LEARNING OBJECTIVES

- Summarize the events that lead to the development of atherosclerosis (Infographic B.2)
- Identify at least five risk factors that affect the initiation or progression of cardiovascular disease (Infographic B.4)
- Describe how total cholesterol, low-density lipoproteins, and high-density lipoproteins interact to affect the risk of cardiovascular disease (Infographic B.5)
- List the cluster of risk factors associated with metabolic syndrome (Infographic B.6)
- Discuss the implications of and recommendations for intake of saturated fatty acids, trans fatty acids, and unsaturated fatty acids in relation to cardiovascular disease (Infographic B.7 and Infographic B.8)
- Summarize the dietary strategies that reduce the risk of heart disease (Infographic B.9)

Some scientific discoveries begin in a laboratory. This one began in a funeral home in 1978. Under glaring lights in the back room of the Cook-Richmond Funeral Home in Bogalusa, Louisiana, two pathologists hovered over the lifeless body of a young African American male and conducted an autopsy, with newspapers spread beneath the body. At the time, there was no morgue in Bogalusa, which is less than two hours north of New Orleans. The pathologists sliced through skin and muscle of the body with scalpels, looking for the usual suspects—internal bleeding, broken bones—then wrote up their report for the coroner. The pathologists weren’t quite done, however.
Death in Bogalusa

FROM TRAGIC DEATHS IN A SOUTHERN TOWN, INSIGHTS INTO HEART DISEASE

Foam cells, lipid-laden white blood cells associated with cardiovascular disease.
Before closing up, they carefully removed the victim’s heart, packaged it in saline, and prepared it for a trip to a medical school in New Orleans. It was an unusual step, not standard for an autopsy. But the pathologists were heeding the instructions of a prominent local physician, who had the blessing of the family of the deceased.

Since 1972, Gerald Berenson, a cardiologist with the Louisiana State University School of Medicine, had spearheaded what was then a novel investigation: an epidemiological study of heart disease in Bogalusa, a rural town of about 16,000 people, located 60 miles north of New Orleans.

The Bogalusa Heart Study began with a fairly simple idea: Follow a large group of children over time and correlate their physical and lifestyle attributes with their risk for developing heart disease in adulthood. The biggest hurdle was a logistical one—how to enlist the thousands of children necessary to produce a robust data set and keep them coming back for evaluation year after year.

And Berenson wanted to do more than make statistical correlations: He also wanted to document the progression of heart disease directly. For that, he needed a different type of evidence.

The heart that Berenson obtained in 1978 was one of more than 200 such organs collected from young people in Bogalusa over the next 20 years. Some died in car accidents. Some drowned. Others succumbed to pneumonia. Still others died of gunshot wounds. The victims were as young as 2 and as old as 39. In fact, nearly every young person who died of whatever cause, was autopsied and their heart was removed. Together, they transformed our understanding of heart disease.

Bogalusa is typical of many rural southern towns in which poverty and poor education have exacerbated problems of public health. Almost 40% of individuals in Bogalusa live below the poverty line.

Sadly, poverty is linked to a number of health problems, most notably heart disease, known more formally as cardiovascular disease (CVD). CVD refers to conditions that impair the heart, arteries, veins, and capillaries, which move blood throughout the human body. CVD is the leading cause of death around the world, accounting for approximately 31% of all deaths in 2014. Although we may often think of CVD as a disease that affects primarily affluent countries, this is not the case as 75% of deaths due to CVD worldwide occur in low- to middle-income countries. A major reason for this is that people in these countries are often diagnosed late in the course of the disease and often have less access to effective healthcare, so their death rates from CVD are higher than for individuals in developed countries. In the United States, CVD has been the number one cause of death for more than 100 years; today an estimated one in three Americans have some form of the disease.

According to 2017 statistics from the American Heart Association, about 2200 Americans die of CVD every day, equating to an average of one death due to CVD every 40 seconds. It’s not just a disease of old age either—more than 124,000 people who died of CVD in the United States in 2014 were younger than 65 years. It’s those early roots
of heart disease—that initially take hold in the youngest victims—that Berenson and his team were after. (INFOGRAPHIC B.1)

**ATHEROSCLEROSIS AND CARDIOVASCULAR DISEASE**

Although often called “heart disease,” CVD strikes the blood vessels—veins and arteries—as well. But even before people experience major events such as heart attack and stroke, the long-term narrowing and loss of elasticity in blood vessels are caused by atherosclerosis.

