his 40s is complaining of chest pains. After talking with him, you learn he has a very stressful job, smokes 2-3 pack of cigarettes daily. He is obese and has a diet heavy in saturated fats. He has been diagnosed with high blood pressure and does not get much physical exercise. Charles is not actually having a heart attack, but you explain that a heart attack is quite possible. Explain to him what the chest pain indicates and why he is a prime candidate for a heart attack.

CASE 7: MARY
An elderly lady in her 70s is complaining of shortness of breath and has intermittent fainting spells. Her doctor has run some tests and has found that her AV node is not functioning properly. What would be your suggestion for her treatment?

CASE 8: PHYLLIS
A woman in her 50s is suspected of having heart disease. You are assisting the nurse with this patient and you are asked to explain to the patient’s daughter who is about your same age, why the following procedures might be beneficial in evaluating her mother for heart disease: blood pressure measurements, cholesterol levels, electrocardiogram, and a chest X-ray.
GROUP WORK:
CARDIOLOGY CASE STUDIES

Assign each group of 4-6 students a patient. Each group must diagnose and provide possible treatments for their patient based upon the information provided and what they have learned in the previous exercises of this module. Each group will present their recommendations to the class for their assigned patient and ask for additional feedback.

CASE 1: CAROL
A middle-aged woman is admitted to the coronary unit with a possible heart attack (myocardial infarction). She called her doctor earlier in the day to complain of indigestion. How would you go about diagnosing and treating her?

Cardiovascular disease is the leading cause of death for both men and women, but it kills more women overall—nearly 500,000 each year, more than the next seven causes of death combined and nearly twice as many as cancer. Women are far less likely than men to get basic medical care that could significantly reduce their risk of cardiovascular disease. Women’s symptoms may vary and may not be the same as men’s.

The following tests should be performed in order to properly diagnose Carol:

• Blood pressure measurements test the elasticity of arteries and how well the left ventricle is functioning.
• EKG (ECG) tests the electrical activity the heart.

Abnormalities in the shape of the waves or their timing may indicate that something may be wrong with the heart’s intrinsic conduction system. It may indicate a heart attack, past or present.
• Cholesterol levels determine the possibility of damage to blood vessels.

CASE 2: SUSAN
A 14-year-old girl is undergoing a physical examination before being allowed to run track. When you listen to her heart with a stethoscope, it has a swishing sound. What are your diagnosis, prognosis, and possible treatments?

Murmurs are abnormal or unusual heart sounds. If blood is interrupted from its normal smooth flow because it strikes obstacles in its path, its flow becomes turbulent and it generates a sound called a heart murmur. Heart murmurs are fairly common in young children and some elderly people with perfectly healthy hearts, possibly because they may have relatively thin heart walls which have a tendency to vibrate rushing blood.

Most often heart murmurs indicate a problem with a defective valve which does not close tightly (is incompetent) and makes a swishing sound which can be heard after the valve has supposedly closed, as the blood flows back through the partially open valves. If blood flows turbulently through narrowed (stenosed) valves, other distinct sounds can be heard.

Treatment should include medication, which will vary depending on the severity of her condition once correctly diagnosed, or if the problem persists, Susan may eventually need a heart valve replacement.

CASE 3: JOHN
A man in his 40s is having angina due to a blood clot that lodged in the left coronary artery. What are possible treatments?

Possible treatments for John include:

• Angioplasty — a surgical procedure which can open the artery with a balloon and then, if indicated, install a stent (a scaffold-like device) that helps to keep the vessel open.
• Cardiac bypass surgery provides an alternative route around a blockage using a blood vessel from the calf or elsewhere in the body.
CASE 4: CHRISTINA
A 45-year-old Hispanic female was diagnosed with type II diabetes five years ago. She has higher than average blood pressure and high cholesterol levels and is overweight. Christina was recently discharged from the hospital where she was recuperating from a heart attack. What is her diagnosis and possible treatment?

Christina should be placed on a healthy diet to insure weight loss. She should work with the dietician to make sure she is getting all the required nutrients. Christina will be prescribed medications to help her heart beat more efficiently such as blood pressure medications, beta blockers and a statin to help lower her cholesterol. Christina should be scheduled for a rehabilitation program that will enable her to get the exercise she needs for weight loss and to strengthen her heart. She will also need to schedule required appointments with her physician and make sure she gets sufficient rest while the heart is recovering from the damage. Daily doses of aspirin will help to prevent blood clotting and possible future heart attacks.

Christina can reduce her risk of heart disease and blood vessel disease by lowering her cholesterol level. Total blood cholesterol above 200mg/dl, LDL cholesterol above 130mg/dl and HDL below 35 mg/dl are indicators of problematic cholesterol.

Minorities like Christina are more likely to die of heart disease because of their economic status, education, and lack of adequate health care. Hispanics are 1.7 times more likely to be hospitalized for congestive heart failure.

People with diabetes tend to have low HDL and high triglyceride levels, both of which boost the risk of heart and artery disease.

Overweight can be a factor in heart disease because too much fat can act like a poison spewing out substances that contribute to diabetes and high blood pressure and put stress on the cardiovascular system to work harder in general. Fat cells produce compounds that cause high blood pressure.

High blood pressure (systolic 140mmHg or higher and/or a diastolic pressure above 90mm Hg for an extended period of time) causes the heart to work harder than normal. The arteries are consequently more prone to injury. High blood pressure also harms arteries and arterioles, as over time they become scarred, hardened, and less elastic, probably speeding atherosclerosis.

CASE 5: ALTON
A 16-year-old Caucasian male has recently felt more tired than usual, as well as dizzy and light-headed on several occasions. He passed out in class a few days ago, and just yesterday had some chest pain. Alton appears to have an unusually slow heart rhythm. What steps should be taken to possibly diagnose and treat his problem?

Alton should have an EKG (ECG) to test the electrical activity of his heart. Abnormalities in the shape of the waves or their timing may indicate that something may be wrong with the heart’s intrinsic conduction system. It may indicate a heart attack, past or present. Other information that can be gained from an EKG.

- Fibrillation — (rapid uncoordinated shuddering of the heart) caused by lack of adequate blood supply to the heart muscle.
- Heart block — damage to the AV node can result in partial or total release of the ventricles from the control of the SA node
- Tachycardia — rapid heart rate over 100 beats per minute.
- Bradycardia — a slow heart rate of less than 60 beats per minute.

Depending on what kind of information is obtained from the EKG, Alton may be prescribed medications to help with the problem.

CASE 6: CHARLES
An Afro American male in his 40s is complaining of chest pains. After talking with him, you learn he has a very stressful job, smokes 2-3 pack of cigarettes daily; he is obese and has a diet heavy in saturated fats. He has been diagnosed with high blood pressure and does not get much physical exercise. Charles is not actually having a heart attack, but you explain that a heart attack is quite possible. Explain to him what the chest pain indicates and why he is a prime candidate for a heart attack.

Charles has many of the risk factors for cardiovascular disease. He is obese, Afro American, under stress and a smoker. Charles should go on a healthy diet, stop smoking, try to reduce his stress levels, and get more exercise. The following should be explained to Charles:

When the heart beats very rapidly, the myocardium,
a layer of the heart which consists of thick bundles of cardiac muscle, may not receive an adequate blood supply. Rapid heart beats results in shortened relaxation periods, the time when blood is able to flow to the heart tissue, resulting in crushing chest pain called angina. Prolonged angina may result in an area of dead tissue in the heart wall caused by a blocking of local blood circulation, called an infarct. This is commonly referred to as a “heart attack.”

Smoking is the single most preventable cause of death in the United States. Smokers have more than twice the risk of heart attacks than non smokers.

People who are sedentary have twice the risk of heart disease as those who are physically active. An inactive lifestyle combined with overeating can lead to excess weight and result in higher blood cholesterol levels and raise the risk of heart disease. For most healthy people 30-60 minutes of physical activity daily is recommended to condition the heart and lungs.

High blood pressure (systolic 140mm Hg or higher and/or a diastolic pressure above 90mm Hg for an extended period of time) causes the heart to work harder than normal and the arteries are consequently more prone to injury. High blood pressure also hurts arteries and arterioles because over time they become scarred, hardened and less elastic which probably speeds atherosclerosis.

Blood pressure measurements test the elasticity of arteries and how well the left ventricle is functioning.

Cholesterol levels determine the possibility of damage to blood vessels. People can reduce their risk of heart disease and blood vessel disease by lowering their cholesterol level. Total blood cholesterol above 200mg/dl, LDL cholesterol above 130HDl mg/dl; and HDL below 35 mg/dl are indicators of problematic cholesterol.

EKG (ECG) tests the electrical activity the heart. Abnormalities in the shape of the waves or their timing may indicate that something may be wrong with the heart’s intrinsic conduction system. It may indicate a heart attack, past or present. Other information that can be gained from an EKG:

- Fibrillation — rapid uncoordinated shuddering of the heart caused by lack of adequate blood supply to the heart muscle.
- Heart block — damage to the AV node can result in partial or total release of the ventricles from the control of the SA node.
- Tachycardia — rapid heart rate over 100 beats per minute.
- Bradycardia — a slow heart rate of less than 60 beats per minute.

A chest X-ray would indicate the heart size, tumors, or possible chest disorders that would affect the heart.

CASE 7: MARY

An elderly lady in her 70s is complaining of shortness of breath and has intermittent fainting spells. Her doctor has run some tests and has found that her AV node is not functioning properly. What would be your suggestion for her treatment?

You would suggest that Mary have surgery to implant an artificial pacemaker.

CASE 8: PHYLLIS

A woman in her 50s is suspected of having heart disease. You are assisting the nurse with this patient. You are asked to explain to the patient’s daughter who is about your same age why the following procedures might be beneficial in evaluating her mother for heart disease: blood pressure measurements, cholesterol levels, electrocardiogram, and a chest X-ray.

High blood pressure (systolic 140mm Hg or higher and/or a diastolic pressure above 90mm Hg for an extended period of time) causes the heart to work harder than normal and the arteries are consequently more prone to injury. High blood pressure also hurts arteries and arterioles because over time they become scarred, hardened and less elastic which probably speeds atherosclerosis.

Blood pressure measurements test the elasticity of arteries and how well the left ventricle is functioning.

Cholesterol levels determine the possibility of damage to blood vessels. People can reduce their risk of heart disease and blood vessel disease by lowering their cholesterol level. Total blood cholesterol above 200mg/dl, LDL cholesterol above 130HDl mg/dl; and HDL below 35 mg/dl are indicators of problematic cholesterol.

EKG (ECG) tests the electrical activity the heart. Abnormalities in the shape of the waves or their timing may indicate that something may be wrong with the heart’s intrinsic conduction system. It may indicate a heart attack, past or present. Other information that can be gained from an EKG:

- Fibrillation — rapid uncoordinated shuddering of the heart caused by lack of adequate blood supply to the heart muscle.
- Heart block — damage to the AV node can result in partial or total release of the ventricles from the control of the SA node.
- Tachycardia — rapid heart rate over 100 beats per minute.
- Bradycardia — a slow heart rate of less than 60 beats per minute.

