

SCIENTIFIC DECISION-MAKING

CORONARY ARTERY DISEASE MODEL



ABOUT THE PROJECT

Baylor
College of
Medicine

CENTER FOR
EDUCATIONAL
OUTREACH

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Activities described in this book are intended for middle or high school students under direct supervision of adults. The authors, Baylor College of Medicine and AHRQ cannot be held responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text. The opinions, findings and conclusions expressed in this publication are solely those of the authors and do not necessarily reflect the views of BCM or the sponsoring agency.

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BioEdSM

BioEdSM Teacher Resources from the Center for Educational Outreach at Baylor College of Medicine.

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All persons depicted in photographs throughout this guide are models and their images are used strictly for illustrative purposes only. The images are not intended to represent the model, nor any person living or deceased.

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CORONARY ARTERY DISEASE MODEL

Overview

In this discovery activity, students learn how coronary artery disease begins and how it causes arteries of the heart to become partially or completely blocked, thereby restricting the flow of oxygen and nutrients to the heart muscle.

Why is Cholesterol Important?

High blood cholesterol is one of the major risk factors for heart disease or heart attack. In the US, heart disease is the number one killer of women and men. The following are steps to take at home to help improve cholesterol levels.

- Follow a low-saturated fat diet.
- Lose weight if overweight.
- Be physically active for at least 30 minutes on most, if not all, days.

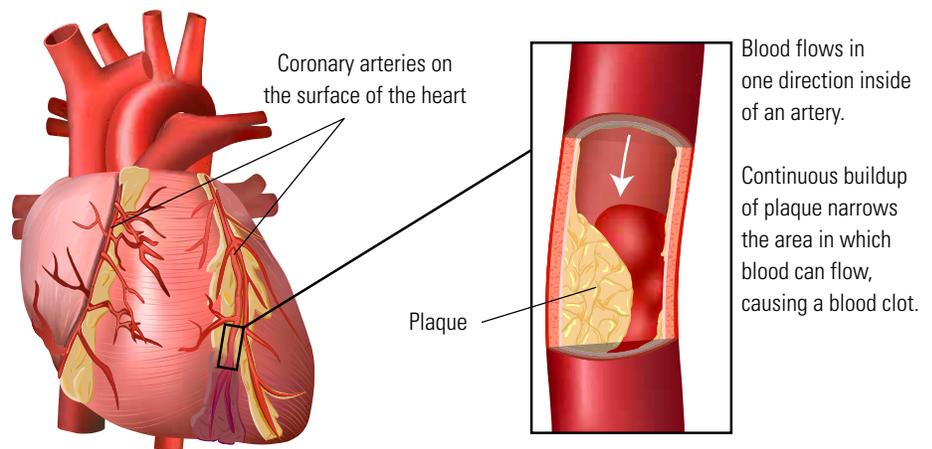
Courtesy of the National Heart, Lung, and Blood Institute, National Institutes of Health (<http://www.nhlbi.nih.gov/health/public/heart/cholesterol/wyntk.htm>).

In the *Scientific Decision-making Teacher's Guide*, students follow the personal stories of Arturo, Brian and Angela, all of whom may be suffering from heart problems brought about by coronary artery disease.

What is CAD? Coronary artery disease or CAD develops when the arteries of the heart become damaged or diseased. CAD usually is a result of plaque build-up in the arteries. This condition, called atherosclerosis (Greek for hard paste), begins with inflammation of, and damage to an artery's innermost layer (endothelium). The cause of this inflammation isn't understood, but elevated levels of cholesterol in the blood, high blood pressure or smoking may contribute to the initial damage. Inflammation in the artery attracts cholesterol and other substances, which build up just below the inner arterial wall. As we age, this buildup, called plaque, may become thick enough to cause significant blockage, resulting in a condition known as ischemia (reduction in blood flow through the vessel). Cardiac ischemia (or myocardial ischemia) is a reduced flow of blood and oxygen to the heart muscle. It can cause damage to, and a general weakening of the heart muscle, or even total heart failure. Common symptoms included chest pressure or pain, neck or jaw pain, nausea and vomiting. However, it also can be "silent" (showing no symptoms).

Over time, plaque can become unstable and rupture, producing blood clots that may block an artery completely. Such blockage in one of the coronary arteries feeding the heart results in a heart attack, or myocardial infarction (MI). Blockage of an artery that feeds the brain results in a stroke.

Plaque Build-up in a Coronary Artery



Information on Cholesterol

For additional detailed information about cholesterol and other cardiovascular related topics, visit the Watch, Learn and Live Interactive Cardiovascular Library (http://watchlearnlive.heart.org/CVML_Player.php?moduleSelect=chlscri).