Atherosclerosis is an inflammatory disease characterized by the accumulation of fatty plaque in the walls of arteries and blood vessels that generally develops over the course of several decades. This process is typically caused by the presence of elevated levels of cholesterol-rich **low-density lipoproteins** (LDLs) in the blood. As blood levels of LDL rise, they infiltrate the artery wall, where the LDLs are likely to become oxidized (by reacting with unstable oxygen-containing molecules). Oxidized LDLs cause injury to cells that line the vessel wall, and this initiates an inflammatory process that attracts white blood cells called **macrophages** inside the arterial lining. Other factors, such as smoking and hypertension, can also cause injury to the arterial wall and trigger inflammation. Inside the vessel wall, macrophages take up the oxidized LDLs in a rapid and uncontrolled fashion. These fat-laden macrophages (now called **foam cells**) die and deposit their accumulated lipids within the wall of the artery, promoting further inflammation.

As a result of artery wall inflammation, the lining of the blood vessel becomes more prone to develop a waxy accumulation of cholesterol and triglycerides, known as a **plaque**. Over time, plaque development, loss of elasticity, and thickening in the blood vessel walls may make it difficult for blood to flow through the vessel. This “traffic jam” increases the chances of forming blood clots that either block flow at that location or break off and travel...
Where in the blood vessel must LDLs be located to promote the development of atherosclerosis?
Atherosclerosis and Cardiovascular Disease

**INFOGRAPHIC B.3 Atherosclerosis in Cerebral Arteries Is a Contributing Factor to Alzheimer Disease** These images show the significant narrowing of cerebral arteries (large blood vessels in the brain) due to atherosclerosis.

![Infographic B.3](image)

**Why might atherosclerosis in cerebral arteries contribute to dementia?**

Photo credits (all photos): Reprinted with permission of Elsevier, from Alzheimer’s & Dementia: The Journal of the Alzheimer’s Association, 7, Roher, A.E., et al. “Intracranial atherosclerosis as a contributing factor to Alzheimer’s disease dementia,” fig. 1B. Copyright © 2011 The Alzheimer’s Association. Published by Elsevier Inc. All rights reserved. Permission conveyed through Copyright Clearance Center, Inc.

Through the bloodstream, blocking blood flow elsewhere, causing tissue damage and tissue death. ([INFOGRAPHIC B.2](#)) When blood flow is blocked in the coronary artery, which supplies blood to the heart, people experience heart attack, or **myocardial infarction**. Most cases of **stroke** result when a clot impedes the supply of blood to the brain. ([INFOGRAPHIC B.3](#))

For the most part, young people do not have heart attacks (and those who do usually suffer from rare genetic conditions). But just because most teenagers do not die from heart disease does not mean they can ignore heart health. That’s because heart disease can be insidiously gaining a foothold long before a person has any obvious symptoms. A recent study found that nearly 25% of young adults aged 18–24 had at least one advanced atherosclerotic plaque.

When Berenson started his study in 1972, the development of heart disease in young adults was far from accepted wisdom. Cardiologists—influenced by the prevailing practice of the day—focused more on the treatment of CVD than on its prevention. But Berenson had been trained in pediatrics as well as cardiology, and he knew it was important to understand the beginnings of heart disease, as well as its endings.

He decided to follow children and young people aged 5–17 years in the local school system, monitoring them twice yearly. Nurses measured their height, weight, smoking history, blood pressure, and blood lipid levels, among other variables. After age 17, they returned for evaluation periodically, up to age 45. Later, it was decided that any of the study participants who died would be autopsied.

From small beginnings, the study grew to enroll some 16,000 individuals. It is now one of the longest-running CVD studies in the world, the only one with a biracial (black–white) study population. Known as the Bogalusa Heart Study, it was the first study...
Lipids in Health and Disease

are more likely to develop CVD, as are African Americans, and both men and women are at increased risk as they age. But there are many risk factors people of all ages can modify, most significantly through diet, exercise, and other lifestyle practices.

Modifiable risk factors include smoking, a diet high in saturated and trans fats, cholesterol, sodium, and added sugar; a sedentary lifestyle; obesity; excessive alcohol consumption; and high blood pressure. (INFOGRAPHIC B.4)

Having high blood pressure (hypertension)—a condition in which blood pushes with excessive force against artery walls—is correlated closely with the extent of atherosclerosis found in the arteries.

RISK FACTORS FOR CARDIOVASCULAR DISEASE

You can’t do anything about some risk factors for CVD. For example, individuals with a family history of heart disease at an early age to demonstrate that heart disease begins in childhood.

Although the exact cause of CVD is often unknown, the Bogalusa study has shown that certain risk factors increase young people’s chances of developing heart disease—and the more risk factors they have, the higher their chances.

- Poor Diets: Diets high in trans fats, saturated fats, and cholesterol and low in polyunsaturated fats, vegetables, fruits, and whole grains increase the risk of CVD. Excess intake of sodium can lead to hypertension, which increases the risk of CVD.