A chest X-ray would indicate the heart size, tumors, or possible chest disorders that would affect the heart.
## The Beat Goes On Quiz Game Questions

<table>
<thead>
<tr>
<th>Fact or Fiction</th>
<th>Structure and Function</th>
<th>Heart Regulation</th>
<th>Valves</th>
<th>Risk Factors</th>
<th>Hodge Podge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>200</strong></td>
<td>Heart disease is the number one killer of adult men and women in the United States.</td>
<td>What are the thick walled pumping chambers of the heart called and how many are there?</td>
<td>What is another name for the sinoatrial node or SA node and where is it located?</td>
<td>How many valves does your heart contain and what is their primary function?</td>
<td>What are the blood vessels that connect the veins to the arteries called?</td>
</tr>
<tr>
<td><strong>400</strong></td>
<td>Pulmonary circulation involves the left side of the heart and is the circulation of oxygen-poor blood to the lungs.</td>
<td>Which thin walled chambers receive the blood in the heart and how many are there?</td>
<td>What stimulates the atrioventricular (AV) node, where is the AV node located, and what is the result of this stimulation?</td>
<td>What is the difference between a bicuspid valve and a tricuspid valve?</td>
<td>Cardiac muscle is self excitable and specialized and it (can/cannot) stimulate its own contraction without an electrical impulse from the central nervous system.</td>
</tr>
<tr>
<td><strong>600</strong></td>
<td>Coronary heart disease can affect any of the body’s arteries, veins, capillaries or the heart muscle.</td>
<td>Name the four chambers of the heart.</td>
<td>What are the Purkinje fibers, where are they located, and what do their contractions cause?</td>
<td>Name the 2 semilunar valves and tell where they are located.</td>
<td>What is a septal defect and how does it affect the heart function?</td>
</tr>
<tr>
<td><strong>800</strong></td>
<td>Dilated cardiomyopathy is the most common form and can be caused by viral infection or an autoimmune reaction.</td>
<td>What is the pericardium and what does it do?</td>
<td>Trace the electrical impulses through the heart starting at the sinoatrial node.</td>
<td>What are the 2 atrioventricular valves and where are they located?</td>
<td>What is considered high blood pressure and how does high blood pressure affect the heart and blood vessels?</td>
</tr>
<tr>
<td><strong>1000</strong></td>
<td>Several conditions, including past or present heart attacks, as well as fibrillations, heart blocks, and irregular heartbeats can be detected using an electrocardiogram.</td>
<td>Trace the flow of blood through the heart starting with the right atrium.</td>
<td>Name the two types of controlling systems which regulate the heart activity.</td>
<td>What is an incompetent valve and how can it be corrected?</td>
<td>What is a myocardial infarction and what does it indicate?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Name the three recognizable waves of a typical electrocardiogram and tell what happens during each wave.</td>
</tr>
</tbody>
</table>
### The Beat Goes On Quiz Game Answers

<table>
<thead>
<tr>
<th>Fact or Fiction</th>
<th>Structure and Function</th>
<th>Heart Regulation</th>
<th>Valves</th>
<th>Risk Factors</th>
<th>Hodge Podge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>200</strong></td>
<td><strong>Fact.</strong></td>
<td>Ventricle. There are two, right and left.</td>
<td>Sinoatrial (SA) node is called the pacemaker and is located in the right atrium.</td>
<td>Four valves located in the heart act to allow blood flow in only one direction through the chambers of the heart.</td>
<td>Your genetics or inheritance.</td>
</tr>
<tr>
<td><strong>400</strong></td>
<td><strong>Fiction.</strong> The right side of the heart pumps oxygen-poor blood to the lungs via the pulmonary artery.</td>
<td>Atria (atrium). There are two, right and left.</td>
<td>The atrioventricular (AV) node is located in the junction of the atria and ventricles, receives impulses from the SA node which causes contraction of the ventricles.</td>
<td>Bicuspid valves consist of two cusps or flaps and tricuspid valves consist of three cusps or flaps.</td>
<td>Several factors contribute to heart disease and include smoking, high cholesterol, lack of physical activity, high blood pressure, overweight, and diabetes.</td>
</tr>
<tr>
<td><strong>600</strong></td>
<td><strong>Fiction.</strong> Coronary heart disease affects the heart muscle itself, while coronary artery disease affects the blood vessels.</td>
<td>The four chambers of the heart are the right and left atria and right and left ventricles.</td>
<td>Purkinje fibers are spread within the muscle of the ventricle walls, receive impulses from the AV bundle to cause contractions that send blood through the large arteries.</td>
<td>The two semilunar valves, the pulmonary and aortic valves, are located at the base of these two large arteries.</td>
<td>A septal defect is a hole in the heart and lets blood flow between the right and left chambers.</td>
</tr>
<tr>
<td><strong>800</strong></td>
<td><strong>Fact.</strong></td>
<td>Pericardium protects and anchors the heart to the surrounding structure and provides a slippery lubricating fluid.</td>
<td>Electrical impulses began in the sinoatrial node travel to the atrioventricular node through the bundle of His (AV bundle) which takes the impulse through to both ventricles to cause them to contract.</td>
<td>Two atrioventricular (AV) valves, right AV valve and left AV valve, are located at the base of the atria to separate the atria and the ventricles.</td>
<td>Low density lipoproteins (LDL), triglycerides, and high density lipoproteins (HDL) make up the total cholesterol reading; high levels of LDL or triglycerides are factors that contribute to heart disease.</td>
</tr>
<tr>
<td><strong>1000</strong></td>
<td><strong>Fact</strong></td>
<td>Right atrium, right ventricle, pulmonary arteries to the lungs, pulmonary veins, left atrium, left ventricle which pumps blood through the aorta to the body</td>
<td>Autonomic nervous system and intrinsic conduction systems which is made of heart tissue</td>
<td>An incompetent valve or leaky valve forces the heart to repump the same blood and can be corrected with a synthetic valve or a valve from a pig.</td>
<td>Medical procedures used to assess heart function include electrocardiogram (EKG), chest X-ray, cardiac catheterization, and echocardiogram.</td>
</tr>
</tbody>
</table>
### THE BEAT GOES ON IMPLEMENTATION PLAN — ADDITIONAL ACTIVITIES & RESOURCES

<table>
<thead>
<tr>
<th>Activity</th>
<th>Estimated Time</th>
<th>Materials/Equipment</th>
<th>Subjects Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pamphlet on a Heart-Related Topic</td>
<td>60 minutes</td>
<td>Instructional/scoring rubric</td>
<td>English</td>
</tr>
<tr>
<td>Feel the Pulse: An activity for measuring heart rate</td>
<td>60 minutes</td>
<td>Copies of the activity</td>
<td>Math, Science</td>
</tr>
<tr>
<td>Let’s Get It Pumping: An activity for calculating stroke volume</td>
<td>60 minutes</td>
<td>Tennis ball, meter stick, calculator, watch with a second hand</td>
<td>Math, Science</td>
</tr>
<tr>
<td>Vital Stats: Students use data tables to record, organize, and analyze vital information related to heart health</td>
<td>60 minutes</td>
<td>Copies of the handout</td>
<td>Math, Science</td>
</tr>
</tbody>
</table>

**Additional Resource:**
HHMI – Hearts and Hypertension Blazing Genetic Trails and The Virtual Lab Series- [www.biointeractive.org](http://www.biointeractive.org);
CREATE A PAMPHLET ON A HEART-RELATED TOPIC

Instructions for Students

ASSIGNMENT
Select and research one heart-related topic from the list provided below, or choose your own heart-related topic to research. Based on your research, prepare an instructional pamphlet to present to share with your class.

PAMPHLET TOPICS

What Is Angina?  Heart Transplants
What Is Congestive Heart Failure? Living with Heart Failure  Surgery and Other Treatments
What Is Atrial Fibrillation? What Are Arrhythmias (Tachycardia / Bradycardia)?  New Frontiers in Treating Heart Disease/ Stem Cell Research
What Is Metabolic Syndrome?  Stroke / TIA
Cardiac Medications and How They Work  Rheumatic Heart Disease
Congenital Heart Defects  Women and Heart Disease
Cardiomyopathy and Athletes  What is Echocardiography?
What is Bacterial Endocarditis?  Numbers that Count for a Healthy Heart
Cholesterol-Lowering Drugs / Statins  How Do Cocaine, Marijuana, and Other Drugs Affect the Heart?

ASSESSMENT RUBRIC

1. Research
   1  2  3  4  5
   Has 1 source.  Has 3 sources.  Has 5 sources.

2. Accuracy
   1  2  3  4  5
   Has many factual errors.  Has some factual errors.  Has no factual errors.

3. Visual information
   1  2  3  4  5
   Has no graphics.  Has graphics that explain the topic.  Has graphics that inform and dazzle!

4. Organization
   1  2  3  4  5
   Is confusing  Is generally clear.  Is very easy to follow.

5. Overall Effectiveness
   1  2  3  4  5
   Does little to explain the topic.  Explains the topic adequately.  Is informative and interesting.
FEEL THE PULSE: AN ACTIVITY FOR MEASURING HEART RATE

Instructions for Students

Objective
Use your knowledge of heart structure and function to measure your heart rate during several kinds of physical activity.

Background Information
Waves of pressure, which are created when the heart muscles contract, force blood to travel through arterial vessels. This action occurs during each heartbeat and is known as a “pulse.” Every beat of the heart creates one pulsation that can be palpated (felt by touch) at various locations on the body such as the temple, neck, wrist, groin, and crook of the elbow. At each of these locations, the arteries can be found just beneath the skin’s surface. The normal pulse rate will vary with age, as well as with other factors such as physical activities.

The chart provided below shows average heart rate at various ages for people 1-3 years old and older. With most types of physical activities, a person’s heart rate will increase in order to supply the muscles with more oxygen. The additional oxygen is needed for production of enough energy to allow the muscles to perform the activity. As the intensity of the activity increases, heart rate will also increase. Very intense activities can cause the heart to beat up to 200 times per minute.

As you and your fellow students carry out the following Feel the Pulse activities, remember that results will vary depending on the individual and the activity involved.

Materials Needed
• Watch with a second hand
• Ruler
• Calculator
• Sheet of graph paper
• Procedures and data table

<table>
<thead>
<tr>
<th>AGE</th>
<th>RANGE</th>
<th>AVERAGE RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1 month</td>
<td>100–180</td>
<td></td>
</tr>
<tr>
<td>2–3 months</td>
<td>110–180</td>
<td></td>
</tr>
<tr>
<td>4–12 months</td>
<td>80–180</td>
<td></td>
</tr>
<tr>
<td>1–3 years</td>
<td>80–160</td>
<td>130</td>
</tr>
<tr>
<td>4–5 years</td>
<td>80–120</td>
<td>100</td>
</tr>
<tr>
<td>6–8 years</td>
<td>70–115</td>
<td>100</td>
</tr>
<tr>
<td>9–11 years</td>
<td>60–110</td>
<td>88</td>
</tr>
<tr>
<td>12–16 years</td>
<td>60–110</td>
<td>80</td>
</tr>
<tr>
<td>&gt; 16 years</td>
<td>50–90</td>
<td>70</td>
</tr>
</tbody>
</table>
FEEL THE PULSE: AN ACTIVITY FOR MEASURING HEART RATE

Name ____________________________________________

DATA TABLE: Pulse Rates per Minute for Various Activities

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>RESTING</td>
<td>WALKING IN PLACE</td>
<td>JUMPING JACKS</td>
<td>WALKING UP &amp; DOWN STEPS</td>
</tr>
</tbody>
</table>

Procedures

1. Sit quietly for 3 minutes. Locate the pulse point in your neck area. To find this pulse point, place your index and middle fingers up underneath your jaw (halfway between your ear and chin) until you feel the pulsation. Count the number of beats for 30 seconds and multiply that value by 2 to get your pulse rate for 1 minute. Record this value in Column 1 (“Resting”) in the Data Table.

2. Walk in place for 3 minutes. When you are finished, take your pulse again and record that value in Column 2 (“Walking in Place”) in the Data Table.

3. Sit quietly for several minutes to allow your pulse to return to the resting rate.

4. Do jumping jacks for 3 minutes. When you are finished, take your pulse again and record that value in Column 3 (“Jumping Jacks”) in the Data Table.