The Watch, Learn and Live Interactive Cardiovascular Library © American Heart Association, Inc. All rights reserved.

Good and Bad Cholesterol

Cholesterol is a kind of lipid (fat) molecule, which is required by the body to build and maintain membranes. It also is an important precursor molecule for the synthesis of vitamin D and several hormones. All animals manufacture cholesterol. Within the body, about 20–25 percent of cholesterol production occurs in the liver. Cholesterol is stored and transported inside an envelope of lipids and proteins, creating particles called lipoproteins. There are five kinds of lipoproteins, but only two—low density lipoproteins (LDLs) and high density lipoproteins—(HDLs) are measured in a person's cholesterol score.

For more information about cholesterol, watch the slide show prepared by the American Heart Association (http://watchlearnlive.heart.org/CVML_Player.php?moduleSelect=chlscri).

MATERIALS

Teacher (see Safety)

- Computer and projector or an interactive white board to display the online animation, What Causes a Heart Attack?
- Small amount (tablespoon) of vegetable shortening in a plastic cup
- Small amount (tablespoon) of vegetable oil in a plastic cup
- Bag of unpopped, plain popcorn kernels
- 3 boxes of small (#1 size) paper clips (15 clips needed per team of students)
- 18 mm x 150 mm glass or plastic test tubes, or six-inch sections of clear tubing (one per team)
- Small cups or sandwich bags to hold about 50 kernels of unpopped popcorn
- Nickel- or quarter-size magnets; most refrigerator magnets will work well (one per group)

Each team of students will need:

- One clear 18-mm x 150-mm glass or plastic test tube (or six-inch section of clear plastic tubing)
- 15 small (#1 size) paper clips
- Small cup or plastic bag containing about 50 unpopped kernels of popcorn
- One nickel- or quarter-sized magnet
- Masking tape (approximately 12-inch strip)
- Two sheets of notebook paper

SETUP

Students will work in teams of four. Place all materials in a central location.

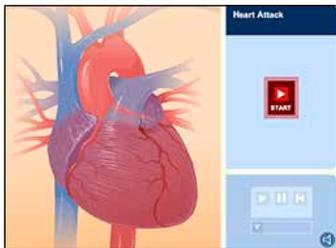
SAFETY

Students should wash their hands with soap and water before and after any science activity, even if wearing gloves. Always follow all district and school laboratory safety procedures..

PROCEDURE

1. In the *Scientific Decision-making Teacher's Guide*, one or more characters may have suffered a heart attack. Tell students that they will create a model to learn more about coronary artery disease (CAD) and investigate what happens during a heart attack (myocardial infarction).

Animation of a Heart Attack



The video animation, found at the URL below, shows how plaque build-up or a coronary artery spasm can lead to a heart attack. (<http://www.nhlbi.nih.gov/health/health-topics/topics/heartattack/causes.html>).

Image courtesy of National Heart, Lung, and Blood Institute, National Institutes of Health.

MODEL PART	WHAT DOES EACH MODEL PART REPRESENT?
Test tube or tubing	Artery, or more specifically, a coronary artery
Popcorn kernels	Red blood cells
Paper clips	Excess cholesterol and other substances
Magnet and tape	Initial inflammation leading to building inside artery walls

2. Show the following video clip (two minutes) on coronary artery disease. The video describes how "plaque" build-up in the arteries leads to heart attack. What Causes a Heart Attack? (<http://www.nhlbi.nih.gov/health/health-topics/topics/heartattack/causes.html>)
3. Ask students, *What do you think plaque in the arteries looks like?* Allow students time to share their ideas. Tell students that plaque consists of fat, cholesterol, calcium and other substances found in blood; and is waxy in appearance.
4. Then, hold up the cup of vegetable oil and ask students to identify the substance. Tell students that it is cooking oil (a kind of fat or lipid), which typically is extracted from plant seeds (corn, canola, olive, etc.). Next, hold up the shortening, and ask students to identify it. Tell students that shortening can be manufactured from plant oils or it can come from animals (i.e., lard). Pass both containers around the class. Ask, *Which of these two kinds of fats is healthier to eat?* Tell students that fats that are liquid at room temperature generally are healthier for the cardiovascular system, and can contribute to higher percentages of HDL cholesterol (HDL), which removes cholesterol from the blood stream. Animal fats and fats that are solid at room temperature contribute to higher levels of circulating LDLs. LDL particles are responsible for depositing cholesterol in blood vessels, which can lead to plaque formation.
4. Provide to each student team: one test tube, 15 paper clips, one magnet, one strip of tape (from which they can tear off pieces), and popcorn kernels, as described in the Materials section.
5. Instruct each team to build a model of coronary artery disease from the materials provided. The models should show a narrowing of the passageway (due to plaque), but still allow "red blood cells" to pass through. Accept all reasonable models.
6. On a sheet of notebook paper, have each team create and fill in a table that describes its model. The first column should list all parts of the model (test tube, popcorn kernels, magnet, paper clips). The second column should indicate what is represented by each component. If students need additional direction, tell them that their model should include an artery, red blood cells, plaque and a source of inflammation (something that causes the lining of the artery to become "sticky").

