Cardiovascular Health

Chapter 15

Cardiovascular Disease (CVD)

- CVD is the leading cause of death in the United States

  Affects more than 85 million Americans

  Claims one life every 40 seconds

  – More than 2200 Americans every day

  CVD results largely from our way of life

The Cardiovascular System

- Consists of the heart and blood vessels—both arteries and veins
    - Move blood through the body
- When lungs are included, the system is known as the cardiorespiratory or cardiopulmonary system

The Heart

- Four-chambered muscle

  Pumps deoxygenated blood to the lungs and oxygenated blood to the rest of the body

- Pulmonary circulation: right side of the heart pumps blood to the lungs
- Systemic circulation: left side of the heart pumps blood through the rest of the body

The Heart (2)

- Path of blood flow:
  - Vena cava
  - Right atrium
  - Right ventricle
  - Pulmonary artery to lungs
  - Pulmonary vein
  - Left atrium
  - Left ventricle
  - Aorta

The Heart (3)

- Heartbeat is controlled by electrical and nerve impulses
  - Diastole: period of relaxation
  - Systole: heart's contraction
- Blood pressure: force exerted by the blood on the walls of blood vessels

The Blood Vessels

- Veins carry blood to the heart

  Thin walls

- Arteries carry blood away from the heart

  Thick elastic walls that expand and relax with the volume of blood

  Coronary arteries

  – Two large vessels that supply blood to the heart

  Capillaries and small veins (venules)