5. Sit quietly for several minutes to allow your pulse to return to the resting rate.

6. Walk up and down steps for 3 minutes. When you are finished, take your pulse again and record that value in Column 4 (“Walking Up & Down Steps”) in the Data Table. (If stairs are not available, stepping up and down from a chair will work just as well.)

7. Prepare a bar graph of your results on your graph paper. Label the y-axis “Pulse Rate per minute.” Label the x-axis “Activities.” Use the Data Table column labels as the x-axis divisions.

Additional Activities

1. Compare your results with those of the other students in your class. How similar are the data?

2. Calculate the average heart rate of your entire class for each activity. To do this, add up every student’s value from Column 1, “Resting,” and divide the result by the total number of students in your class. Perform the same calculation for each of the other three activities.

3. Keep a record of your heart rate for one week. Make sure you note the time of day and the activity you are engaged in when you record the data. Do the time of day and activity affect your heart rate? If so, how?
PUMP IT UP: CALCULATE YOUR HEART’S STROKE VOLUME
Instructions for Students

Objective
You will use your knowledge of heart structure and function to perform an activity calculating the stroke volume of your heart.

Background Information
Approximately the size of a clenched fist, the heart is the most powerful muscle in the body. It is capable of pumping blood throughout the entire body, from the head to the toes. The human heart contracts more than 2 billion times in an average person’s lifetime.

To understand how hard the heart works on a daily basis, perform the following simple experiment:

Put a tennis ball in your hand. Squeeze the tennis ball 10 times; then 60 times in 1 minute. The force being applied by the hand to squeeze the tennis ball is very similar to the force that is needed to squeeze the blood out of the heart during the heart’s normal pumping activity.

An average heart pumps 70 milliliters (70/1000 L or 0.070 L) per beat. The amount of blood pumped in one beat of the heart is called “stroke volume.” Stroke volume can be calculated by using the surface area of the heart.

Materials Needed
• Tennis ball  
• Meter stick or height-measuring device  
• Calculator  
• Watch with a second hand  
• Calculation Chart and Data Table

Procedure for Calculating Stroke Volume
To calculate your own heart’s stroke volume, refer to the Data Table included in this activity.

Enter your findings in the Calculation Chart. An example of how to record your data is given in the Chart.

1. Find your height in the Data Table. Record this value in Column 1 on the Calculation Chart.

2. The surface area of your heart is listed beside your height in the Data Table. Record this value in Column 2 in the Calculation Chart.

3. Multiply your Surface Area times the Standard value of 3.1. The total calculated will be your cardiac output. Record this value in Column 3 in the Calculation Chart.

4. Using a watch with a second hand, count your resting pulse rate (while sitting) for 30 seconds and multiply that value by 2 to get your pulse rate for 1 minute. Record this value in Column 4 in the Calculation Chart.

5. Divide your value in Column 3 (“Cardiac output”) by your value in Column 5 (“Resting pulse rate”). Record your answer in Column 5. This final calculation is your “Stroke volume” (how much blood your heart pumps in one beat, measured in liters of blood).
PUMP IT UP: CALCULATE YOUR HEART’S STROKE VOLUME

Name ______________________________________________________

<table>
<thead>
<tr>
<th>Height (in feet and inches)</th>
<th>Heart surface area (dm²)</th>
<th>Heart surface area (dm²) X 3.1 standard = Cardiac output</th>
<th>Resting pulse rate (beats per min.)</th>
<th>Cardiac output divided by resting pulse rate = Stroke volume (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5’5”</td>
<td>1.93</td>
<td>5.983</td>
<td>64</td>
<td>0.093484375 L (rounds to 0.093 L)</td>
</tr>
</tbody>
</table>

DATA TABLE: Heart Surface Area Based on Individual’s Height

<table>
<thead>
<tr>
<th>Height</th>
<th>Surface area (dm²)</th>
<th>Height</th>
<th>Surface area (dm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4’1”</td>
<td>1.25</td>
<td>5’1”</td>
<td>1.75</td>
</tr>
<tr>
<td>4’2”</td>
<td>1.30</td>
<td>5’2”</td>
<td>1.8</td>
</tr>
<tr>
<td>4’3”</td>
<td>1.35</td>
<td>5’3”</td>
<td>1.85</td>
</tr>
<tr>
<td>4’4”</td>
<td>1.4</td>
<td>5’4”</td>
<td>1.9</td>
</tr>
<tr>
<td>4’5”</td>
<td>1.43</td>
<td>5’5”</td>
<td>1.93</td>
</tr>
<tr>
<td>4’6”</td>
<td>1.45</td>
<td>5’6”</td>
<td>1.95</td>
</tr>
<tr>
<td>4’7”</td>
<td>1.5</td>
<td>5’7”</td>
<td>2.0</td>
</tr>
<tr>
<td>4’8”</td>
<td>1.55</td>
<td>5’8”</td>
<td>2.05</td>
</tr>
<tr>
<td>4’9”</td>
<td>1.6</td>
<td>5’9”</td>
<td>2.1</td>
</tr>
<tr>
<td>4’10”</td>
<td>1.65</td>
<td>5’10”</td>
<td>2.15</td>
</tr>
<tr>
<td>4’11”</td>
<td>1.68</td>
<td>5’11”</td>
<td>2.18</td>
</tr>
<tr>
<td>5’</td>
<td>1.7</td>
<td>6’</td>
<td>2.2</td>
</tr>
</tbody>
</table>
STAT! HURRY UP AND ORGANIZE YOUR DATA!
USING TABLES TO RECORD AND ANALYZE INFORMATION
Instructions for Students

CREATING DATA TABLES
Data tables are used to record information in an organized manner. Each data table should have a title. Additional headings given to the columns and rows located within the data table indicate where particular data are to be placed. The data table can then be understood and interpreted by reading the title and the column and row headings.

Here is an example of a data table:

<table>
<thead>
<tr>
<th>Acceptable Childhood Blood Lead Levels (μ/dL)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Organization</td>
</tr>
<tr>
<td>1973</td>
<td>CDC</td>
</tr>
<tr>
<td>1975</td>
<td>CDC</td>
</tr>
<tr>
<td>1985</td>
<td>CDC</td>
</tr>
<tr>
<td>1986</td>
<td>WHO</td>
</tr>
<tr>
<td>1986</td>
<td>EPA</td>
</tr>
<tr>
<td>1990</td>
<td>CDC</td>
</tr>
</tbody>
</table>

Organizations providing information:
CDC — Centers for Disease Control and Prevention, www.cdc.gov/

As you study this table, can you tell:
• The title of the whole data table?
• The title of each column?
• The title of each row?
• Data tables often include totals at the bottom. Would it be possible to include totals in this table?
• Would it be possible to provide an average at the bottom of the “Blood Lead” column?

EXERCISE
The second page of these instructions provides you information from the National Center for Health Statistics (NCHS), which gathered data on cardiovascular deaths among certain groups in 2003. Your job is to organize this information into a table.

In order to construct your table, you will need to consider whether information is variable (changes) or is constant (remains the same).

What pieces of the given information are variable? What about age? Four different age categories are represented. The same four categories are repeated for each population group, but these age categories differ from one another. Can you identify two other variables that will help you construct a useful table?

What pieces of the given information are constant? What about the source of the information? You know that the NCHS provided all the data, so that is a constant. What about the year in which all the data was collected? Is that a variable or a constant? How many health issues does the information deal with?

Variables should be placed in columns or rows. Constants can be placed above the table, rather than in a column or row.

Remember that your data table should have a title. Your columns and rows will also need to be labelled, so that your table can be easily read and understood.

ADDITIONAL ACTIVITY
Use one of these web sites to find information on a topic that is of interest to you, and create another data table using that information:
• Centers for Disease Control and Prevention, www.cdc.gov/
• National Center for Health Statistics,  www.cdc.gov/nchs/
• US Environmental Protection Agency, www.epa.gov/
• World Health Organization, www.who.int/en/
STAT! HURRY UP AND ORGANIZE YOUR DATA!
AN ACTIVITY WITH DATA TABLES

INFORMATION TO PLACE IN YOUR DATA TABLE

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in white females in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 45 years</td>
<td>6,268</td>
</tr>
<tr>
<td>45-64 years</td>
<td>29,481</td>
</tr>
<tr>
<td>65-84</td>
<td>171,422</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>211,222</td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in white males in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 45 years</td>
<td>12,448</td>
</tr>
<tr>
<td>45-64 years</td>
<td>67,270</td>
</tr>
<tr>
<td>65-84</td>
<td>191,030</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>97,877</td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in black females in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 45 years</td>
<td>3,077</td>
</tr>
<tr>
<td>45-64 years</td>
<td>10,778</td>
</tr>
<tr>
<td>65-84</td>
<td>24,903</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>17,331</td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in black males in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 45 years</td>
<td>4,220</td>
</tr>
<tr>
<td>45-64 years</td>
<td>16,352</td>
</tr>
<tr>
<td>65-84</td>
<td>22,681</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>6,319</td>
</tr>
</tbody>
</table>

QUESTIONS
The following questions relate to interpretation and analysis of the table you constructed. Use your completed table to answer these questions:

1. Which group as a whole has the most deaths due to cardiovascular disease, males or females?
2. Does your data table allow you to predict whether cardiovascular deaths are increasing or decreasing?
3. Which is greater, the number of cardiovascular deaths in males ages 65-84 years or the number of cardiovascular deaths in males older than 85 years?
4. What happens to the number of cardiovascular deaths of white females as the age of this group increases?
5. Which age group is characterized by the least number of deaths due to cardiovascular disease, regardless of gender or race?
6. Blacks who die due to cardiovascular disease make up what percentage of the total number of deaths in the table? Include both female and male populations when performing your calculations.
7. Could a researcher use your table to:
   a. investigate the causes of heart disease?
   b. determine the number of deaths due to cardiovascular disease for Hispanic females in 2003?
   c. find out how much the black population has increased since 2003?
   d. compare the effects of cardiovascular disease on younger and older black females?
STAT! HURRY UP AND ORGANIZE YOUR DATA!
AN ACTIVITY WITH DATA TABLES

INFORMATION TO PLACE IN YOUR DATA TABLE

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in white females in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Black Females</th>
<th>Black Males</th>
<th>White Females</th>
<th>White Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45 years</td>
<td>6,268</td>
<td>12,448</td>
<td>6,268</td>
<td>12,448</td>
</tr>
<tr>
<td>45-64 years</td>
<td>29,481</td>
<td>67,270</td>
<td>29,481</td>
<td>67,270</td>
</tr>
<tr>
<td>65-84</td>
<td>171,422</td>
<td>191,030</td>
<td>171,422</td>
<td>191,030</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>211,222</td>
<td>97,877</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in black females in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Black Females</th>
<th>Black Males</th>
<th>White Females</th>
<th>White Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45 years</td>
<td>3,077</td>
<td>4,220</td>
<td>6,268</td>
<td>12,448</td>
</tr>
<tr>
<td>45-64 years</td>
<td>10,778</td>
<td>16,352</td>
<td>29,481</td>
<td>67,270</td>
</tr>
<tr>
<td>65-84</td>
<td>24,903</td>
<td>22,681</td>
<td>171,422</td>
<td>191,030</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>17,331</td>
<td>6,319</td>
<td>211,222</td>
<td>97,877</td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in white males in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Black Females</th>
<th>Black Males</th>
<th>White Females</th>
<th>White Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45 years</td>
<td>12,448</td>
<td>4,220</td>
<td>6,268</td>
<td>12,448</td>
</tr>
<tr>
<td>45-64 years</td>
<td>67,270</td>
<td>16,352</td>
<td>29,481</td>
<td>67,270</td>
</tr>
<tr>
<td>65-84</td>
<td>191,030</td>
<td>22,681</td>
<td>171,422</td>
<td>191,030</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>97,877</td>
<td>6,319</td>
<td>211,222</td>
<td>97,877</td>
</tr>
</tbody>
</table>

The National Center for Health Statistics reported the following information for deaths caused by cardiovascular diseases in black males in the United States in the year 2003.