Note: It is anticipated that most groups will design a model in which the magnet is taped to the side of the tube. One or more paper clips are dropped into the tube (artery) and attracted by the magnet to simulate plaque buildup. Popcorn kernels added to the tube represent red blood cells flowing through the artery.
7. Next, ask each team to build a model of heart attack. This can be accomplished in at least two ways: by creating a build-up of plaque (paper clips) that completely blocks the tube or by making the tube so narrow that red blood cells (popcorn) form a clot that blocks the tube.



8. Have the teams share their models with the class, and explain their designs.
9. Have students return all materials to the original location. Instruct students to use the second sheet of notebook paper to write three things he or she learned from this activity about CAD. Have students submit their answers as they leave the classroom, or complete the assignment as homework.

EXTENSION OR HOMEWORK

- Make copies of the student page, "Heart Disease Risk Factors," for each student. Have students read the essay in class or as homework.
- Have students work in teams of 2–3 to create posters on heart-healthy themes, such as describing the process of CAD; risk factors; negative effects of smoking; importance of physical activity, diet and nutrition; or teens and heart disease.
 - Approve each team's poster idea, and have groups create standard 22-in. x 28-in. posters.
 - Exhibit the posters in school public areas, such as hallways and cafeterias. Consider having team members stand near their posters to answer questions during a lunch period or school-wide heart event, such as a walk-a-thon or blood drive.
 - A poster-grading rubric is included at the end of this activity (see p. 17). ■

HEART DISEASE AND RISK FACTORS

REFERENCE

When discussing health, risk factors are conditions or behaviors that increase the likelihood of developing a disease. Some risk factors can be controlled, but others cannot. Not everyone has the same risk for coronary artery disease (CAD) or a heart attack. It is important to know behaviors that increase or decrease the risk for developing heart disease.

The three main risk factors for heart disease that cannot be modified are gender (sex), age, and heredity (family history and genetics). You cannot control the genes you inherit, or the reality that risk for heart attack increase with age. In fact, 82% of people who die from CAD are 65 or older. Men's risk of a heart attack increases during middle age; women's rises noticeably after 55 years of age. But even then, a woman's risk is lower than a man's. People of African American, Mexican American, American Indian, and native Hawaiian descent are at higher risk for heart disease than members of other groups. And individuals whose parent or parents had heart disease are more likely to than others to develop CAD.

The inability to change our age or heredity makes it even more important to manage risk factors over which we have some control. Personal choices about diet, exercise and smoking can affect cholesterol levels, blood pressure, body weight and blood sugar levels, all important factors related to the risk for heart attack. By understanding our risks and making decisions to lower risks that may be modified, we can take steps, even at an early age, to reduce the chances for CAD or heart attack.

Smoking is a major risk factor in men and women, and combined with other risk factors, it greatly increases the chance of cardiovascular problems. Smokers are 2–4 times more likely than non-smokers to develop CAD or have a heart attack. Further, constant exposure to other people's cigarette smoke (secondhand smoke) increases the risk of heart disease in the nonsmoker. The *2012 Report of the United States Surgeon General* describes tobacco use among youth ages 12–17 as epidemic, and 90% of all smokers begin before age 18. Tobacco use causes immediate and long-term damage, including CAD. Among young people who continue to smoke, one in three will die prematurely. Among youth who continue to smoke, one in three will die prematurely from smoking. Smoking harms nearly every organ in the body and is one of the main preventable causes of death and disease in the United States.

High total cholesterol and “bad” LDL cholesterol are associated with increased risk for heart disease. Total cholesterol values typically should not be higher than 200 mg/dL. LDL cholesterol is the main source of cholesterol that builds up in the walls of the arteries and causes CAD. Foods high in saturated fats are high in cholesterol; we can reduce the risk for CAD by limited these foods. “Good” HDL cholesterol lowers the risk for heart disease by helping to (1) remove LDL cholesterol from the bloodstream, (2) prevent formation of plaque in the arteries, and (3) remove

plaque that already has collected on artery walls. Higher HDL values are associated with lower risk of heart disease. Regular, vigorous exercise is a great way to increase HDL cholesterol levels.