- Physical Inactivity: It is estimated that individuals who engage in 150 minutes of moderate- to vigorous-intensity exercise per week will reduce the risk of CVD mortality by 30–35% compared with those who are physically inactive.

- Obesity: Particularly central or abdominal obesity is a major independent risk factor for CVD. It also increases the occurrence of other CVD risk factors (hypertension, diabetes, high blood cholesterol, and high triglycerides).

- Smoking: Smokers are two to four times more likely to develop heart disease or experience a stroke than are nonsmokers. Exposure to secondhand smoke at home or work increases the risk of heart disease.

- Excessive Alcohol Consumption: Excessive alcohol consumption causes hypertension that dramatically increases the risk of stroke. Drinking large amounts can also cause the heart to enlarge and heart muscles to thin and weaken. Heavy or at-risk alcohol use is defined as more than 3 drinks a day or 7 per week for women, and 4 drinks a day or 14 per week for men.

- Heart-Related Conditions: The risk of CVD is increased by high blood pressure, blood glucose, LDL cholesterol, and triglycerides and by low HDL cholesterol. Improving one’s diet and exercising regularly will help manage these conditions.

- Physical Inactivity: It is estimated that individuals who engage in 150 minutes of moderate- to vigorous-intensity exercise per week will reduce the risk of CVD mortality by 30–35% compared with those who are physically inactive.

Unmodifiable risk factors for CVD are age, race, and family history of CVD (genetics).

INFographic B.4 Modifiable Risk Factors for Cardiovascular Disease

Appropriate diet and lifestyle choices may reduce our risk of CVD by about 80%.

If you exercised five days per week, how many minutes would you have to exercise each day to meet the recommendations to reduce your risk of cardiovascular disease?

Although many risk factors for CVD are modifiable, more than 90% of Americans eat a “poor” diet for heart health, according to the American Heart Association. For example, the concentrations of cholesterol and triglycerides in blood are a major risk factor for CVD. Blood cholesterol levels measuring less than 200 milligrams of cholesterol per deciliter of blood (mg/dl)—the standard units of measurement for cholesterol—are considered desirable. Yet the average cholesterol level for a U.S. adult is just under 200 mg/dl—meaning the average American has a borderline high level. It is of even greater concern that approximately 40% of adults have cholesterol levels that exceed 200 mg/dl. People with high levels of total blood cholesterol have approximately twice the risk of heart disease as those who do not. Normal triglyceride levels vary by age and sex, but anything above 200 mg/dl is considered elevated. High triglyceride levels are common in people with heart disease or diabetes and correlate with lower levels of HDL cholesterol, or “good” cholesterol. (INFOGRAPHIC B.5)

One of the most important tools Berenson and his Bogalusa study team used to evaluate healthy diets was children’s intake of fat and cholesterol. Besides asking children about their diets, the Bogalusa researchers also directly measured levels of lipids in their blood by looking at the lipoproteins that transport lipids around the body. Likewise, physicians use a diagnostic test called a lipid panel to provide information about levels of triglycerides, total cholesterol, and cholesterol in high-density lipoproteins (HDL-C) and low-density lipoproteins (LDL-C) in blood.

Recall from Chapter 5 that lipoproteins contain different proportions of proteins, cholesterol, triglycerides, and other components that affect their density and function—as well as their impact on the risk of CVD. The LDLS ferry cholesterol to all of the cells of the body. This cholesterol forms the root of the plaques that slowly constrict blood flow through the vessels that feed the heart and brain. The lower your LDL cholesterol level, the lower your risk of heart attack and stroke. If you have other risk factors for CVD, it's best to keep your LDL-C level below 100 mg/dl, as this greatly reduces your risk of heart disease. On the other hand, a high HDL cholesterol level helps protect against heart disease and stroke. Normal triglyceride levels vary by age and sex, but anything above 200 mg/dl is considered elevated. High triglyceride levels are common in people with heart disease or diabetes and correlate with lower levels of HDL cholesterol, or “good” cholesterol.

**INFOGRAPHIC B.5** Classification of Cholesterol and Triglyceride Concentration in Blood

The concentrations of total cholesterol, HDL cholesterol, LDL cholesterol, and triglycerides in blood significantly affect the risk of cardiovascular disease.

For which of these values does the risk of heart disease decrease as the value increases?
Metabolic syndrome is a cluster of risk factors associated with the development of cardiovascular disease and type 2 diabetes.

**Factors Associated with Metabolic Syndrome**

Metabolic syndrome is a cluster of risk factors associated with the development of cardiovascular disease and type 2 diabetes.