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Black Females</th>
<th>Black Males</th>
<th>White Females</th>
<th>White Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 45 years</td>
<td>4,220</td>
<td>6,319</td>
<td>211,222</td>
<td>97,877</td>
</tr>
<tr>
<td>45-64 years</td>
<td>16,352</td>
<td>22,681</td>
<td>171,422</td>
<td>191,030</td>
</tr>
<tr>
<td>65-84</td>
<td>22,681</td>
<td>171,422</td>
<td>191,030</td>
<td>191,030</td>
</tr>
<tr>
<td>Older than 85 years</td>
<td>6,319</td>
<td>97,877</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answers will vary depending on how students group their data, but the tables created in your class should look similar to the following:

<table>
<thead>
<tr>
<th>Deaths Due to Cardiovascular Disease in the U.S. in 2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Range</td>
</tr>
<tr>
<td>&lt; 45 years</td>
</tr>
<tr>
<td>45-64 years</td>
</tr>
<tr>
<td>65-84 years</td>
</tr>
<tr>
<td>&gt; 85 years</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>
QUESTIONS
The following questions relate to interpretation and analysis of the table you constructed. Use your completed table to answer these questions:

1. Which group as a whole has the most deaths due to cardiovascular disease, males or females?
   The female population had more deaths. Males had 418,197 deaths and females had 474,482 deaths.

2. Does your data table allow you to predict whether cardiovascular deaths are increasing or decreasing?
   No, there needs to be at least one other year of data for comparison.

3. Which is greater, the number of cardiovascular deaths in males aged 65-84 years or the number of cardiovascular deaths in males older than 85 years?
   The number of cardiovascular deaths is greater in males ages 65-84 than in males older than 85. This answer is true for both white males and black males.

4. What happens to the number of cardiovascular deaths of white females as the age of this group increases?
   The number of cardiovascular deaths of white females increases.

5. Which age group is characterized by the least number of deaths due to cardiovascular disease, regardless of gender or race?
   Individuals less than 45 years have the least number of deaths due to cardiovascular disease.

6. Blacks who die due to cardiovascular disease make up what percentage of the total number of deaths in the table? Include both female and male populations when performing your calculations.
   The total number of cardiovascular deaths in the black population is equal to the number of cardiovascular deaths in black females plus the number of cardiovascular deaths in black males = 56,089 + 49,572 = 105,661. The total number of deaths due to cardiovascular disease in all populations is 418,393 + 56,089 + 368,625 + 49,572 = 892,679.
   To find the percentage, divide the number of cardiovascular deaths in the black population by the number of total deaths and multiply by 100: (105,661/892,679) x 100 = 11.8%, or, rounding to the nearest whole number, about 12%.

7. Could a researcher use your table to:
   a. investigate the causes of heart disease?
   b. determine the number of deaths due to cardiovascular disease for Hispanic females in 2003?
   c. find out how much the black population has increased since 2003?
   d. compare the effects of cardiovascular disease on younger and older black females?
   The answer is D.
VISIT THE VISIBLE HEART
Information for Teachers

What It Is
*The Visible Heart* is an online resource that may be freely accessed at www.visibleheart.com. In addition to the website, a free copy of *The Visible Heart* CD is available by e-mail at visibleheart@medtronic.com.

Why It Is Interesting
*The Visible Heart* project provides a stunning look at the physical movement of the heart. Here, teachers and students can view video clips of select portions of the heart in action, including the heart valves. Such four-dimensional views, from a variety of angles, allow for a greater understanding of what actually happens in the heart when it beats.

Also included are videos of how the heart moves when various instruments are inserted to improve its function, such as a defibrillation lead or an ablation catheter.

Links to additional helpful resources, such as the American Heart Association, Medtronic, Inc., and the *Visible Heart Laboratory* are all available on the website. In particular, the *Visible Heart Laboratory* link includes an interactive *Atlas of Human Cardiac Anatomy*; this feature provides an array of excellent 3-D perspectives from which to view different parts of the heart.

The Methods section of the website provides a fascinating summary of what the visible heart actually is. It also details the scientific process of creating a suitable environment for a functional, beating heart.

Who Created It
The project is a joint venture of the University of Minnesota and Medtronic, Inc.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Arts</th>
<th>English</th>
<th>Health</th>
<th>Math</th>
<th>Science</th>
<th>Social Studies</th>
<th>Provided materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finding Inner Peace: Can Meditation Improve Your Health?</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>Teacher's guide</td>
</tr>
<tr>
<td>A Discovery-Based Approach to Understanding Clinical Trials</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>Teacher's guide, student instructions, glossary</td>
</tr>
<tr>
<td>Edgar Allan Poe and Science of the Heart</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>Teacher's guide, student worksheet</td>
</tr>
<tr>
<td>The Tell-Tale Heart, by Edgar Allan Poe</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>Text of short story</td>
</tr>
</tbody>
</table>
FINDING INNER PEACE: CAN MEDITATION IMPROVE YOUR HEALTH?
Teacher's Guide

Subjects
English, Healthful Living, Sociology, World History

Background
Meditation is an integral part of many Eastern religions practiced around the globe. These include Hinduism, Buddhism, Islam, Judaism, and Christianity. The goal is to achieve the integration of mind, spirit, and body. If meditation does not result in positive changes in one’s life or attitudes, it is said that this is evidence that the process of meditation is not yet complete.

The practice of meditation is becoming more widespread in the Western world, including the United States. Some form of meditation is being practiced by more than 10 million Americans. Modern meditation is becoming less associated with any particular religion and more often associated with an ethical lifestyle. People practice meditative techniques to achieve inner peace, and many feel it can actually improve their physical health and mental well-being.

A follow-up of two studies of transcendental meditation (TM) conducted in the late 1980s and mid-1990s showed that people who had normal to high blood pressure and who practiced the technique were 23% less likely to die than people who did not. The TM group had a 30% decrease in the rate of deaths due to heart disease and stroke (Boyles, 2005).

Problem
Heart disease is the number one cause of death for Americans, male and female. Can the use of meditation actually improve cardiovascular health? Do persons who actively participate in meditation experience fewer heart attacks? Strokes? And if they do, can we accurately conclude this is the direct result of the meditation and not any other factors that led to a lesser incidence of disease?

Suggested Activities
1. Ask each student to record three different methods she or he uses to reduce stress. Students can be placed into groups according to common stress reducers or remain as one large class. Together you can create a graph showing the class’s use of stress-reducing methods.

2. You can use the following questions for class discussion or as writing prompts.
   a. How did you learn that this activity reduced your stress?
   b. Do other members of your family participate in this particular stress-reducing activity?
   c. What evidence can you provide that your stress level is actually reduced after this particular activity?

3. This topic provides your students an opportunity for research on the Internet or in your school library. Divide the class into groups, and assign each a group a religion that actively incorporates meditation into its practices. Ask each group to research the type of meditation practices their assigned religion incorporates (e.g., deep breathing, physical postures, mindfulness). You may also ask your students to research the potential health benefits of these practices.

4. Ask your students to write an article for the school newspaper discussing how meditation may benefit the cardiovascular health of an individual. Ask your students to keep in mind the causes of heart disease include hypertension, heredity, anxiety, stress, and disease. Find out if the student paper would like to publish one or more of the articles.

5. Ask your students to survey students, teachers, and other personnel in your school. How many practice meditation? How many believe it would improve cardiovascular health? (Many people may believe in the health benefits of meditation although they do not actively engage in meditation.) Your class can prepare a report on your school’s use of meditative practices and perceptions of the health benefits.

Reference
A Discovery-Based Approach to Understanding Clinical Trials
With a Focus on Heart Health

Subjects: English, Health, Science, Social Studies

OVERVIEW
In modern society, the drugs we take and the medical procedures we undergo are the result of extensive research. Most people have seen the ads for clinical trials, recruiting people with heart disease or high blood pressure or some other possible mental or physical ailment. Yet, many don’t fully understand the procedures involved in clinical research.

According to the U.S. National Institutes of Health clinical trials website (ClinicalTrials.gov), clinical research is the “fastest and safest way to find treatments that work in people and ways to improve health.” This lesson plan, designed to be covered in one class period (or at the end and beginning of two successive classes), will help students to learn about the make-up of clinical research and the provisions in place to ensure the safety of the human participants. Alternatively, teachers may choose to assign only parts of this lesson.

The activities described here will also be useful in teaching critical reading and informational writing skills. Social Studies teachers may wish to expand on the content provided by focusing on the history, ethics, and regulations of clinical trials. General information may be found online at “The history of clinical testing and its regulation” (www.roche.com/pages/facets/18/histclinte.htm).

Objectives: Students think critically about the ways in which scientific researchers approach health problems, while also learning to analyze texts and write informational, science-based compositions.

RESOURCES
• Handouts: “Introducing Clinical Trials” for the Engagement Activity; “Culturally Tailored Approach to Improve Medication Use in Patients with Heart Attacks,” Question sheet, FAQ, and Glossary for the Exploration Activity.
• Students and teachers may also wish to consult the ClinicalTrials.gov website

ENGAGEMENT ACTIVITY
(15 minutes)
a. At the beginning of class, provide students individually or in groups with a copy of the attached “Introducing Clinical Trials” handout, which lists four different clinical trials. (Alternatively, place the handout on an overhead projector.)
b. Ask the students individually or in groups to look over the handout and jot down answers to the following questions:

1. What is the purpose of each of these trials?
2. Would you consider participating in one of these trials, if you met the requirements? Why?
3. Would you do it if you got paid?
4. What questions would you want to ask the researchers before you agreed to participate?
5. Would you be interested in the results of any of these trials? Why?
6. Who else would be interested in the results of these trials?
c. Groups can report out to the class, or the teacher may engage the class in a quick discussion based on the questions provided.

EXPLORATION ACTIVITY
This activity may also be assigned as individual or group homework. (30 minutes)
a. Divide students into small groups and provide each group with copies of the example clinical trial (“Culturally Tailored Approach to Improve Medication Use in Patients with Heart Attacks”), Question sheet, FAQ, and Glossary.
b. Ask each group to answer the questions on the “Questions about ‘Culturally Tailored Approach to Improve Medication Use in Patients with Heart Attacks’” handout.
EXPLANATION ACTIVITY
(15 minutes)

a. Groups share and discuss their answers to the “Questions about ‘Culturally Tailored Approach to Improve Medication Use in Patients with Heart Attacks’” with the entire class.

ELABORATION ACTIVITY
This writing activity can be assigned as homework to be done by individual students, or it can be an in-class group project. Choose a or b:

a. Students may locate an additional clinical trial description that interests them on either the unchealthcare.org website (clinical trials are listed under “Health & Patient Care”) or the ClinicalTrials.gov website, and use the descriptions to answer the questions on the “Introducing Clinical Trials” handout.

b. Using “Culturally Tailored Approach to Improve Medication Use in Patients with Heart Attacks” as a model, students individually or in groups devise their own proposed clinical trials. They, of course, will not conduct this trial but will describe their proposed trials, outlining the protocol, exclusion/inclusion criteria, measurements, and time-line. Suggestions for possible trials:

i. The effect of video games on violence in teenagers
ii. The effect of fast food advertising on teenage food purchases
iii. The correlations between wearing sandals and blistered and calloused feet

EVALUATION ACTIVITY
Teachers may choose to evaluate students based on class participation and completion of the Elaboration activity.
INTRODUCING CLINICAL TRIALS

Questions for Students

Below are brief descriptions of four different clinical trials. Use this information and your own understanding to answer the following questions:

1. What is the purpose of each of these trials?
2. Would you consider participating in one of these trials, if you met the requirements? Why?
3. Would you do it if you got paid?
4. What questions would you want to ask the researchers before you agreed to participate?
5. Would you be interested in the results of any of these trials? Why?
6. Who else would be interested in the results of these trials?