Blood pressure is the force of the blood against the walls of the arteries. When it stays elevated over time, it is called high blood pressure. This condition increases the heart's workload, and strains the heart, blood vessels and kidneys. High blood pressure has been associated with heart attack, stroke and kidney failure. Because it usually has no warning signs or symptoms, high blood pressure is especially dangerous and sometimes is referred to as the silent killer. When combined with other risk factors, such as obesity, diabetes, high cholesterol, or smoking, high blood pressure can increase the risk of a heart attack several fold.

In the last 30 years, obesity has tripled among people aged 12–19 years. Excess body fat, especially around the waist, increases the risk of a heart attack, even in the absence of other risk factors. Quite simply, the heart must work harder to supply nutrients and oxygen to the extra body mass. Losing just 10 pounds lowers the risk of a heart attack. Even in young people, overweight or obesity increases the risk of developing heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems and certain cancers.

Physical inactivity is a risk factor that almost anyone can change. Regular exercise, such as 30 minutes of walking per day, helps to prevent heart and blood vessel disease, and it actually strengthens the heart. The combination of regular exercise and a healthy diet is one of the best defenses against heart disease, because it helps control risk factors like high cholesterol, high blood pressure and diabetes.

Diabetes (uncontrolled high blood sugar) is a major risk factor for heart and blood vessel disease. In combination with other risk factors, it can harm the heart and cause more severe cardiovascular problems, and at a younger age. Surgical treatments for heart disease, such as bypass surgery or angioplasty, are less successful in persons with diabetes. In fact, people with diabetes have the same risk for future heart problems as do individuals who have had a heart attack. Sixty-five percent of diabetes patients die from some form of heart or blood vessel disease, so it is important for people with diabetes to work closely with healthcare providers to manage and control blood sugar levels through a program of diet and exercise.

There are three kinds of diabetes. Type 1 diabetes is inherited and usually is diagnosed in children or teenagers. Type 2, the most common form, can develop at any age. Being overweight and inactive increases the risk for type 2 diabetes. A third form of diabetes, gestational diabetes, develops in some women during pregnancy. It usually goes away after the baby is born, but it does increase a woman's risk of developing type 2 diabetes later in life.

POSTER PRESENTATION GRADING RUBRIC

FOR ACTIVITY EXTENSION

TEAM MEMBERS _____

DATE _____

POSTER THEME _____

CRITERIA	SCORE				POINTS
	7 points	8 points	9 points	10 points	
Display	No evidence of planning. Not neat or poorly designed.	Some evidence of planning. Design, layout, and neatness are satisfactory.	Well planned in terms of design, layout, and neatness.	Exceptionally well-planned and executed in terms of design, layout, and neatness.	_____ x 2 _____
Organization and Visual Appeal	Information is not organized clearly (presented randomly)	Information somewhat difficult to follow, and eyes are drawn to areas out of sequence.	Logical progression and sequence of information. Information is easy to follow.	Excellent logical progression for poster. Eyes naturally follow the flow of information.	_____ _____
Content	Many content errors. Theme is not addressed and content is inaccurate or not useful.	A few errors in content, and theme is ineffectively addressed. Some content is difficult for intended age.	Most of the content is accurate and addresses the theme in a clear and effective manner. Age appropriate.	All content is accurate and addresses the theme in a clear and effective manner. Age appropriate.	_____ x 2 _____
Creativity and Originality	No planning or thought given to the theme. Ineffective in conveying message in a creative or original way.	Message is presented with a theme, but lacks originality.	Message has a theme and shows some creativity and originality.	Shows exceptional creativity and originality.	_____ _____
Use of Text	Too many words and terms are too technical or are undefined. Evidence of cut and paste from sources.	Several long statements and wordy. Several terms are not defined or need explanation.	Statements are mostly brief and convey the thought. Most terms are defined, if needed.	Statements are brief and convey the thought. All terms are defined, if needed.	_____ _____
Grammar	More than 3 grammatical or mechanical mistakes.	There are 2–3 grammatical or mechanical mistakes.	There is 1 grammatical or mechanical mistake.	No grammatical or mechanical mistakes.	_____ _____
Pictures and Diagrams	Graphics are poor (wrong size, resolution or missing) and do not further understanding of the topic.	Some of the graphics make the topic easier to understand, but few are of appropriate size and resolution.	Most of the graphics make the topic easier to understand, and most are of appropriate size and resolution.	Graphics make the topic easier to understand and are interesting. Size and resolution are appropriate.	_____ _____
Labels	None of the items are labeled.	Some items labeled correctly, and few can be read from at least 3 feet away.	Most items labeled correctly, and most can be read from at least 3 feet away.	Items labeled correctly, and can be read from at least 3 feet away.	_____ _____
Total					_____ _____