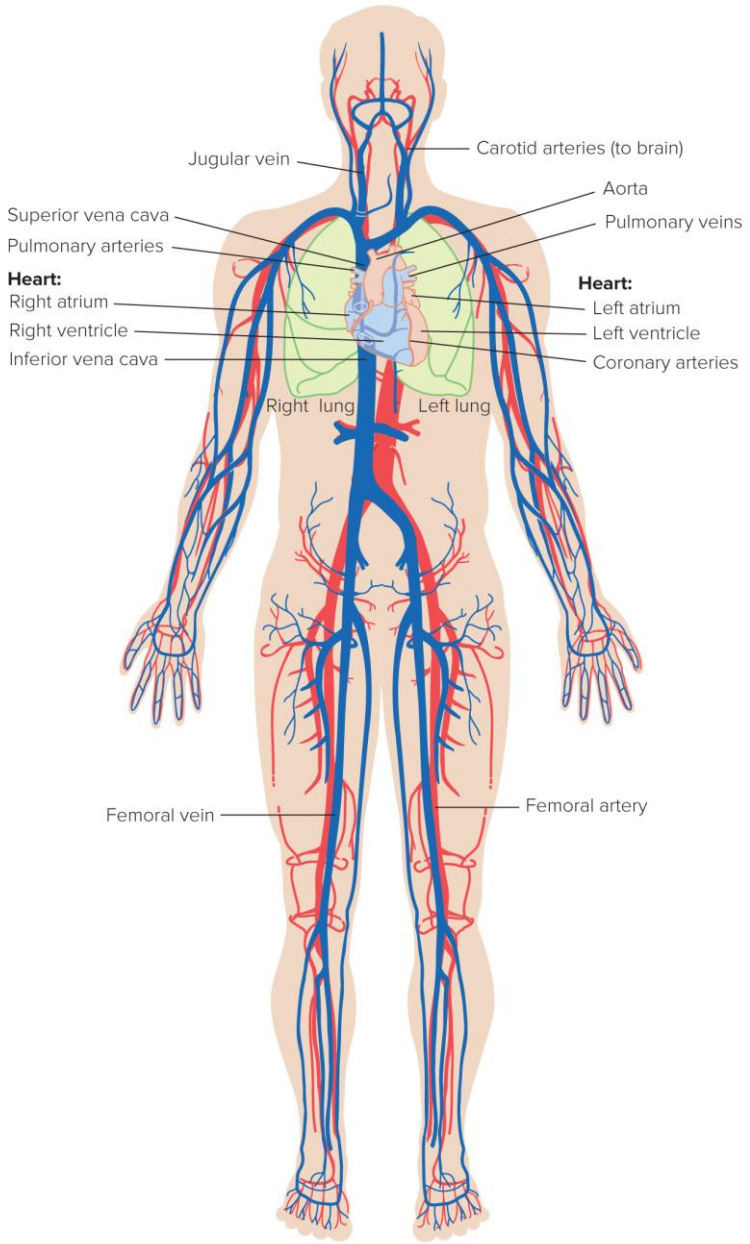

Figure 15.1

The Cardiorespiratory System

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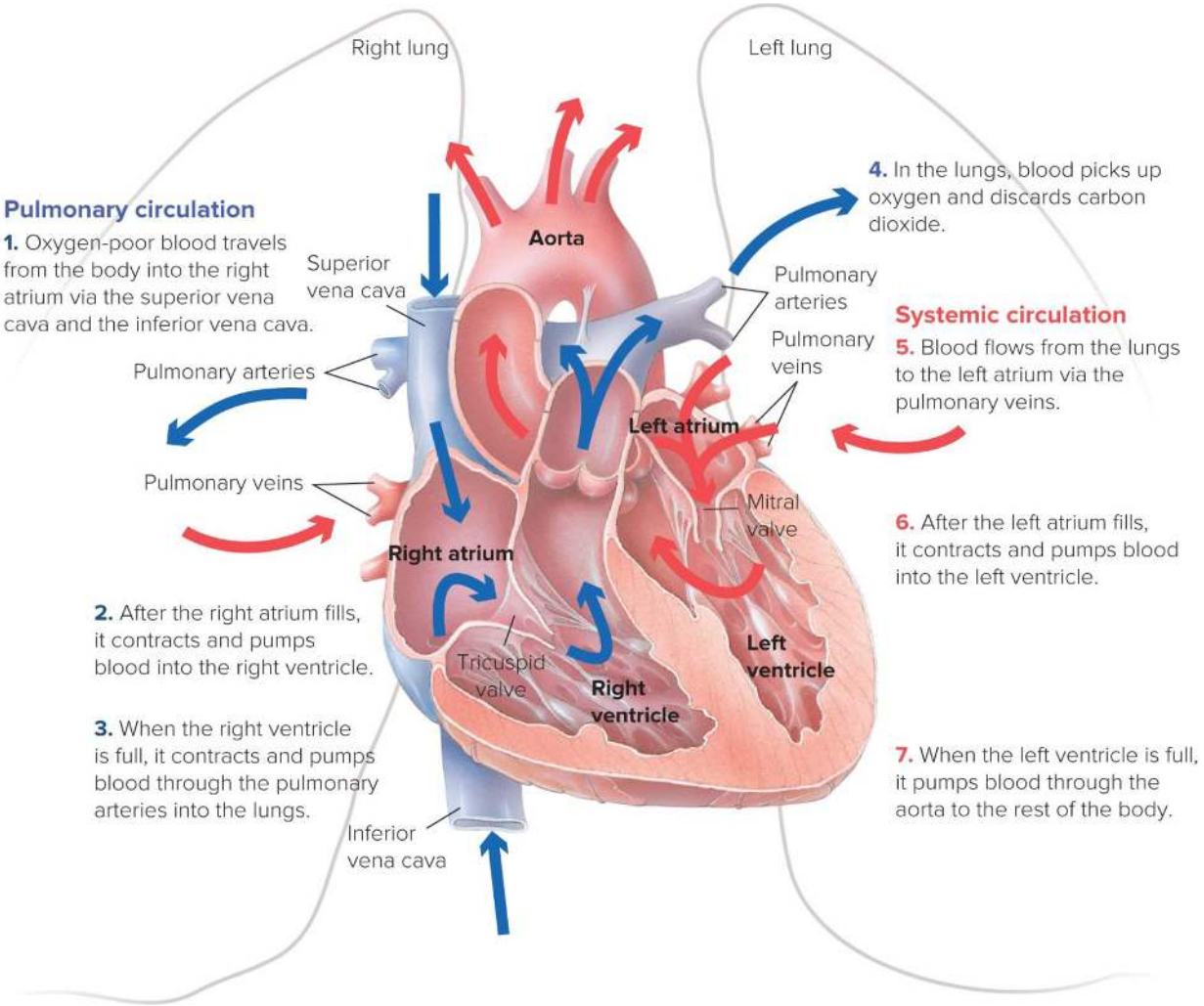

Figure 15.2 Circulation in the Heart

Blue arrows indicate oxygen-poor blood; red arrows indicate oxygen-rich blood.

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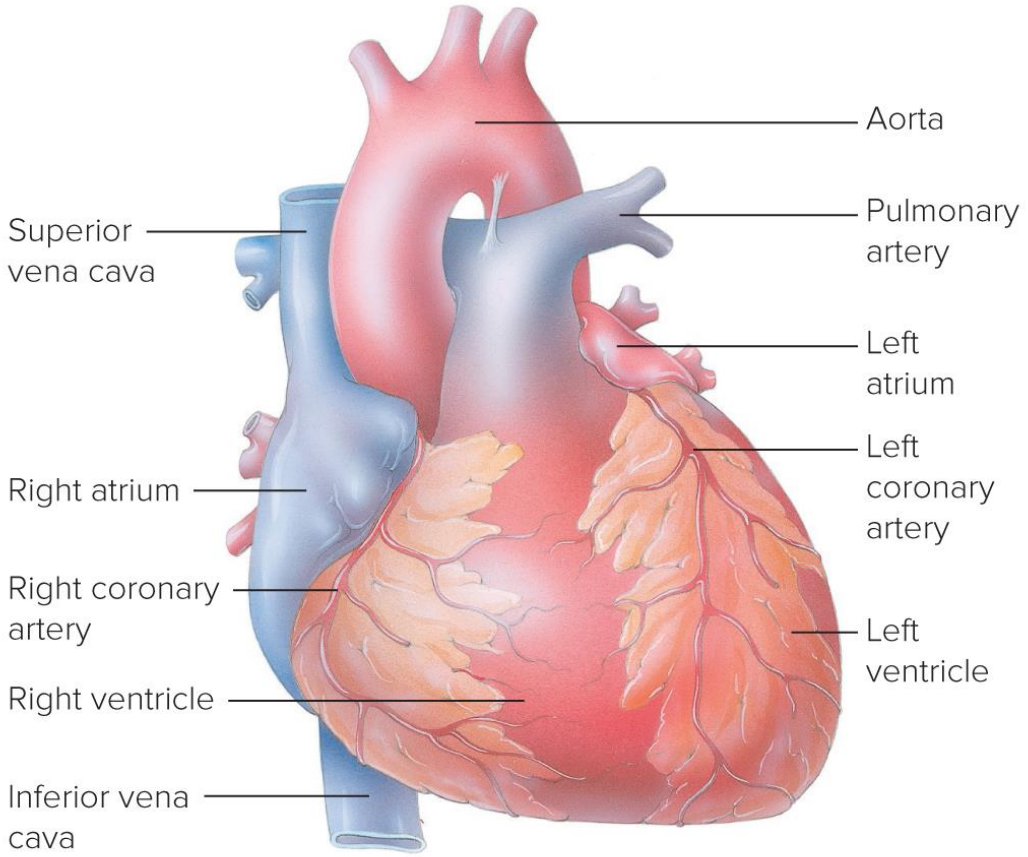

Figure 15.3 Blood Supply to the Heart

Blood pumped through the chambers of the heart does not reach the cells of the heart, so the organ has its own network of arteries, veins, and capillaries. Two large vessels, the right and left coronary arteries, branch off the aorta and supply the heart muscle with oxygenated blood.