<table>
<thead>
<tr>
<th>Think You Might Have Gum Disease?</th>
<th>Lung study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESEARCH PATIENTS NEEDED</strong></td>
<td>Do you currently smoke cigarettes?</td>
</tr>
<tr>
<td>UNC Center for Inflammatory Disorders</td>
<td>Have you quit smoking, but smoked for at least 10 years?</td>
</tr>
<tr>
<td>-and-</td>
<td>The Center of Environmental Medicine at UNC is looking for individuals for a research study. This study involves 1 visit and a total of 1½ hours of your time.</td>
</tr>
<tr>
<td>UNC Center for Oral and Systemic Diseases</td>
<td>You will be reimbursed for completion of the study. If you participate, you will have a breathing test and learn more about your lungs. Participants that are interested in quitting smoking will be given information and guidance to help them quit.</td>
</tr>
<tr>
<td>Male and female subjects with periodontal (gum) disease are needed for a clinical research study. This study will assess the effect of gum treatments on general health. Eligible subjects will receive certain treatments at reduced fees or no charge.</td>
<td></td>
</tr>
<tr>
<td>For information please call or e-mail the UNC School of Dentistry GO Health Center.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genetic Study of Anorexia Nervosa in Families</th>
<th>African American Couples Needed for a Research Study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>We are seeking families with at least two members who have or had anorexia nervosa, and who would be willing to participate. Experts from around the world are working to help identify the genes that might predispose individuals to develop anorexia nervosa.</strong></td>
<td><strong>If you have been living with your partner for at least 9 months, are not taking anti-hypertensive or anti-depressant medications, are between the ages of 18 and 50, and are willing to have blood samples and blood pressure taken, then you may qualify for a study about the benefits of partner relationships.</strong></td>
</tr>
<tr>
<td><strong>UNC Eating Disorders Program</strong></td>
<td><strong>Receive up to $200 per couple for completion of 2 lab visits.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>If interested, please call the UNC Stress and Health Research Program.</strong></td>
</tr>
</tbody>
</table>

All advertisements on this page were retrieved on April 27, 2005, from unchealthcare.org
FAQ: ABOUT CLINICAL TRIALS

WHAT IS A CLINICAL TRIAL?
A clinical trial is an experimental research study that evaluates the effect of a new drug or medical device on human beings. Clinical research is a process of discovery that is intended to improve medical care. Researchers attempt to answer questions such as “Which medication works better?” or “What is the best way to treat a medical problem?”

WHO CAN PARTICIPATE IN A CLINICAL TRIAL?
All participants in a clinical trial are volunteers who have agreed to take part in a particular study. Some volunteers seek out clinical trials, and some are referred to clinical trial opportunities by their physicians. There are opportunities to be involved in clinical trials for persons with specific diseases and conditions and for persons in generally good health. Participants in a study are referred to as “subjects” or “participants.” They can leave a study at any time for any reason.

WHAT ARE THE BENEFITS AND RISKS OF PARTICIPATING IN A CLINICAL TRIAL?

Benefits
• Play an active role in personal health care.
• Gain access to new research treatments before they are widely available.
• Obtain expert medical care at leading health care facilities during the trial.
• Help others by contributing to medical research.

Risks
• There may be unpleasant, serious or even life-threatening side effects to experimental treatment.
• The experimental treatment may not work for the participant.
• The trial may require more time and attention than standard treatment, including trips to the study site, more treatments, hospital stays or complex requirements.
• The participant may be placed in the “placebo” group

HOW IS THE SAFETY OF THE PARTICIPANT PROTECTED?
The ethical and legal codes that govern medical practice also apply to clinical trials. In addition, most clinical research is federally regulated with built-in safeguards to protect the participants. Each trial follows a carefully controlled protocol, a plan that details what researchers will do in the study. As a clinical trial progresses, researchers report their results at scientific meetings, to medical journals, and to various government agencies. Individual participants’ names remain secret and are not mentioned in these reports.

Every clinical trial in the U.S. must be approved and monitored by an Institutional Review Board (IRB) to make sure the risks are as low as possible and are worth any potential benefits. An IRB is an independent committee of physicians, statisticians, community advocates, and others that ensures that a clinical trial is ethical and the rights of study participants are protected.

WHAT SHOULD PEOPLE CONSIDER BEFORE PARTICIPATING IN A TRIAL?
People should know as much as possible about the clinical trial and feel comfortable asking the members of the health care team questions about it. The following questions might be helpful for the participant to discuss with the health care team:
• What is the purpose of the study?
• Who is going to be in the study?
• Why do researchers believe the experimental treatment being tested may be effective? Has it been tested before?
• What kinds of tests and experimental treatments are involved?
• How do the possible risks, side effects, and benefits in the study compare with my current treatment?
• How might this trial affect my daily life?
• How long will the trial last?
• Will hospitalization be required?
• Who will pay for the experimental treatment?
• Will I be reimbursed for other expenses?
• What type of long-term follow-up care is part of this study?
• How will I know that the experimental treatment is working?
• Will results of the trials be provided to me?
• Who will be in charge of my care?
• What happens if I’m injured because of the study?

INFORMATION ON THIS PAGE WAS ADAPTED FROM UNIVERSITY OF MARYLAND’S BROCHURE “THINKING ABOUT ENROLLING IN A CLINICAL TRIAL?” AND FROM CLINICALTRIALS.GOV.
Baseline—1. Information gathered at the beginning of a study from which variations found in the study are measured. 2. A known value or quantity with which an unknown is compared when measured or assessed. 3. The initial time point in a clinical trial, just before a participant starts to receive the experimental treatment being tested.

Blind — A clinical trial is “blind” if participants are unaware of whether they are in the experimental or control arm of the study.

Control group — In many clinical trials, one group of patients will be given an experimental drug or treatment, while the control group is given either a standard treatment for the illness or a placebo.

Double-blind study — A clinical trial design in which neither the participating individuals nor the study staff know which participants are receiving the experimental drug and which are receiving a placebo (or another therapy). Double-blind trials are thought to produce objective results, since the expectations of the doctor and the participant about the experimental drug do not affect the outcome.

Efficacy — The maximum ability of a drug or treatment to produce a result regardless of dosage. A drug passes efficacy trials if it is effective at the dose tested and against the illness for which it is prescribed.

Eligibility Criteria — Summary criteria for participant selection; includes Inclusion and Exclusion criteria.

Expanded access — Refers to any of the FDA procedures that distribute experimental drugs to participants who are failing on currently available treatments for their condition and also are unable to participate in ongoing clinical trials.

Hypothesis—A supposition or assumption advanced as a basis for reasoning or argument, or as a guide to experimental investigation.

Inclusion/exclusion Criteria — The medical or social standards determining whether a person may or may not be allowed to enter a clinical trial. Often based on age, gender, the type and stage of a disease, previous treatment history, and other medical conditions. These criteria are not used to reject people personally, but rather to identify appropriate participants and keep them safe.

Informed consent — The process of learning the key facts about a clinical trial before deciding whether or not to participate. It is also a continuing process throughout the study to provide information for participants.

Interventions—Primary interventions being studied; types of interventions are Drug, Gene Transfer, Vaccine, Behavior, Device, or Procedure.

Open-label trial—a clinical trial in which doctors and participants know which drug or vaccine is being administered.

Peer review — Review of a clinical trial by experts chosen by the study sponsor. These experts review the trials for scientific merit, participant safety, and ethical considerations.

Placebo — An inactive pill, liquid, or powder that has no treatment value. In clinical trials, experimental treatments are often compared with placebos to assess the treatment’s effectiveness. In some studies, the participants in the control group will receive a placebo instead of an active drug or treatment. No sick participant receives a placebo if there is a known beneficial treatment.

Prevention Trials—Refers to trials to find better ways to prevent disease in people who have never had the disease or to prevent a disease from returning. These approaches may include medicines, vitamins, vaccines, minerals, or lifestyle changes.

Protocol — A study plan carefully designed by the researcher(s) to safeguard the health of the participants in a clinical trial as well as answer specific research questions. A protocol describes what types of people may participate; the schedule of tests, procedures, medications, and dosages; and the length of the study.

Randomized trial — A study in which participants are randomly (i.e., by chance) assigned to one of two or more treatment arms of a clinical trial.

Single-blind study — A study in which one party, either the investigator or participant, is unaware of what medication the participant is taking; also called single-masked study.

You can find more definitions at ClinicalTrials.gov.
CULTURALLY TAILORED APPROACH TO IMPROVE MEDICATION USE IN PATIENTS WITH HEART ATTACKS

PURPOSE
Our research aims to improve the use of medicines known to prevent recurrent heart attacks. In particular, we know that statin treatment is useful after heart attacks, but many patients do not use it. There are a few possible reasons for this. Patients cannot find affordable medicine. Their doctor may not prescribe the medicine after they leave the hospital. Some people may culturally mistrust using the medicine. So they may decide not to take it even if it is prescribed.

We are developing a hospital based culturally attuned program to target this problem. In this program, a community health worker counsels and helps patients in accessing pharmacy assistance programs. We will test whether this program can improve appropriate statin use.

We will enroll patients who have heart attacks. We will compare patients who are counseled by the community health worker with those who get the usual care at baseline and at 6, 12 and 24 months. We will test if their “bad” cholesterol levels are controlled. We will find out how regularly they have filled their questionnaire and taken the medicine. Finally, we will test if they are getting benefit from the statin treatment. We will do this using blood tests and imaging the patients’ arteries with ultrasound. We will also measure how cost-effective it is for a hospital to run the program.

It is our goal to develop a community health worker model that is culturally sensitive for people with cultural, educational or educational barriers. Statin use is known to benefit patients in theory; such a culturally competent program will improve health outcomes in practice. After we test it, a cost-effective program such as this can be implemented in other hospitals.

Study Type: Interventional

Study Design: Prevention, Randomized, Open Label, Active Control, Parallel Assignment, Efficacy Study

Official Title: Culturally-Tailored Hospital-Based Model to Improve Statin Use and Outcomes in Patients With Coronary Disease

Further study details as provided by Johns Hopkins University:

Outcome Measures:
• Achievement of LDL-cholesterol goals
• Self-reported medication adherence
• Brachial artery reactivity (a measure of vascular function)
• Markers of systemic inflammation

Secondary Outcome Measures:
• Cost of the health worker intervention

Expected Total Enrollment: 138

Study start: March 2006

Expected completion: December 2009

The lipid-specific and pleiotropic benefits of statin therapy, and secondary prevention of coronary artery disease (CAD) mortality have been demonstrated. Statin therapy in particular is underutilized in both white and Black American populations who have CAD and who do not have access to therapy or who cannot afford it. Systems factors related to these findings involve a lack of continuous access to medications following hospital discharge for many Black Americans and for white Americans who do not have the ability to...

<table>
<thead>
<tr>
<th>Condition</th>
<th>Coronary Arteriosclerosis Myocardial Infarction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Behavioral: Navigation by a health worker</td>
</tr>
</tbody>
</table>
readily afford their medicines or who do not have the educational background to understand the importance of therapy. In many cases, there is failure by primary care physicians to continue statin therapy after discharge in patients who have poor access to therapy or who do not comply with pharmacotherapy. Patient factors include mistrust and volitional nonadherence related to beliefs and personal priorities, and a lack of education and support related to preventive therapy.