**RISK FACTORS**

- Large waistline
- High triglyceride level
- Low HDL cholesterol level
- High blood pressure
- High fasting blood sugar

What is considered a normal triglyceride level?
A Heart-Protective Diet

When all known risk factors were considered in the Bogalusa study, a clear pattern emerged: “We found that those individuals who had higher levels of known risk factors on the average had more fatty streaks—the precursors to plaques—in their coronary arteries and aortas than individuals who had lower levels,” recalls William Newman, a pathologist with Louisiana State University School of Medicine in New Orleans, who performed autopsies for the Bogalusa study. In other words, although many of them were not even old enough to vote, these young people already had telltale signs of heart disease. Some even had developed full-blown plaques that were beginning to obstruct blood flow. Had these young people lived, those with the higher levels of atherosclerosis would have been at risk for a heart attack or other complications of heart disease.

“The autopsy studies were really landmark studies,” says Peter Katzmarzyk, an epidemiologist at the Pennington Biomedical Research Center in Baton Rouge. Before those studies, he recalls, scientists didn’t really understand that serious health events such as heart attack and stroke have their genesis in childhood. “The Bogalusa Heart Study really put that on the map.” And it made a strong case that averting severe consequences of heart disease later in life would mean addressing the lifestyle choices we make when we are young.

The science behind the influence of dietary fat and fatty acids on CVD is complex and continually evolving. As early as the 1950s, scientists and the public were talking about the dangers of high-fat diets, particularly those that contain saturated fatty acids—but recently, we’ve begun to realize the picture isn’t quite so straightforward.

A HEART-PROTECTIVE DIET

Although saturated fatty acids do, indeed, have the potential to raise total and LDL cholesterol levels, an important factor to consider is what people who cut back on saturated fatty acids eat instead. Much of the confusion

INFOGRAPHIC B.7 Sources of Saturated Fat in the U.S. Population, 2005–2006

The percent contribution of specific foods to total saturated fat intake for individuals aged 2 years and older.
we encounter in both the scientific literature and the lay press regarding the risk of consuming high amounts of saturated fat arises because we often do not consider this critical issue—what replaces saturated fats in the diet? For instance, if people replace high-fat foods with lower-fat options that are high in carbohydrates, particularly refined starches, added sugar, and potatoes (which happens frequently), then they won’t likely see any health benefits.

Low-fat diets high in carbohydrates, particularly when low in fiber and high in sugar, actually increase triglyceride levels in the blood. And some recent analyses even suggest that certain sources of saturated fatty acids long thought to be contributors to CVD, such as those in dairy products, actually may not affect blood lipids levels or increase the risk of CVD as negatively as other sources. We are currently seeing a fascination in the United States with coconut oil, a source of saturated fatty acids, as advertisements present it as a panacea of sorts. The purported benefits to heart health, however, are not supported by current scientific evidence. Several studies have found that it raises LDL cholesterol to the same degree as saturated fats from other sources, such as butter, beef fat, and palm oil. This is not particularly surprising as coconut oil contains more saturated fat than any other commonly consumed fat in the U.S. diet. Based on current evidence, the best overall strategy to protect your heart health is to replace saturated fatty acids with unsaturated ones and to emphasize vegetables, fruits, and whole grains in the diet. (INFOGRAPHIC B.8)

The Dietary Guidelines for Americans recommend limiting overall saturated fat intake to 10% or less of total daily calories. In contrast to earlier editions, the 2015 Guidelines do not establish specific limits for dietary cholesterol, but qualify that eating as little as possible is advisable within a healthy eating pattern. For those with increased risk for heart disease and high blood cholesterol levels, recommendations from the National Cholesterol Education Program (NCEP) of the National Institutes of Health are to keep calories from saturated fat under 7%. NCEP

INFOGRAPHIC B.8 Dietary Fat Substitutions and Heart Disease Risk
(The bars represent the range within which the true mean may fall.)

<table>
<thead>
<tr>
<th>REPLACE 5% of energy from:</th>
<th>OUTCOME</th>
<th>Increasing risk</th>
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<tbody>
<tr>
<td>saturated fat with monounsaturated fats</td>
<td>Decreasing risk</td>
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<tr>
<td>saturated fat with polyunsaturated fats</td>
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<td></td>
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<tr>
<td>saturated fat with carbohydrates from whole grains</td>
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<td></td>
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<tr>
<td>saturated fat with carbohydrates from refined starches and added sugars</td>
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<tr>
<td>carbohydrates from refined starches and added sugars with polyunsaturated fats</td>
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The risk of heart disease decreases as saturated fats are replaced with an equal amount of calories from unsaturated fats or carbohydrates from whole grains or when refined starches and added sugars are replaced with equal calories from polyunsaturated fats. Data are adapted from the Nurses’ Health and the Health Professionals’ follow-up studies.