Risk Factors for Cardiovascular Disease

- Major risk factors that can be changed:
  - Tobacco use
  - High blood pressure
  - High cholesterol
  - Physical inactivity
  - Obesity
  - Diabetes

Major Risk Factors that Can Be Changed

- Tobacco use
  - Damages the lining of arteries
  - Reduces HDLs; and raises triglycerides and LDLs
  - Nicotine increases blood pressure and heart rate
  - CO displaces O_2
  - Causes platelets to stick together, leading to clotting
  - Speeds the development of fatty deposits in the arteries
- Exposure to environmental tobacco smoke (ETS) also increases risk

Major Risk Factors that Can Be Changed (2)

- High blood pressure, or hypertension
  - Too much pressure against arterial walls
  - Systolic and diastolic blood pressure (mm Hg)
    - Normal blood pressure = below 120 systolic/80 diastolic
  - Primary (essential) hypertension: underlying cause unknown
  - Secondary hypertension: caused by an identifiable underlying illness
  - Atherosclerosis
    - Heart has to work harder; it weakens and enlarges; the arteries narrow, scar, and harden

Major Risk Factors that Can Be Changed (3)

- Health risks of high blood pressure
  - Often called a “silent killer”
- Prevalence
  - About 33% of adults have hypertension; 30% have prehypertension
    - Rate is highest in African Americans
- Treatment
  - Lifestyle changes can control hypertension
    - DASH diet
    - Sodium restriction
    - Adequate potassium

Table 15.1 Blood Pressure Classification for Healthy Adults

CATEGORY [a]	SYSTOLIC (mm Hg)	and/or	DIASTOLIC (mm Hg)
Normal [b]	below 120	and	below 80
Prehypertension	120–139	or	80–89
Hypertension [c] stage 1	140–159	or	90–99
Hypertension stage 2	160 and above	or	100 and above

[a] When systolic and diastolic pressures fall into different categories, the higher category should be used to classify blood pressure status.

[b] The risk of death from heart attack and stroke begins to rise when blood pressure is above 115/75.

[c] Based on the average of two or more readings taken at different physician visits. In people older than 50, systolic blood pressure greater than 140 mm Hg is a much more significant CVD risk factor than diastolic blood pressure.

SOURCE: National Heart, Lung, and Blood Institute. 2011. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (NIH Publication No. 03-5233). Bethesda, MD: National Heart, Lung, and Blood Institute. These guidelines are under development, according to the National Heart, Lung, and Blood Institute (http://www.nhlbi.nih.gov/health -pro/guidelines/current/hypertension-jnc-7).

Major Risk Factors that Can Be Changed (4)

- High cholesterol
  - Excessive cholesterol clogs the arteries
  - Low-density lipoproteins (LDLs)—"bad"
    - Shuttle cholesterol from liver to organs and tissues
    - Can accumulate on artery walls and be oxidized by free radicals
  - High-density lipoproteins (HDLs)—"good"
    - Shuttle unused cholesterol back to liver for recycling
    - By removing cholesterol from blood vessels, help protect against atherosclerosis

Major Risk Factors that Can Be Changed (5)

- Controlling high cholesterol

  Guidelines for treatment of blood cholesterol are based on an individual's risk of developing CVD in the next 10 years

  - Offers lifestyle modifications
  - Suggests statin therapy at different intensity doses

  People who treat their high cholesterol can reduce their risk of heart attack by 40%