This trial will thus take place in lower income and lower educational level Black and white American patients identified at the time of hospitalization and will continue for two years after a myocardial infarction, coronary artery bypass graft, or percutaneous intervention. The overall hypothesis is that a quality of care intervention delivered to Black and white American patients with lower incomes and/or education by a culturally competent community health worker (CHW) within an existing hospital system will result in improved outcomes. The CHW will counsel patients and help them access resources, including Maryland and private pharmacy assistance programs. The specific aims are to compare the impact of a hospital-based CHW intervention versus usual care (UC) on (1) the percent who achieve LDL cholesterol goals, (2) adherence to the statin regimen, and (3) health outcomes including inflammatory markers and vascular function at 6, 12, and 24 months after hospitalization for the premature CAD event. We will determine the cost of achieving the LDL-C goal in each group. Outcome measures include patient adherence (pill counts, modified Hill-Bone questionnaire), lipid parameters, hs-CRP, and brachial artery reactivity as a marker of endothelial function.

Intention to treat analyses will be used. Multivariable adjusted analysis using generalized linear models or generalized estimating equations will be used to determine the independent effect of the interventions after adjusting for covariates. A sample size of 68 subjects per group can detect hypothesized differences in the proportion of participants meeting goal levels of LDL-C with 92% power, as the primary outcome at 2 years. This proposal will demonstrate the effectiveness of a potentially generalizable model of culturally competent care that will improve the use of statin therapy and its health outcomes in Black and white Americans with documented CAD and poor access to statin pharmacotherapy.

ELIGIBILITY
Ages Eligible for Study: 21 years and above.

Genders Eligible for Study: Both

Inclusion Criteria:
• Admitted to Johns Hopkins Hospital or Johns Hopkins Bayview Medical Center.
• Diagnoses of Myocardial Infarction, unstable angina, percutaneous intervention, coronary artery bypass surgery.
• One of the following:
  » Less than a high school education (defined as completion of the 12th grade).
  » No insurance for medications with a household income of $50,000 or less.
  » Any incurrence co-pay with a household income of $50,000 or less.

Exclusion Criteria:
• physician contraindicates statin use
• chronic glucocorticosteroid therapy
• autoimmune disease (i.e. lupus erythematosus)
• current chemotherapy or radiation
• immediate life-threatening comorbidity (i.e. HIV-AIDS, end-stage renal disease, or cancer)
• history of hepatic or renal failure
• myositis with creatine kinase (CK) elevations
• any prior adverse response to statin therapy
• statin allergy
• rhabdomyolysis
• pregnant women

ClinicalTrials.gov processed this record on July 27, 2007
UNDERSTANDING CLINICAL TRIALS: EXAMPLE STUDY

QUESTIONS ABOUT “CULTURALLY TAILORED APPROACH TO IMPROVE MEDICATION USE IN PATIENTS WITH HEART ATTACKS”

You can find answers to these questions in the researchers’ description of this clinical trial.

1. What are the inclusion criteria for this study?
2. What are the exclusion criteria for this study?
3. Would you qualify for this study?
4. What are the community health workers going to do in this study?
5. What is the problem the researchers are trying to solve?
6. What is the researchers’ overall hypothesis?
7. Why are heart attack patients not taking the medicines that can help them? List four reasons indicated by the researchers.
8. How will the researchers know if their approach is successful? List three measurements the researchers are going to use to evaluate the effectiveness of their treatment.
9. The study design includes an “active control.” Who will be in the control group?
10. The study is “interventional.” What does it mean if you “intervene” in something? How are the researchers “intervening” in the lives and/or treatment of the study participants?

There may be different opinions about the following questions. So you will need to use a combination of information from the researchers’ description of their planned clinical trial and your own understanding to respond to these questions.

11. While they may never read the actual study, many members of the general public may benefit from this clinical trial. In your view, which of the following groups could potentially benefit from what the researchers find out? Briefly explain your thinking.
   • Heart patients who need help to understand complicated medical information.
   • Heart patients who have a high school education.
   • Uninsured heart patients who do not know about pharmacy assistance programs in Maryland.
   • Heart patients in North Carolina.
   • Heart patients who do not trust doctors.
   • Hospitals trying to help heart patients who are “non-compliant” (do not take their prescribed meds).
   • Cancer patients.

12. In your view, is this a good idea for a clinical trial? Why or why not?
BACKGROUND
During an average lifetime, the human heart beats more than two and a half billion times without stopping for rest. This low, steady rhythm truly is the background music of our lives.

Because of its constant presence in human life, we may take the heart for granted. So it is interesting to stop and really look around at all the references to the heart in popular culture, from Valentine’s Day greetings to the “I Love New York” campaign (which was soon adapted to many other uses, with the phrase “I heart ...” becoming very well known) to such commonplace phrases as these:

- Have a heart (to be merciful)
- Have a change of heart (to reconsider)
- Know something by heart (to memorize)
- Be broken-hearted (to be very unhappy)
- Be light-hearted (to be joyful)
- Have your heart in the right place (to mean well)
- Cry your heart out (to grieve)
- With a heavy heart (to be somber)
- Set your heart on something (to desire)
- Get to the heart of the matter (to get to the main point)

If you read this list to your students, they are very likely to be able to add to it!

Because of the universality of images and meanings connected to the heart, it is not difficult to find ties between this scientific topic (the cardiovascular system) and several non-science disciplines, most notably language arts. While many works of art and literature could serve as the basis for integrated learning around this topic, the work given as an example here is Edgar Allan Poe’s “The Tell-Tale Heart,” first published in 1843.

THE TELL-TALE HEART
Briefly, the plot of this short story is as follows. The narrator murders an innocent old man and then carefully dismembers the body. He buries the remains under the floor boards of the old man’s room. The police arrive. The narrator is initially bold and confident, but then is unnerved and driven to confess by the relentless sound of the beating of his victim’s heart.

Notably, the story’s first word is “True”—an important word in any culprit’s vocabulary as he tries to explain away his crime. One way to measure the truth of this narrator’s story is to gather some scientific evidence of his claim. He notices a change in the heartbeat he hears. Is this real or imaginary?

Some initial questions you may ask your students:
Why might the narrator imagine that he hears the old man’s heart beating louder and louder? Could this instead be the narrator’s own heart? Why might his own heart beat louder and louder?

Is heart rate constant? What measurements can we make concerning the beating heart? What activity or experiences may influence heart rate? Using the “Feel the Pulse” activity and worksheet from The Beat Goes On “Additional Activities” section, students can collect data on changes in their own heart rates based on different activities.

The conclusions they reach should be that heart rate is not constant and that a variety of activities and experiences can change heart rate. They can then begin to speculate on what is causing the apparent changes in the heartbeat the narrator hears.

Ask the class to find all the references to the heart in the story (including the last word of the story). Ask them also to note how the story seems to speed up as the narrator’s agitation grows. The narrator asks his reader to “observe how healthily—how calmly” he tells his story. Ask your students to assess whether his symptoms suggest that he is healthy and calm as his story moves along. What are the signs he shows of increasing unwellness?
THE UNSOLVED MYSTERY OF EDGAR ALLAN POE’S DEATH

A topic for discussion or research is that of Poe’s death at the age of 40, a medical mystery that still confounds Poe scholars. A number of web pages are devoted to this topic; and one particularly effective web site—Knowing Poe—hosts an interactive experience that enables students to be detectives working on this case. Knowing Poe and other online resources are described below.

ON-LINE RESOURCES

Knowing Poe
knowingpoe.thinkport.org/default_flash.asp

This engaging web site, which opens to the sounds of a heart beat and a raven’s caw, is in three parts: “Poe the Person,” “Poe the Writer,” and the “Poe Library.” A particularly interesting and interactive feature, located within “Poe the Person,” is the section entitled “It’ll Be the Death of Me,” which asks visitors to solve the mystery of Poe’s death. Abundant clues, including original letters, are given, and there is an audio guide through the investigation. This is clearly designed with a teen audience in mind, and would provide a lively and informative experience for students in a computer lab or as homework.

Of particular relevance to The Beat Goes On module: within “It’ll Be the Death of Me” there is a file of evidence devoted to “The Heart of Poe,” which includes a discussion of Poe’s possible heart condition and a letter from his physician.

The Mysterious Death of Edgar Allan Poe
eapoe.org/geninfo/poedeath.htm

This web page outlines the range of hypotheses—from rabies to “cooping” (a corrupt practice involving kidnapping citizens and strong-arming their votes)—surrounding Poe’s death at election time in Baltimore in 1849. A doctor’s earlier diagnosis of heart disease, though Poe himself denied that such a diagnosis had been made, is often given as a probable cause, especially when considered alongside the physical stresses caused by his alcoholism.

Lisa’s Rival
en.wikipedia.org/wiki/Lisa%27s_Rival

This web page describes the plot of an episode of The Simpsons, which aired in 1994 and is based on “The Tell-Tale Heart,” with Lisa Simpson taking on the role of the guilt-ridden narrator. A Google search for “Lisa’s Rival” will yield additional descriptions of this episode.

Poe in the Literature, Arts, and Science Database
litmed.med.nyu.edu/People?action=view&id=2265

New York University’s School of Medicine has long hosted this database of annotations to literary works (poetry, fiction, and non-fiction) connected in any way to science, with a particular emphasis on the medical sciences. Entries for Poe range from the short story “The Masque of the Red Death” (related to death and dying, epidemics, and science) to the “Sonnet —to Science” (related to alternative medicine, medical education, psycho-social medicine, and science). In addition to medicine-related commentary on each work, there is often a link to an on-line text of the work being discussed. An entry for “The Tell-Tale Heart” is also included. The link to the entire database is litmed.med.nyu.edu.

EDGAR ALLAN POE (1809-1849)

Born in Boston on January 19, 1809, Edgar Allan Poe became a southerner by an act of fate. Already abandoned by his father, actor David Poe, Edgar was left an orphan in 1811 when his mother, actress Eliza Poe, died in Richmond, Va. There he was taken in by a well-to-do tobacco merchant, John Allan, and his wife, Frances. Although the Allans never formally adopted him, Poe spent his childhood and adolescence in their home, living with them in Richmond from 1811 to 1815, joining them for stints in Scotland and England between 1815 and 1820, and returning with them to Richmond in 1820.

In Richmond, he attended school and fell in love—first with a schoolmate’s mother, Jane Stanard, who would inspire his poem “To Helen,” and then with a neighbor girl named Elmira Royster. Engaged to Royster, Poe left for the University of Virginia in 1826, but both his engagement and his education faltered. Perhaps because he had not received adequate funds from Allan, Poe ran up gambling debts in Charlottesville and returned home in December. After quarreling with Allan, Poe moved to Boston in 1827 and, under the name of Edgar A. Perry, enlisted in the U.S. Army. His first book, Tamerlane and Other Poems, appeared anonymously a few months later, attracting little attention. Before the year was out, he returned to the South when his battery was transferred...
to Fort Moultrie on Sullivan’s Island, a South Carolina locale he would later use in his story “The Gold-Bug.”

Obtaining an honorable discharge in 1829, Poe moved to Baltimore and came out with *Al Aaraaf, Tamerlane, and Minor Poems*. Still largely unknown as a poet, he entered the U.S. Military Academy at West Point in 1830, but became dissatisfied and was expelled the following year. After a brief stay in New York City, where he published *Poems*, he moved in with his aunt Maria Clemm and her daughter, Virginia, in Baltimore.