What is the most effective dietary substitution we can make to reduce the risk of coronary heart disease?
created the *Therapeutic Lifestyle Changes* (TLC) program, which incorporates diet, physical activity, and weight management to lower blood cholesterol levels and reduce the risk of heart disease. Also endorsed by the American Heart Association, the TLC dietary component focuses on lowering saturated fat and dietary cholesterol along with other heart-healthy strategies, such as eating foods that have added plant sterols and stanols and contain sufficient soluble fiber.

When the Bogalusa Heart Study began in 1972, Berenson and his colleagues were interested in identifying risk factors in children that contribute to developing heart disease, in part because other studies had identified risk factors in adulthood. The Nurses’ Health Study, for instance, has followed more than 120,000 women since 1976, looking for links between their diets and lifestyles and their risks of various diseases. When the researchers examined women’s fat intake, they found that women who ate the most *polyunsaturated fatty acids* were least likely to develop heart disease.

Research also indicates that replacing saturated fats with *monounsaturated fatty acids* can improve blood lipid profiles and reduce the risk of heart disease, but not as effectively as what is seen when saturated fats are replaced with *polyunsaturated fatty acids*. Also, you can get too much of a good thing—there is no consistent rationale or recommendation for the specific amount of monounsaturated fatty acids we should obtain from our diets, but the American Heart Association suggests that people get no more than 25–35% of their total calories from fat, most of which should come from unsaturated fatty acids, and that saturated fat not exceed 7% of total calories.

Furthermore, different unsaturated fats have different effects on the body as well. Omega-6 *polyunsaturated fatty acids*, for instance, appear to improve blood lipid profiles, especially when they take the place of saturated fatty acids, reducing the risk of heart disease. The American Heart Association suggests that this type of fat should make up no less than 5–10% of our total calories, given that they appear to reduce inflammation, a culprit in the initiation of plaque development.

Some research suggests that omega-3 *fatty acids* may hold particular health benefits, but the picture remains somewhat unclear. For example, as we learned in Chapter 5, low levels of the omega-3 docosahexaenoic acid (DHA) in the diet are associated with an increase in the risk of Alzheimer disease and other forms of dementia, and higher intakes of oily fish are consistently associated with reduced risk of dementia. It’s unclear, however, whether fish oil supplements containing DHA and eicosapentaenoic acid (EPA), another omega-3 fatty acid, hold any benefits relative to the risk of dementia.

Everyone’s diet contains a ratio of omega-6 and omega-3 fatty acids. Most Americans, and others who follow a Western diet, eat much more omega-6 fatty acids than omega-3 fatty acids, with a typical ratio of 10:1. It has long been argued that lowering this ratio, (such as to 5:1 or 4:1) would improve our health, but recent evidence raises significant questions regarding the general recommendation as high intakes of linoleic acid are associated with a significant reduction in the risk of heart disease. Although our knowledge of the health implications of the consumption of specific types of fatty acids is not complete by any means, for some dietary fats, the effect on health is clear.

Trans fatty acids are a case in point. They were added to foods to help lengthen shelf life and were often found in many commercial cakes, cookies, pies, and pastries. Responding to the weight of evidence of increased risk of CVD, the FDA banned addition of trans fats to foods in 2018. (Refer to Chapter 5.) Trans fats were found to raise LDL-C and lower HDL-C, along with raising total cholesterol levels. In the Nurses’ Health Study, women who ate diets high in trans fats had a significantly higher risk of heart disease.

But people don’t make a meal of unsaturated and saturated fats or of omega-3 and omega-6 fatty acids; instead, they think in terms of food. Some foods are naturally rich in heart-healthy fats, such as nuts. Unsalted peanuts and some tree nuts, specifically walnuts, almonds, pecans, and pistachios, are particularly beneficial, and eating at least...
LIPIDS IN HEALTH AND DISEASE

Stay Tuned
For more information about the links between diet and cancer, see Spotlight C Plant-Based Diets.