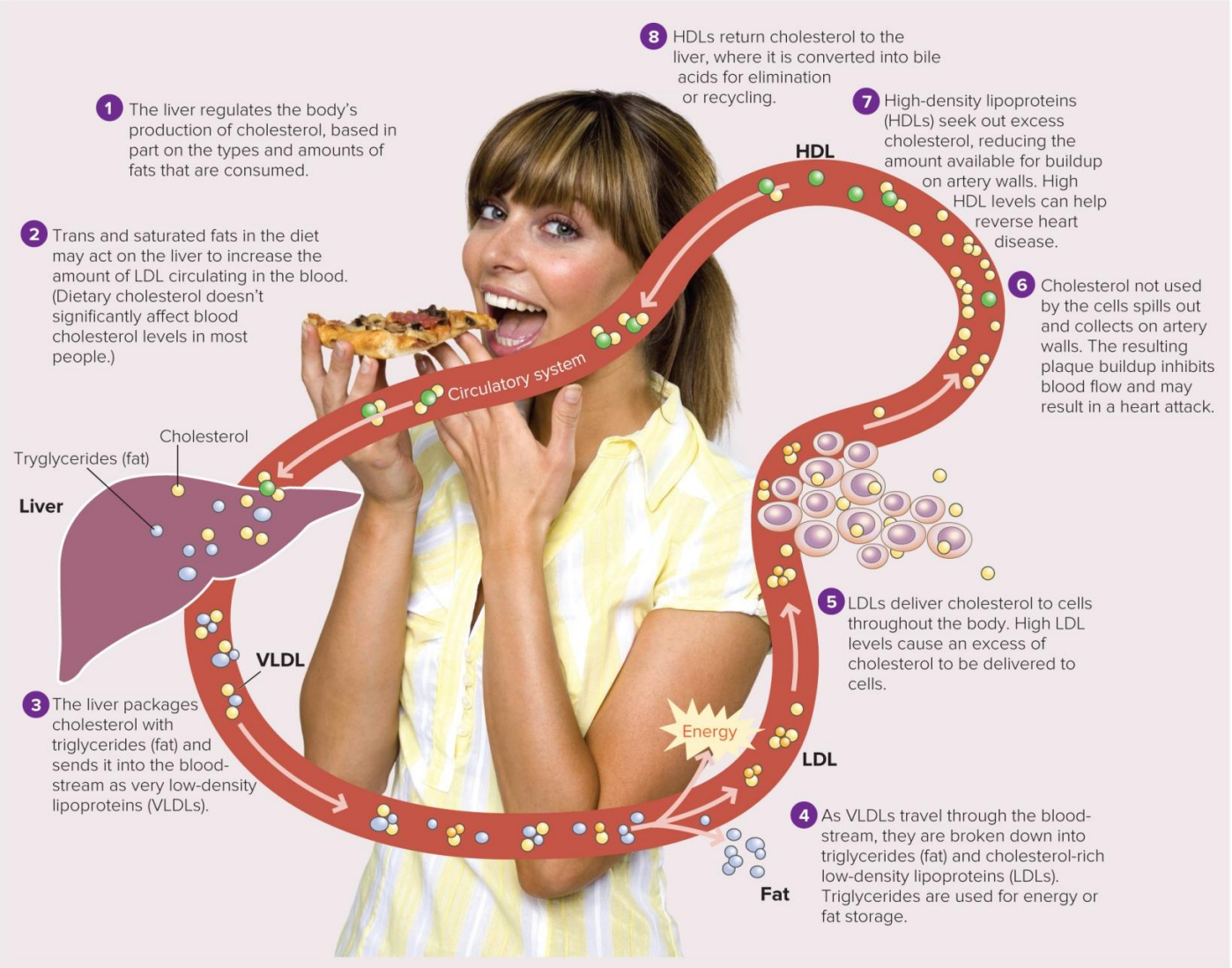

Figure 15.4 Cholesterol in the Body

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Table 15.2 People Who Benefit from Treatment of High Cholesterol

1. People age 75 and under with known cardiovascular disease, including previous heart attacks, chest pain due to partially clogged arteries, history of invasive treatment for clogged arteries, previous stroke, or previous clogged arteries in the limbs.
2. People age 21 and over with high LDL levels, 190 mg/dl or greater.
3. People ages 40–75 with a history of diabetes, an LDL level 70–189 mg/dl, and no known history of cardiovascular disease.
4. People ages 40–75 without diabetes or known cardiovascular disease but with a high risk of developing it over the next 10 years and an LDL level over 70 mg/dl. *

*10-year cardiovascular risk is calculated using a new tool available on the ACC website: ASCVD Risk Estimator.

SOURCE: Stone, N. J., et al. 2013. ACC/AHA guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Journal of the American College of Cardiology.

Table 15.3 Prevalence of High Cholesterol in Adult Americans

GROUP	TOTAL CHOLESTEROL ≥ 200 mg/dl	TOTAL CHOLESTEROL ≥ 240 mg/dl
Both sexes	42.8%	13.1%
Males	40.4	11.6
Females	45.9	14.4
Non-Hispanic white males	39.9	11.5
Non-Hispanic white females	45.9	15.3
Non-Hispanic black males	37.4	8.8
Non-Hispanic black females	40.7	10.9
Hispanic males	46.2	14.8
Hispanic females	43.4	13.7

SOURCE: Mozaffarian, D., et al. 2016. Heart disease and stroke statistics—2016 Update: A report from the American Heart Association. Circulation 133: e38-e360.

Major Risk Factors that Can Be Changed (6)

- Physical inactivity

  40–60 million Americans are so sedentary that they are at high risk for developing CVD

  Exercise reduces risk by:

  - Controlling blood pressure and resting heart rate
  - Lowering LDLs
  - Increasing HDLs
  - Maintaining weight
  - Improving the condition of blood vessels
  - Preventing or controlling diabetes

Major Risk Factors that Can Be Changed (7)

- Obesity
  - Risk is two to three times more likely at BMI > 30
    - Increased strain on the heart
  - Strongly associated with:
    - Hypertension
    - High cholesterol
    - Insulin resistance
    - Diabetes
    - Physical inactivity
    - Increasing age
    - Endothelial cell dysfunction
    - Hypertrophy

Major Risk Factors that Can Be Changed (8)

- Diabetes

  Loss of 5–10 years of life

  Higher rates of other risk factors:
  - Hypertension
  - Obesity
  - Unhealthy blood lipid levels

  Elevated blood glucose and insulin can damage the endothelial cells lining the arteries
  - More vulnerable to atherosclerosis

  People with prediabetes are also at increased risk

Contributing Risk Factors that Can Be Changed

- High triglyceride levels
  - Reliable predictor of heart disease
- Insulin resistance and metabolic syndrome
- Inflammation
- Psychological and social factors
  - Stress; chronic hostility and anger
  - Suppression of psychological distress
  - Depression; anxiety
  - Social isolation and low socioeconomic status
- Alcohol and drugs

Table 15.4 Characteristics of Metabolic Syndrome

FACTOR	CRITERIA
Large waistline (abdominal obesity)	35 or more inches (88 cm) for women 40 or more inches (102 cm) for men
High triglyceride level	150 mg/dl or higher Or taking medication to treat high triglycerides
Low HDL level	Less than 50 mg/dl for women Less than 40 mg/dl for men Or taking medication to treat low HDL
High blood pressure	130/85 mm Hg or higher (one or both numbers) Or taking medication to treat high blood pressure

A person having three or more factors listed here is diagnosed with metabolic syndrome.