Now that he was somewhat settled back in the South, Poe’s career began to take shape. While in Baltimore, he wrote six stories and submitted them to a contest in 1833. He won first place for “MS. Found in a Bottle” and, more important, drew the notice of one of the contest’s judges, John Pendleton Kennedy. Encouraged by his new mentor, in 1835 Poe wrote stories and reviews for Richmond’s *Southern Literary Messenger*. The following year, Poe moved to Richmond and went to work for the *Messenger*. Over the next two years, he supplied it with reviews and stories, and the publication’s circulation climbed. In 1836, he publicly married his cousin Virginia, then thirteen.

Despite their success, Poe broke with publisher Thomas White in 1837 and moved to New York, then to Philadelphia, where he worked for *Burton’s Gentleman’s Magazine* from 1839 to 1840 and *Graham’s Magazine* from 1841 to 1842. Even as he performed his various editorial duties, which included writing reviews and reading proofs, Poe churned out fiction, producing some of his most memorable stories. During this time, Lea & Blanchard came out with *Tales of the Grotesque and Arabesque*, which contained “William Wilson,” “The Fall of the House of Usher,” and twenty-three other stories, many of which had already appeared in *Burton’s, Godey’s Lady’s Book*, and other publications. During his remaining years in Philadelphia, he published “The Murders in the Rue Morgue,” “The Masque of the Red Death,” “The Pit and the Pendulum,” and “The Tell-Tale Heart” in his own and other publications.

Poe’s fiction was by now attracting favorable attention from reviewers and readers alike. He also began a successful lecturing career. On a personal level, however, the rising author was struggling and suffering. In 1842 his wife showed signs of tuberculosis. Meanwhile, poverty dogged the family, even while Poe’s testy personality and drinking problems caused him to alienate potential supporters.

In 1844, Poe moved to New York City and joined the staff of the *Evening Mirror*. In 1845 the *Mirror* published “The Raven,” which quickly became his most famous work. Later that year, after he had moved to the *Broadway Journal*, Wiley and Putnam published *Tales*, which included “The Purloined Letter” and eleven other stories. On the heels of this successful collection, the same publisher came out with *The Raven and Other Poems*.

Meanwhile, Poe’s personal problems continued, as he drank excessively, flopped at a public reading, and published a bizarre attack on Henry Wadsworth Longfellow, accusing the poet of plagiarism. In Fordham, N.Y., where Poe moved the family in 1846, he suffered from illness, depression, and poverty as he watched Virginia’s condition worsen. She died in 1847.

Poe’s career was in marked decline. Over the next two years, he produced only a handful of notable works, including *Eureka* and “Annabel Lee,” while apparently trying to fill the void left by Virginia’s death. He poured out his heart in letters to a married woman named Annie Richmond, confessing to a suicide attempt in 1848, and proposed to fellow poet Sarah Helen Whitman. In 1849, his engagement to Whitman over, he returned to Richmond, where he reunited with Shelton. More than two decades after their first engagement failed, the two planned marriage again. On his way back north, perhaps to pick up Maria Clemm, Poe mysteriously turned up partly conscious near a polling booth in Baltimore on October 3. Although the cause of his death on October 7 was listed as “congestion of the brain,” the full circumstances remain a mystery.

The downward slope of Poe’s life and career continued even after his death, thanks largely to his literary executor, Rufus Griswold, who marked his erstwhile friend’s passing with an obituary and “Memoir” portraying him as an unscrupulous madman. Later writers and scholars have resurrected Poe’s reputation, and today he stands as one of the South’s preeminent writers.

THE TELL-TALE HEART
by Edgar Allan Poe

First published in January 1843 in The Pioneer.

TRUE!—nervous—very, very dreadfully
nervous I had been and am; but why will
you say that I am mad? The disease had
sharpened my senses—not destroyed—not
dulled them. Above all was the sense of
hearing acute. I heard all things in the heaven and in
the earth. I heard many things in hell. How, then, am
I mad? Hearken! and observe how healthily—how
calmly—I can tell you the whole story.

It is impossible to say how first the idea entered my
brain; but once conceived, it haunted me day and
night. Object there was none. Passion there was none.
I loved the old man. He had never wronged me. He
had never given me insult. For his gold I had no
desire. I think it was his eye! yes, it was this! He had
the eye of a vulture—a pale blue eye, with a film over
it. Whenever it fell upon me, my blood ran cold; and
so by degrees—very gradually—I made up my mind
to take the life of the old man, and thus rid myself of
the eye forever.

Now this is the point. You fancy me mad. Madmen
know nothing. But you should have seen me. You
should have seen how wisely I proceeded—with
what caution—with what foresight—with what
dissimulation I went to work! I was never kinder
to the old man than during the whole week before I
killed him. And every night, about midnight, I turned
the latch of his door and opened it—oh so gently! And
then, when I had made an opening sufficient for my
head, I put in a dark lantern, all closed, closed, that
no light shone out, and then I thrust in my head. Oh,
you would have laughed to see how cunningly I thrust
it in! I moved it slowly—very, very slowly, so that I
might not disturb the old man’s sleep. It took me an
hour to place my whole head within the opening so far
that I could see him as he lay upon his bed. Ha! would
a madman have been so wise as this. And then, when
my head was well in the room, I undid the lantern
cautiously—oh, so cautiously—cautiously (for the
hinges creaked)—I undid it just so much that a single
thin ray fell upon the vulture eye. And this I did for
seven long nights—every night just at midnight—but I
found the eye always closed; and so it was impossible
to do the work; for it was not the old man who vexed
me, but his Evil Eye. And every morning, when the
day broke, I went boldly into the chamber, and spoke
courageously to him, calling him by name in a hearty
tone, and inquiring how he has passed the night. So
you see he would have been a very profound old man,
indeed, to suspect that every night, just at twelve, I
looked in upon him while he slept.

Upon the eighth night I was more than usually
cautious in opening the door. A watch’s minute hand
moves more quickly than did mine. Never before
that night had I felt the extent of my own powers—of
my sagacity. I could scarcely contain my feelings
of triumph. To think that there I was, opening the
door, little by little, and he not even to dream of my
secret deeds or thoughts. I fairly chuckled at the idea;
and perhaps he heard me; for he moved on the bed
suddenly, as if startled. Now you may think that I
drew back—but no. His room was as black as pitch
with the thick darkness (for the shutters were close
fastened, through fear of robbers,) and so I knew that
he could not see the opening of the door, and I kept
pushing it on steadily, steadily.

I had my head in, and was about to open the lantern,
when my thumb slipped upon the tin fastening, and
the old man sprang up in bed, crying out—“Who’s
there?”

I kept quite still and said nothing. For a whole hour
I did not move a muscle, and in the meantime I did
not hear him lie down. He was still sitting up in the
bed listening;—just as I have done, night after night,
hearkening to the death watches in the wall.

Presently I heard a slight groan, and I knew it was
the groan of mortal terror. It was not a groan of
pain or of grief—oh, no!—it was the low stifled
sound that arises from the bottom of the soul when
overcharged with awe. I knew the sound well. Many
a night, just at midnight, when all the world slept, it has welled up from my own bosom, deepening, with its dreadful echo, the terrors that distracted me. I say I knew it well. I knew what the old man felt, and pitied him, although I chuckled at heart. I knew that he had been lying awake ever since the first slight noise, when he had turned in the bed. His fears had been ever since growing upon him. He had been trying to fancy them causeless, but could not. He had been saying to himself—"It is nothing but the wind in the chimney—it is only a mouse crossing the floor," or "It is merely a cricket which has made a single chirp." Yes, he had been trying to comfort himself with these suppositions: but he had found all in vain. All in vain; because Death, in approaching him, had stalked with his black shadow before him, and enveloped the victim. And it was the mournful influence of the unperceived shadow that caused him to feel—although he neither saw nor heard—to feel the presence of my head within the room.

When I had waited a long time, very patiently, without hearing him lie down, I resolved to open a little—a very, very little crevice—in the lantern. So I opened it—you cannot imagine how stealthily, stealthily—until at length a simple dim ray, like the thread of the spider, shot from out the crevice and fell full upon the vulture eye. It was open—wide, wide open—and I grew furious as I gazed upon it. I saw it with perfect distinctness—all a dull blue, with a hideous veil over it that chilled the very marrow in my bones; but I could see nothing else of the old man's face or person: for I had directed the ray as if by instinct, precisely upon the damned spot.

And have I not told you that what you mistake for madness is but over-acuteness of the senses?—now, I say, there came to my ears a low, dull, quick sound, such as a watch makes when enveloped in cotton. I knew that sound well, too. It was the beating of the old man's heart. It increased my fury, as the beating of a drum stimulates the soldier into courage.

But even yet I refrained and kept still. I scarcely breathed. I held the lantern motionless. I tried how steadily I could maintain the ray upon the eye. Meantime the hellish tattoo of the heart increased. It grew quicker and quicker, and louder and louder every instant. The old man's terror must have been extreme! It grew louder, I say, louder every moment!—do you mark me well I have told you that I am nervous: so I am. And now at the dead hour of the night, amid the dreadful silence of that old house, so strange a noise as this excited me to uncontrollable terror. Yet, for some minutes longer I refrained and stood still. But the beating grew louder, louder! I thought the heart must burst. And now a new anxiety seized me—the sound would be heard by a neighbour! The old man's hour had come! With a loud yell, I threw open the lantern and leaped into the room. He shrieked once—once only. In an instant I dragged him to the floor, and pulled the heavy bed over him. I then smiled gaily, to find the deed so far done. But, for many minutes, the heart beat on with a muffled sound. This, however, did not vex me; it would not be heard through the wall. At length it ceased. The old man was dead. I removed the bed and examined the corpse. Yes, he was stone, stone dead. I placed my hand upon the heart and held it there many minutes. There was no pulsation. He was stone dead. His eye would trouble me no more.

If still you think me mad, you will think so no longer when I describe the wise precautions I took for the concealment of the body. The night waned, and I worked hastily, but in silence. First of all I dismembered the corpse. I cut off the head and the arms and the legs.

I then took up three planks from the flooring of the chamber, and deposited all between the scantlings. I then replaced the boards so cleverly, so cunningly, that no human eye—not even his—could have detected any thing wrong. There was nothing to wash out—no stain of any kind—no blood-spot whatever. I had been too wary for that. A tub had caught all—ha! ha!

When I had made an end of these labors, it was four o'clock—still dark as midnight. As the bell sounded the hour, there came a knocking at the street door. I went down to open it with a light heart,—for what had I now to fear? There entered three men, who introduced themselves, with perfect suavity, as officers of the police. A shriek had been heard by a neighbour during the night; suspicion of foul play had been aroused; information had been lodged at the police office, and they (the officers) had been deputed to search the premises.

I smiled,—for what had I to fear? I bade the gentlemen welcome. The shriek, I said, was my own in a dream. The old man, I mentioned, was absent in the country. I took my visitors all over the house. I bade them search—search well. I led them, at length, to his chamber. I showed them his treasures, secure, undisturbed. In the enthusiasm of my confidence, I brought chairs into the room, and desired them here to rest from their fatigues, while I myself, in the wild
audacity of my perfect triumph, placed my own seat
upon the very spot beneath which reposed the corpse
of the victim.

The officers were satisfied. My manner had convinced
them. I was singularly at ease. They sat, and while
I answered cheerily, they chatted of familiar things.
But, ere long, I felt myself getting pale and wished
them gone. My head ached, and I fancied a ringing in
my ears: but still they sat and still chatted. The ringing
became more distinct:—It continued and became more
distinct: I talked more freely to get rid of the feeling:
but it continued and gained definiteness—until, at
length, I found that the noise was not within my ears.