5 ounces per week (roughly 900 calories) is consistently associated with a lower risk of heart disease. As long as you don’t add nuts to the foods you’re already eating—thereby increasing your fat and calorie intake—they are a good component of a healthy diet, contributing unsaturated fatty acids, fiber, protein, folate, minerals, antioxidants, and phytochemicals. (INFOGRAPHIC B.9)

Another great food source of healthy fats is fish, especially oily, cold-water fish such as anchovies, sardines, trout, albacore tuna, and salmon. The American Heart Association recommends at least two weekly servings of these fish, which provide omega-3 fatty acids, protein, vitamin D, and other key nutrients. Research shows that the oil found in these fatty fish—rich in healthy fats—lowers triglyceride levels, blood pressure, and heart rate, so it’s not surprising that eating fish regularly is associated with a lower risk of CVD. Many companies sell fish oil as a dietary supplement, but it is questionable whether the general population’s supplementation with omega-3 fish oil yields the same health benefits as consuming whole fish. However, the American Heart Association does support the use of fish oil supplements for reducing the risk of future cardiovascular events in individuals with prior heart disease. Whereas whole fish consumption is encouraged, some types of fish can have high levels of mercury and other environmental pollutants. Thus, it is prudent to limit consumption of certain species, such as shark, swordfish, king mackerel, and tilefish.

Fat Intake and Health—Beyond Cardiovascular Disease

Since it began, the Bogalusa Heart Study has generated thousands of research studies and helped train hundreds of students in medicine and public health. Although the study focused on heart disease in childhood, including the effects of diet, eating unhealthy foods is not associated with just heart problems. Many studies have shown that people who eat high-fat diets, particularly diets high in animal fats, are more likely to develop cancer. Indeed, more than 30% of cancers in adults could be delayed or even prevented by eating a healthy diet, exercising regularly, and maintaining a healthy weight. Not surprisingly, a heart-healthy diet also protects against cancer. Specifically, a diet rich in plant-based foods (such as fruits and vegetables), whole grains, and fish appears to be protective, whereas a diet with few servings of fruits and vegetables and extra portions of processed meat, sodium, alcohol, refined carbohydrates, and high amounts of total fat have the opposite effect. Diet is one of the biggest risk factors for many diseases—including cancer—over which we have some control. Naturally, watching your calorie intake and having a healthy body weight also help.

High-fat diets may increase the risk of obesity, although that idea remains somewhat controversial. Fat is calorie-dense, and any extra is more likely to be stored as body fat than excess protein or carbohydrate. Obesity is a particular problem in Louisiana, which is one of a series of states (those located between Texas and Florida) that epidemiologists refer to as the “diabetes belt,” “stroke belt,” or “obesity belt.” For some reason—no one knows exactly why—CVD seems to cluster in this region.

The CVD phenomenon in Louisiana is all too familiar to Berenson, Principal Investigator of the Bogalusa Heart Study. The many house calls he’s made to study participants in Louisiana over the decades have helped him retain an air of the old-fashioned family doctor. “If there was any kind of medical problems I went and examined them myself and took care of them,” Berenson recalled in an interview with Tulane’s Global Health News in 2012. Initially, he had to examine more than 4000 patients.

Because he grew up there, Berenson knew Bogalusa like the back of his hand. And that firsthand knowledge of this town proved crucial in solidifying support for the
Fat Intake and Health—Beyond Cardiovascular Disease

**INFOGRAPHIC B.9** Diet Strategies to Reduce the Risk of Heart Disease

Select foods that can reduce your risk of heart disease.

- **Plant sterols or stanols** reduce cholesterol absorption and thereby reduce blood cholesterol. They are added to some food products, which are allowed to display an FDA-approved health claim stating that they may reduce the risk of heart disease.

- **Oily, cold-water fish** such as salmon, trout, and albacore tuna contain **omega-3 fatty acids**, which can lower blood triglycerides and delay clotting.

- **Plant-based diets** that provide abundant deeply colored fruit and vegetables supply thousands of phytochemicals (flavonoids) that reduce LDL oxidation and blood clotting.

- **Nut consumption** has consistently been found to reduce the risk of heart disease. A recent study observed that those who ate nuts nearly every day had a 20% lower risk of dying of heart disease and cancer than those who did not eat nuts.

- **Moderate alcohol consumption** raises HDL cholesterol and reduces the risk of CVD. Moderate drinking is one drink for a woman and no more than two for a man.

- **Whole grain oats, barley, and rye, as well as legumes** are good sources of **soluble fiber**, which can lower blood cholesterol concentrations and reduce the risk of heart disease.

- **Substituting unsaturated oils for saturated fats** improves blood lipids and reduces the risk of CVD.

- **What two types of foods have been shown to reduce blood clotting?**

- **The frequent consumption of what type of food has recently been shown to reduce the risk of death from both heart disease and cancer?**

**Photo credits (top):** Eli Ensor; (left side — top to bottom): aluxum/Getty Images, svariophoto/Shutterstock, doug4537/Getty Images; (right side — top to bottom): C Squared Studios/Getty Images, Janine Lamontagne/Getty Images, mama_mia/Shutterstock
study. In fact, nearly everyone in the town has participated in the study in some way. Teachers and nurses at local schools serve as study liaisons, and the pathologists who conducted the autopsies had Berenson as an instructor in medical school. Even Berenson and the coroner were old friends. In fact, it was because of his relationship with the coroner that Berenson was able to work out the arrangement that enabled the heart autopsies to be performed. “Eighty percent of the known deaths in the area we were able to autopsy,” says Berenson proudly. “Nobody gets that kind of rate.”