SOURCE: Adapted from National Heart, Lung, and Blood Institute. 2015. How Is Metabolic Syndrome Diagnosed? (http://www.nhlbi.nih.gov /health/health-topics/topics/ms/diagnosis).

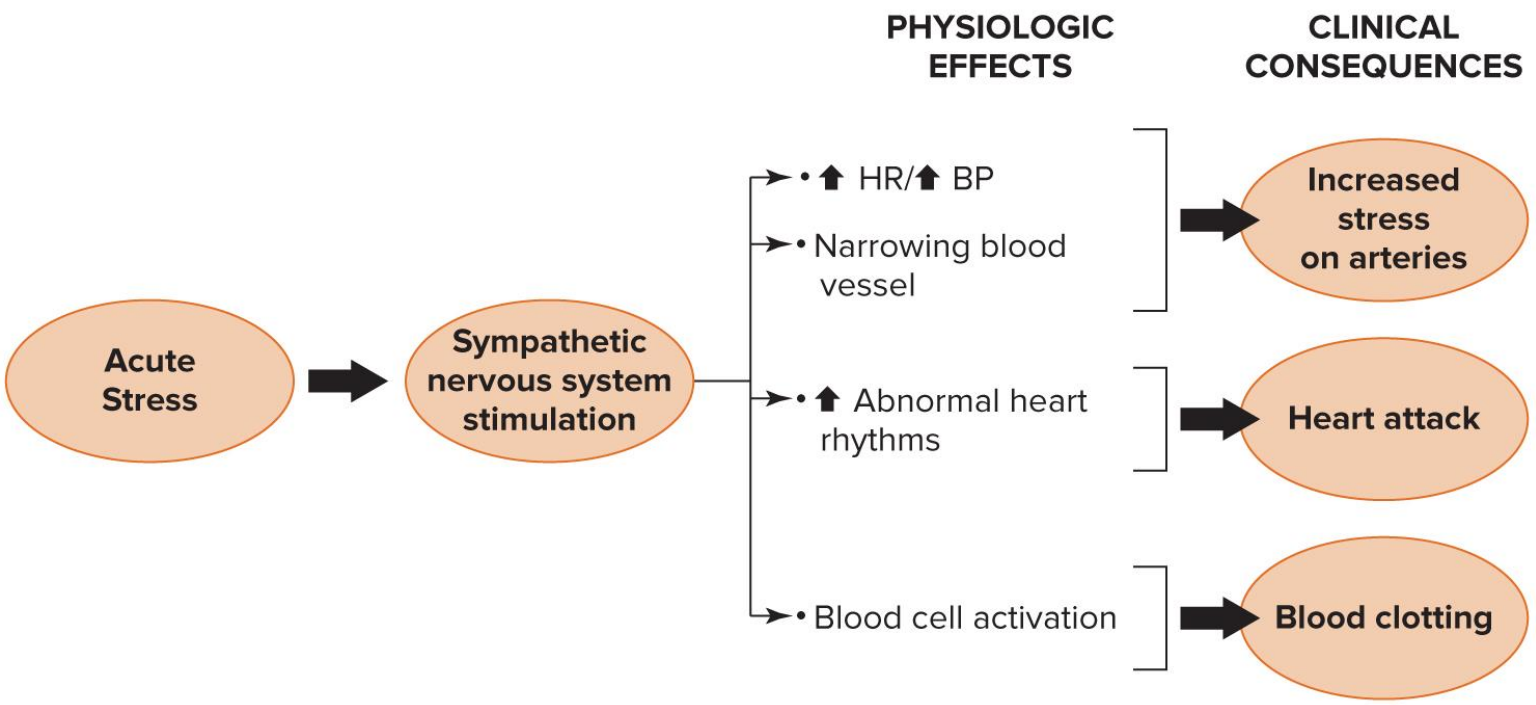

Figure 15.5 The Effects of Stress and Emotions on the Cardiovascular System

SOURCE: Adapted from Rozanski, A., et al. 1999. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. Circulation 99:2192–2217.

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Major Risk Factors that Can't Be Changed

- Genetics

  CVD has a genetic component associated with high cholesterol levels, blood clotting, and obesity