No doubt I now grew very pale;—but I talked more
fluently, and with a heightened voice. Yet the sound
increased—and what could I do? It was a low, dull,
quick sound—much such a sound as a watch makes
when enveloped in cotton. I gasped for breath—and
yet the officers heard it not. I talked more quickly—
more vehemently; but the noise steadily increased. I
arose and argued about trifles, in a high key and with

violent gesticulations; but the noise steadily increased.
Why would they not be gone? I paced the floor to
and fro with heavy strides, as if excited to fury by
the observations of the men—but the noise steadily
increased. Oh God! what could I do? I foamed—I
raved—I swore! I swung the chair upon which I
had been sitting, and grated it upon the boards, but
the noise arose over all and continually increased.
It grew louder—louder—louder! And still the men
chatted pleasantly, and smiled. Was it possible they
heard not? Almighty God!—no, no! They heard!—
they suspected!—they knew!—they were making
a mockery of my horror!—this I thought, and this
I think. But anything was better than this agony!
Anything was more tolerable than this derision! I
could bear those hypocritical smiles no longer! I felt
that I must scream or die! and now—again!—hark!
louder! louder! louder! louder!

“Villains!” I shrieked, “dissemble no more! I admit
the deed!—tear up the planks! here, here!—It is the
beating of his hideous heart!”

The End
THE TELL-TALE HEART
by Edgar Allan Poe

First published in January 1843 in The Pioneer.

TRUE!—nervous—very, very dreadfully nervous I had been and am; but why will you say that I am mad? The disease had sharpened my senses—not destroyed—not dulled them. Above all was the sense of hearing acute. I heard all things in the heaven and in the earth. I heard many things in hell. How, then, am I mad? Hearken! and observe how healthily—how calmly—I can tell you the whole story.

It is impossible to say how first the idea entered my brain; but once conceived, it haunted me day and night. Object there was none. Passion there was none. I loved the old man. He had never wronged me. He had never given me insult. For his gold I had no desire. I think it was his eye! yes, it was this! He had the eye of a vulture—a pale blue eye, with a film over it. Whenever it fell upon me, my blood ran cold; and so by degrees—very gradually—I made up my mind to take the life of the old man, and thus rid myself of the eye forever.

Now this is the point. You fancy me mad. Madmen know nothing. But you should have seen me. You should have seen how wisely I proceeded—with what caution—with what foresight—with what dissimulation I went to work! I was never kinder to the old man than during the whole week before I killed him. And every night, about midnight, I turned the latch of his door and opened it—oh so gently! And then, when I had made an opening sufficient for my head, I put in a dark lantern, all closed, closed, that no light shone out, and then I thrust in my head. Oh, you would have laughed to see how cunningly I thrust it in! I moved it slowly—very, very slowly, so that I might not disturb the old man's sleep. It took me an hour to place my whole head within the opening so far that I could see him as he lay upon his bed. Ha! would a madman have been so wise as this, And then, when my head was well in the room, I undid the lantern cautiously—oh, so cautiously—cautiously (for the hinges creaked) I undid it just so much that a single thin ray fell upon the vulture eye. And this I did for seven long nights—every night just at midnight—but I found the eye always closed; and so it was impossible to do the work; for it was not the old man who vexed me, but his Evil Eye. And every morning, when the day broke, I went boldly into the chamber, and spoke courageously to him, calling him by name in a hearty tone, and inquiring how he has passed the night. So you see he would have been a very profound old man, indeed, to suspect that every night, just at twelve, I looked in upon him while he slept.

Upon the eighth night I was more than usually cautious in opening the door. A watch's minute hand moves more quickly than did mine. Never before that night had I felt the extent of my own powers—of my sagacity. I could scarcely contain my feelings of triumph. To think that there I was, opening the door, little by little, and he not even to dream of my secret deeds or thoughts. I fairly chuckled at the idea; and perhaps he heard me; for he moved on the bed suddenly, as if startled. Now you may think that I drew back—but no. His room was as black as pitch with the thick darkness (for the shutters were close fastened, through fear of robbers,) and so I knew that he could not see the opening of the door, and I kept pushing it on steadily, steadily.

I had my head in, and was about to open the lantern, when my thumb slipped upon the tin fastening, and the old man sprang up in bed, crying out—“Who’s there?”

I kept quite still and said nothing. For a whole hour I did not move a muscle, and in the meantime I did not hear him lie down. He was still sitting up in the bed listening;—just as I have done, night after night, hearkening to the death watches in the wall.

Presently I heard a slight groan, and I knew it was the groan of mortal terror. It was not a groan of pain or of grief—oh, no!—it was the low stifled sound that arises from the bottom of the soul when overcharged with awe. I knew the sound well. Many
a night, just at midnight, when all the world slept, it has welled up from my own bosom, deepening, with its dreadful echo, the terrors that distracted me. I say I knew it well. I knew what the old man felt, and pitied him, although I chuckled at heart. I knew that he had been lying awake ever since the first slightest noise, when he had turned in the bed. His fears had been ever since growing upon him. He had been trying to fancy them causeless, but could not. He had been saying to himself—"It is nothing but the wind in the chimney—it is only a mouse crossing the floor," or "It is merely a cricket which has made a single chirp." Yes, he had been trying to comfort himself with these suppositions: but he had found all in vain. All in vain; because Death, in approaching him, had stalked with his black shadow before him, and enveloped the victim. And it was the mournful influence of the unperceived shadow that caused him to feel—although he neither saw nor heard—to feel the presence of my head within the room.

When I had waited a long time, very patiently, without hearing him lie down, I resolved to open a little—a very, very little crevice—in the lantern. So I opened it—you cannot imagine how stealthily, stealthily—until at length a simple dim ray, like the thread of the spider, shot from out the crevice and fell full upon the vulture eye.

It was open—wide, wide open—and I grew furious as I gazed upon it. I saw it with perfect distinctness—all a dull blue, with a hideous veil over it that chilled the very marrow in my bones; but I could see nothing else of the old man's face or person: for I had directed the ray as if by instinct, precisely upon the damned spot.

And have I not told you that what you mistake for madness is but over-acuteness of the senses?—now, I say, there came to my ears a low, dull, quick sound, such as a watch makes when enveloped in cotton. I knew that sound well, too. It was the beating of the old man's heart. It increased my fury, as the beating of a drum stimulates the soldier into courage.

But even yet I refrained and kept still. I scarcely breathed. I held the lantern motionless. I tried how steadily I could maintain the ray upon the eye. Meantime the hellish tattoo of the heart increased. It grew quicker and quicker, and louder and louder every instant. The old man's terror must have been extreme! It grew louder, I say, louder every moment!—do you mark me well I have told you that I am nervous: so I am. And now at the dead hour of the night, amid the dreadful silence of that old house, so strange a noise as this excited me to uncontrollable terror. Yet, for some minutes longer I refrained and stood still. But the beating grew louder, louder! I thought the heart must burst. And now a new anxiety seized me—the sound would be heard by a neighbour! The old man's hour had come! With a loud yell, I threw open the lantern and leaped into the room. He shrieked once—once only. In an instant I dragged him to the floor, and pulled the heavy bed over him. I then smiled gaily, to find the deed so far done. But, for many minutes, the heart beat on with a muffled sound. This, however, did not vex me; it would not be heard through the wall. At length it ceased. The old man was dead. I removed the bed and examined the corpse. Yes, he was stone, stone dead. I placed my hand upon the heart and held it there many minutes. There was no pulsation. He was stone dead. His eye would trouble me no more.

If still you think me mad, you will think so no longer when I describe the wise precautions I took for the concealment of the body. The night waned, and I worked hastily, but in silence. First of all I dismembered the corpse. I cut off the head and the arms and the legs.

I then took up three planks from the flooring of the chamber, and deposited all between the scantlings. I then replaced the boards so cleverly, so cunningly, that no human eye—not even his—could have detected any thing wrong. There was nothing to wash out—no stain of any kind—no blood-spot whatever. I had been too wary for that. A tub had caught all—ha! ha!

When I had made an end of these labors, it was four o'clock—still dark as midnight. As the bell sounded the hour, there came a knocking at the street door. I went down to open it with a light heart,—for what had I now to fear? There entered three men, who introduced themselves, with perfect suavity, as officers of the police. A shriek had been heard by a neighbour during the night; suspicion of foul play had been aroused; information had been lodged at the police office, and they (the officers) had been deputed to search the premises.

I smiled,—for what had I to fear? I bade the gentlemen welcome. The shriek, I said, was my own in a dream. The old man, I mentioned, was absent in the country. I took my visitors all over the house. I bade them search—search well. I led them, at length, to his chamber. I showed them his treasures, secure, undisturbed. In the enthusiasm of my confidence, I brought chairs into the room, and desired them here to rest from their fatigues, while I myself, in the wild
audacity of my perfect triumph, placed my own seat upon the very spot beneath which reposed the corpse of the victim.

The officers were satisfied. My manner had convinced them. I was singularly at ease. They sat, and while I answered cheerily, they chatted of familiar things. But, ere long, I felt myself getting pale and wished them gone. My head ached, and I fancied a ringing in my ears; but still they sat and still chatted. The ringing became more distinct:—It continued and became more distinct: I talked more freely to get rid of the feeling, but it continued and gained definiteness—until, at length, I found that the noise was not within my ears.

No doubt I now grew very pale;—but I talked more fluently, and with a heightened voice. Yet the sound increased—and what could I do? It was a low, dull, quick sound—much such a sound as a watch makes when enveloped in cotton. I gasped for breath—and yet the officers heard it not. I talked more quickly—more vehemently; but the noise steadily increased. I arose and argued about trifles, in a high key and with violent gesticulations; but the noise steadily increased. Why would they not be gone? I paced the floor to and fro with heavy strides, as if excited to fury by the observations of the men—but the noise steadily increased. Oh God! what could I do? I foamed—I raved—I swore! I swung the chair upon which I had been sitting, and grated it upon the boards, but the noise arose over all and continually increased.

It grew louder—louder—louder! And still the men chatted pleasantly, and smiled. Was it possible they heard not? Almighty God!—no, no! They heard!—they suspected!—they knew!—they were making a mockery of my horror!—this I thought, and this I think. But anything was better than this agony! Anything was more tolerable than this derision! I could bear those hypocritical smiles no longer! I felt that I must scream or die! and now—again!—hark! louder! louder! louder! louder!

“Villains!” I shrieked, “dissemble no more! I admit the deed!—tear up the planks! here, here!—It is the beating of his hideous heart!”

The End

---

**LEGEND**

Text in red: References to the heart. After your students have located these references, ask them how each reference differs from the one before. How does the first reference to “a hearty tone” lead, by the story’s end, to a “hideous heart”? Ask your students whether it is always clear whose heart is being referred to. Is it sometimes the victim’s heart or is it always the narrator’s heart being described? (Are there other points in the story when the narrator confuses himself with his victim?) If your students have done the wet lab in *The Beat Goes On* or have learned about EKGs, they can even draw an EKG reading that shows the narrator’s heart rate as the story progresses. Based on the symptoms they find in the story, what do your students think would happen to the narrator’s heart rate at various points in the story?

Text underlined: The narrator’s internal and external “symptoms.” Ask your students to imagine they are in the role of the police officers who interview the narrator. What would they see? What would they record in their notes? Ask your students to imagine that one of the officers is a medical investigator: what would this officer being taking notice of? How would these observers interpret the symptoms?

Text in purple: Some key words or phrases for discussion. Many of these relate to the narrator’s opinion of himself, of his health, and of his prowess as a story-teller. These statements are directed to a listener who is addressed as “you.” Who do your students think is the listener? Ask your students whether the narrator is accurate in his assessments, and also whether the listener is convinced by them.