But to truly help the children in his town, Berenson knows he needs to address more than just their food-related cardiovascular risk factors. In one very depressing statistic, he found that many children in Bogalusa start smoking as early as the third grade.

Smoking is a risk factor for CVD. The reality that a potentially lifelong habit of smoking could begin in childhood sent Berenson on a new mission: to get heart disease prevention taught in elementary schools, alongside standard subjects like reading and math. He and his colleagues developed a curriculum called Health Ahead/Heart Smart that builds on the lessons of the Bogalusa Heart Study and attempts to teach children how to apply those lessons in practical ways to help prevent heart disease.

It’s this personalized approach to medicine, combined with Berenson’s brand of southern tenacity, that has ensured success of the Bogalusa Heart Study over the years. “I’m often asked ‘Why Bogalusa?’” The answer is simple, he says: “It’s where I’m from.”

▼▼▼
**Spotlight B BRING IT HOME**

**Fast-food facts**

The term *fast food* brings to mind high-calorie, high-fat, and low-nutrition menu items. However, for many, particularly young to middle-aged Americans, eating out not only is considered necessary but also provides a significant source of their overall nutrition. In a 2016 Gallup poll, 8 in 10 Americans reported eating at fast-food restaurants at least monthly; almost half said that they eat fast food at least weekly. Only 4% said that they never eat at fast-food restaurants.

Is it possible to find healthful menu items at chain restaurants? Although greater variety and control of ingredients and preparation methods can usually be achieved by preparing food at home, with a bit of planning and awareness, you can still make positive choices when eating out.

**Explore and consider**

Visit the corporate website for a major fast-food chain (for example, www.mcdonalds.com, www.wendys.com, www.subway.com, or www.in-n-out.com), and find the nutrition information or facts. Using the chart provided, compare a typical meal you or a friend might order (for example, cheeseburger, large fries, and large cola) with another meal that has a better overall nutrient profile and a more positive—or at least less negative—potential impact on blood lipid profile (total, LDL and HDL cholesterol levels). Nutrition information and suggestions can also be found at https://www.fastfoodnutrition.org/.

### Typical restaurant meal at

<table>
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<th>Food Item or Beverage</th>
<th>Serving Size</th>
<th>Calories</th>
<th>Fat (g)</th>
<th>Percent Calories from Fat* (for meal only)</th>
<th>Saturated Fat (g)</th>
<th>Fiber (g)</th>
<th>Sodium (mg)</th>
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Consider

1. As you reviewed the nutrition facts information for the restaurant you chose, did calorie or fat content of menu items surprise you? Why or why not?

2. Briefly comment on the differences between the typical and healthier meals you chose.

3. With regard to total fat and saturated fat, discuss the potential impact of the meals you chose on blood lipid levels and heart disease risk.

4. Do you think it is possible to find a reasonably healthy meal at a fast-food restaurant? Why or why not?

5. Do you think the posting of calorie information on menu boards makes a difference in what customers order? Do you think requiring calorie or other nutrition information has the potential of lowering risk of heart disease and obesity in the United States? Why or why not?

6. What might you propose on a food industry, policy, or consumer level not only to encourage healthier options but also to direct individuals toward making better food choices at fast-food and chain restaurants?
Atherosclerosis, a thickening and hardening of the arteries along with plaque development along blood vessel walls, is a major cause of heart attack and stroke.

Atherosclerosis is a form of CVD that often begins when an injury to a vessel wall triggers inflammation and low-density lipoprotein (LDL) cholesterol infiltration there, which results in plaque accumulation.

CVD risk factors increase the risk of vessel injury as well as the rate and extent of the progression of plaque buildup and arterial blockage.

The presence of risk factors increases the risk of developing and promoting CVD. Some risk factors cannot be modified (for example, race, age, and a family history of heart disease), but certain lifestyle choices can significantly affect the risk of CVD.

Modifiable risk factors for CVD include smoking; a diet high in saturated and trans fats, cholesterol, sodium, and added sugar; a sedentary lifestyle; obesity; diabetes; elevated lipid levels in the blood (cholesterol, LDL-C, and triglycerides); excessive alcohol consumption; and high blood pressure.

The concentrations of various lipids in the blood correlate with the risk of atherosclerosis and CVD. A high level of total blood cholesterol is a major risk factor, particularly when accompanied by high levels of LDL cholesterol and low levels of HDL cholesterol.