- Age

  About 70% of heart attack victims are 65 and older

- Gender

  Men have higher risk earlier in life

- Race and ethnicity

  African Americans have a higher risk of hypertension, heart disease, and stroke

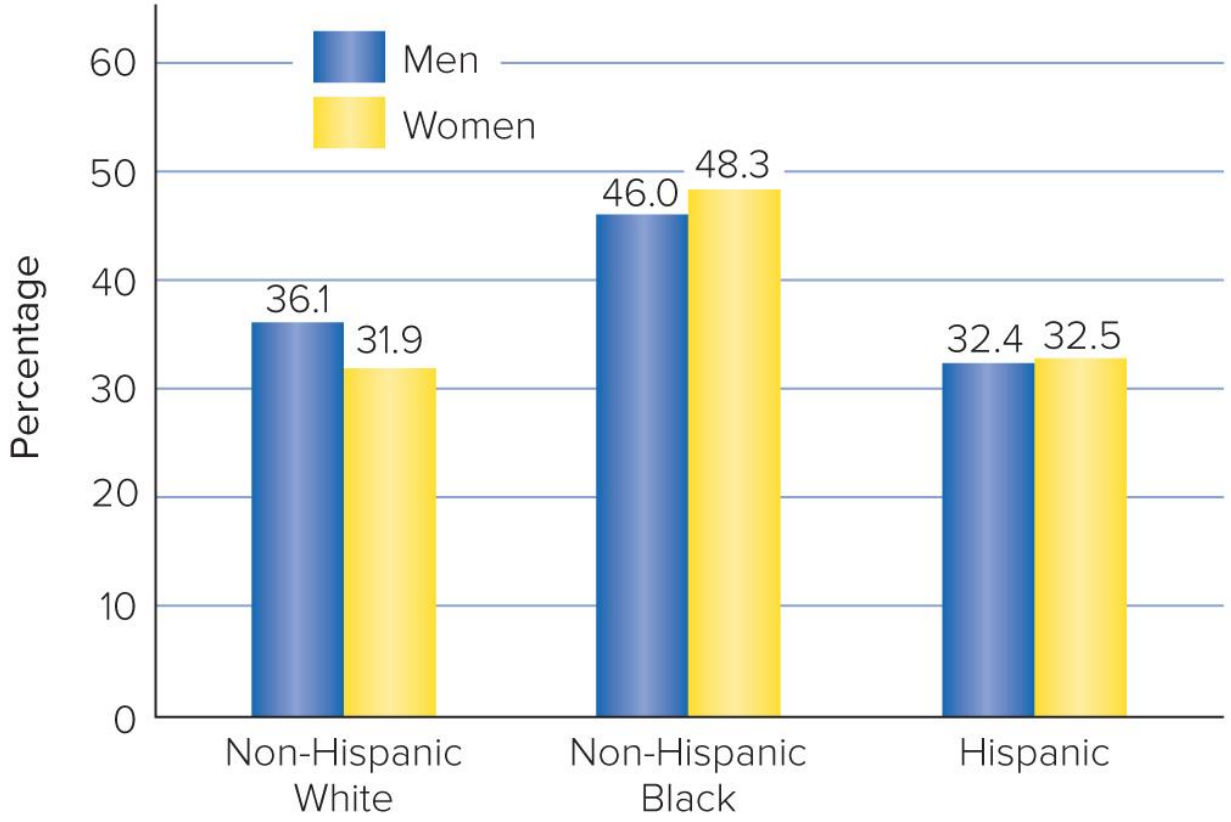

Figure 15.6 Percentage of Adult Americans with Cardiovascular Disease

SOURCE: Mozaffarian, D., et al. 2016. Heart disease and stroke statistics—2016 Update: A report from the American Heart Association. Circulation 133: e38-e360.

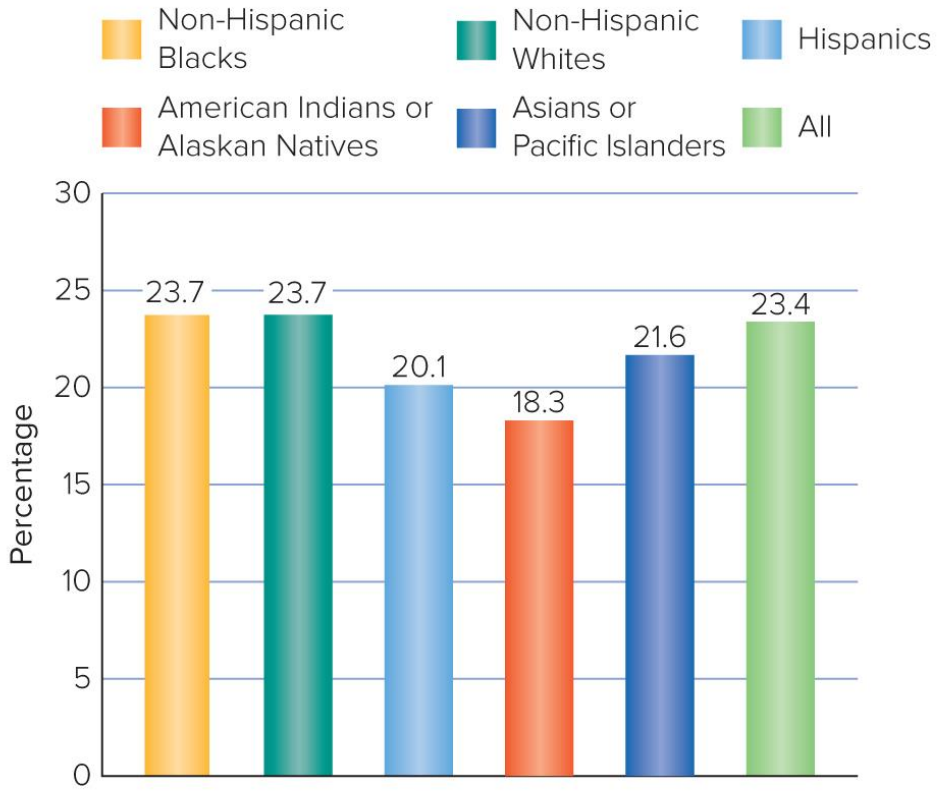

Figure 15.7 Percentage of U.S. Deaths Due to Heart Disease, by Race and Ethnicity

23.7% of non-Hispanic blacks; 23.7% of non-Hispanic whites; 20.1% of Hispanics; 18.3% of American Indians/Alaskan Natives; and 21.6% of Asians/Pacific Islanders died of heart disease.

SOURCE: National Center for Health Statistics. 2015. LCWK1: Deaths, percent of total deaths, and death rates for the 15 leading causes of death in 5-year age groups, by race and sex: United States, 1999–2014 and LCWK2: Deaths, percent of total deaths, and death rates for the 15 leading causes of death in 10-year age groups, by race and sex: United States, 1999–2014 (http://www .cdc.gov/nchs/nvss/mortality_tables.htm).

Possible Risk Factors Currently Being Studied

- Homocysteine
  - Amino acid, circulating in the blood at elevated levels
- Infectious agents
- Lipoprotein(a), or Lp(a)
  - Strong genetic component
- LDL particle size
  - Small, dense particles increase risk
- Blood viscosity and iron
- Uric acid

Possible Risk Factors Currently Being Studied (2)

- Time of day and time of year

  More heart attacks and sudden deaths occur between 6:00AM and noon

  50% more occur in the winter months than in the summer months

Major Forms of Cardiovascular Disease

- Atherosclerosis
- Coronary artery disease and heart attack
- Stroke
- Peripheral arterial disease
- Congestive heart failure
- Congenital heart disease
- Rheumatic heart disease
- Heart valve disorders

Atherosclerosis

- Thickening and hardening of the arteries
  - Plaques accumulate in artery walls
- Effects can be deadly
  - Coronary heart disease (CHD) or coronary artery disease (CAD)
    - Heart attack; stroke
- Main risk factors: tobacco use, physical inactivity, high blood cholesterol levels, high blood pressure, and diabetes

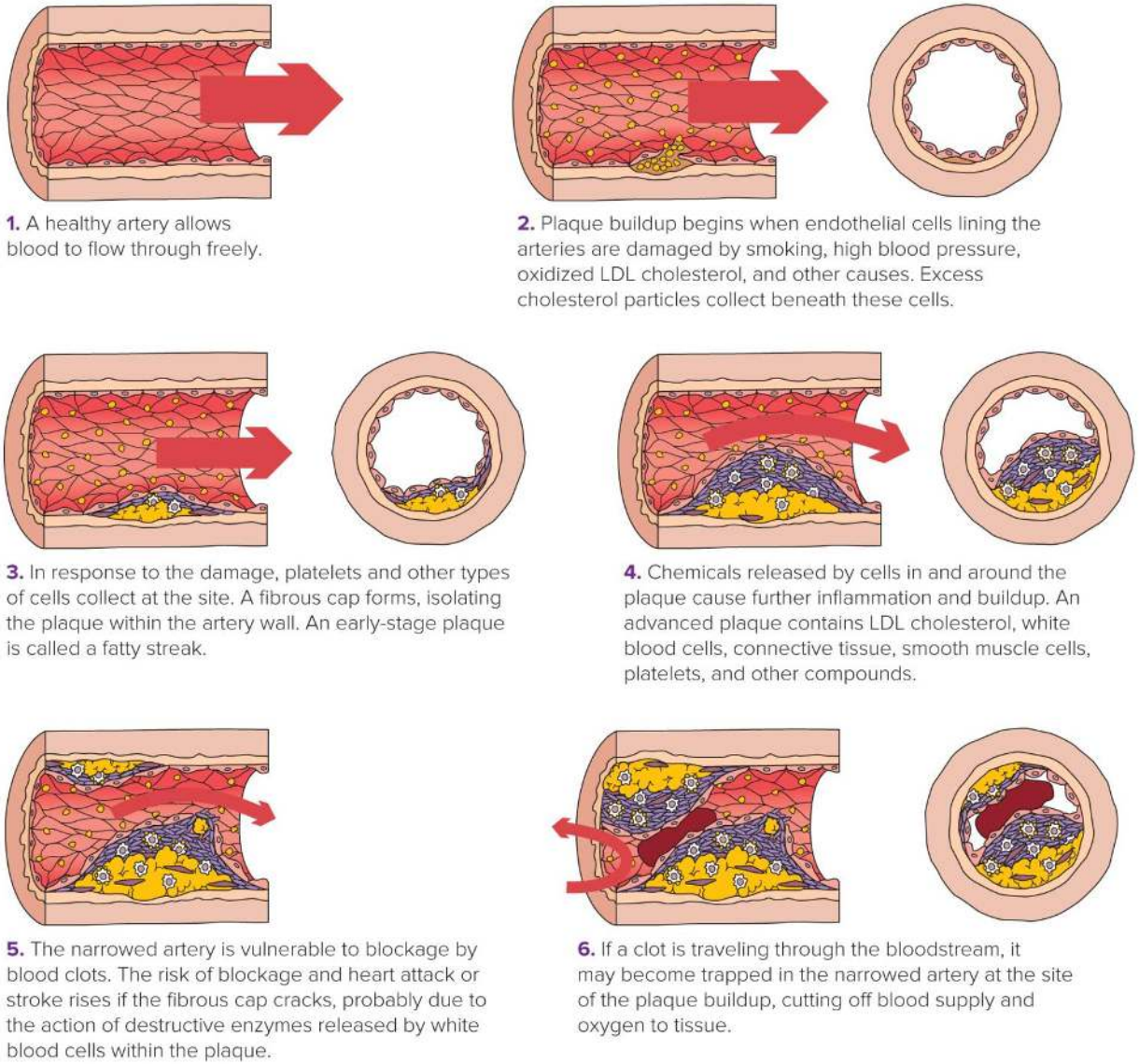

Figure 15. 8 Atherosclerosis: The Process of Cardiovascular Disease

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Coronary Artery Disease and Heart Attack