Metabolic syndrome is a cluster of risk factors associated with the development of cardiovascular disease (CVD) and type 2 diabetes. Diagnosis of metabolic syndrome involves the presence of at least three of the following abnormalities: excessive abdominal fat, high blood pressure, elevated levels of triglycerides in the blood, low levels of high-density lipoproteins (HDLs), and elevated blood glucose levels.

Diet, including the intake of fatty acids and cholesterol, plays a critical role in the development or prevention of CVD.

Available evidence suggests that replacing saturated fats with monounsaturated and polyunsaturated fatty acids may be beneficial in lowering CVD risk.

The Therapeutic Lifestyle Changes (TLC) program was created by the National Institutes of Health’s National Cholesterol Education Program (NCEP) and is endorsed by the American Heart Association as a heart-healthy regimen that can lower blood cholesterol and reduce the risk of CVD.

The dietary component of the TLC program focuses on lowering saturated fat and dietary cholesterol levels along with other heart-healthy strategies such as eating foods that contain plant sterols and stanols and sufficient soluble fiber.

Additional dietary strategies to improve blood lipid profiles and reduce the risk of CVD include minimizing intake of trans fatty acids and lowering the ratio of omega-6 fatty acids to omega-3 fatty acids.

The science behind the biological and health effects of dietary fat and fatty acids is complex and continually evolving.
1. Atherosclerosis is theorized to begin with:
   a. a heart attack.
   b. injury to the lining of the artery.
   c. excessive sugar intake over time.
   d. blood clot formation.
   e. a stroke.

2. All of the following are true with regard to inflammation of blood vessel walls, EXCEPT that it:
   a. can be triggered by damage or injury to the blood vessel wall.
   b. occurs when white blood cells move to vessel walls in response to LDL cholesterol in the blood.
   c. causes further damage to blood vessel walls.
   d. makes blood vessels more prone to accumulation of plaque.
   e. helps keep vessel walls flexible and protects against heart attack.

3. Modifiable CVD risk factors do NOT include:
   a. diets that are high in saturated fat, sodium, and added sugar.
   b. smoking, sedentary lifestyle, obesity, and high blood pressure.
   c. consumption of excessive amounts of alcohol.
   d. risk factors such as family history, increasing age, and race.

4. For adults, a healthy blood cholesterol level is considered to be less than:
   a. 100 mg/dl.
   b. 120 mg/dl.
   c. 160 mg/dl.
   d. 200 mg/dl.
   e. 240 mg/dl.

5. A higher risk of CVD is associated with higher levels of:
   a. linolenic acid.
   b. chylomicrons.
   c. red blood cells.
   d. LDL cholesterol.
   e. HDL cholesterol.

6. A primary function of HDLs is to:
   a. aid in the digestion of lipids in the small intestine.
   b. transport cholesterol to all cells of the body.
   c. transport cholesterol from tissues to the liver.
   d. transport triglycerides to adipose tissue.
   e. link amino acids to form proteins.

7. All of the following are among the cluster of conditions that characterize metabolic syndrome, EXCEPT:
   a. excessive abdominal fat.
   b. high blood pressure.
   c. prediabetes or type 2 diabetes.
   d. low levels of LDL cholesterol in the blood.
   e. elevated levels of triglycerides in the blood.

8. Current evidence indicates that reducing saturated fats in the diet is most effective in reducing the risk of CVD when:
   a. saturated fats are replaced by unsaturated fats.
   b. all dietary cholesterol is eliminated.
   c. saturated fats are replaced by carbohydrate-rich foods.
   d. saturated fats are replaced by low-fat breads and cereals.
   e. total fat intake is kept under 20% of calories from fat.
9. The Therapeutic Lifestyle Changes (TLC) dietary component for individuals with increased risk of CVD focuses on all of the following, EXCEPT:
   a. foods that contain plant sterols and stanols.
   b. sufficient soluble fiber intake.
   c. lowering intake of monounsaturated fats.
   d. lowering intake of dietary cholesterol.
   e. lowering saturated fat to less than 7% of total calories.

10. Trans fatty acids:
   a. are recommended to make up at least 5% of daily calories from fat.
   b. shorten the shelf life of food products.

   c. in place of saturated fats lower risk of heart disease.
   d. are found only in processed foods, not found naturally in any other foods.
   e. were banned by the FDA in 2018.

TAKE IT FURTHER

Contrast two 45-year-old men, one with a low risk of CVD and one with an elevated risk of CVD. List five ways in which diet, exercise, and other lifestyle choices might have increased the risk of CVD for one of these men more than the other.