- Heart attack, or myocardial infarction (MI), is usually the result of a chronic disease process

  Damage to heart tissue from lack of oxygenated blood

  Symptoms
  - Chest pain or pressure
  - Arm, neck, or jaw pain
  - Difficulty breathing
  - Excessive sweating
  - Nausea and vomiting
  - Loss of consciousness

Table 15.5 U.S. Deaths from Acute Myocardial Infarction, 2013

AGE	NUMBER OF DEATHS	DEATHS PER 100,000
Birth–24	62	0.06
25–44	2,217	2.6
45–64	25,470	30.5
65 and over	86,266	186.7

SOURCE: National Center for Health Statistics. 2016. Deaths: Final data for 2014. National Vital Statistics Reports 65(4): 1–122. Hyattsville, MD: National Center for Health Statistics.

Coronary Artery Disease and Heart Attack (2)

- Angina
  - Arteries are narrowed by disease
  - Stressed heart cannot receive enough oxygen
  - Angina pectoris—chest pain—is usually relieved by rest or nitroglycerin
- Arrhythmias and sudden cardiac death
  - Electrical conduction system disrupted
  - Ventricular fibrillation
  - Cardiac defibrillation
    - Automated external defibrillators (AEDs)

Coronary Artery Disease and Heart Attack (3)

- Helping a heart attack victim

  Most deaths from a heart attack happen within 2 hours of initial symptoms

  Know the main warning signs

  Aspirin has an immediate anticlotting effect

  If no pulse found: cardiopulmonary resuscitation (CPR)

Coronary Artery Disease and Heart Attack (4)

- Detecting and treating heart disease

  Testing and evaluating:

  - Electrocardiogram (ECG or EKG)
  - Electron-beam computed tomography (EBCT)
  - Echocardiography—ultrasound waves
  - Multi-slice computed tomography (MSCT)
  - Magnetic resonance imaging (MRI)
  - Nuclear myocardial perfusion imaging
  - Positron emission tomography (PET)

Coronary Artery Disease and Heart Attack (5)

- Detecting and treating heart disease

  If tests indicate coronary artery disease: coronary angiogram

  Treatments:

  - Balloon angioplasty and stent
  - Low-dose aspirin therapy
  - Prescription drugs
  - Coronary bypass surgery

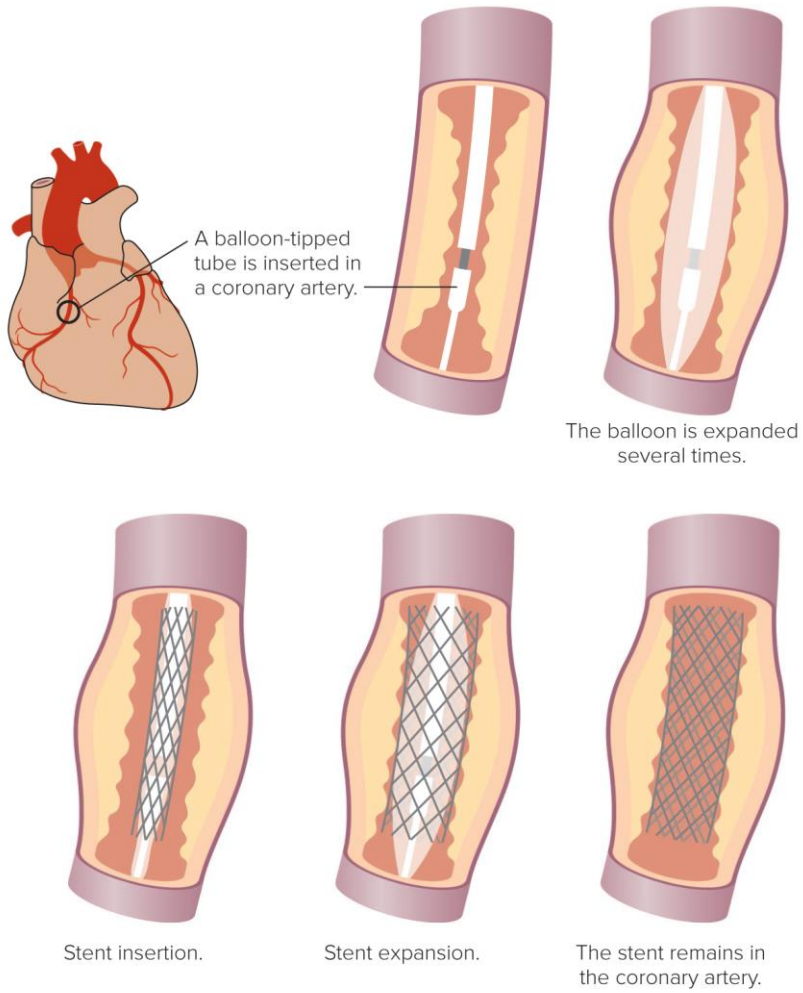

Figure 15.9 Balloon Angioplasty and Stenting

A balloontipped catheter is fed into the artery. The balloon is advanced to the site of the narrowing and then inflated, flattening the fatty plaque and widening the arterial opening. A stent, a small metal tube, is inserted and expanded and remains in the coronary artery.

Stroke

- Blood supply to the brain is cut off, and brain tissue subsequently dies
  - Ischemic stroke: blockage in blood vessels
    - Thrombotic stroke
    - Embolic stroke
  - Hemorrhagic stroke: a blood vessel ruptures in the brain
    - Intracerebral hemorrhage
    - Subarachnoid hemorrhage
    - Aneurysm

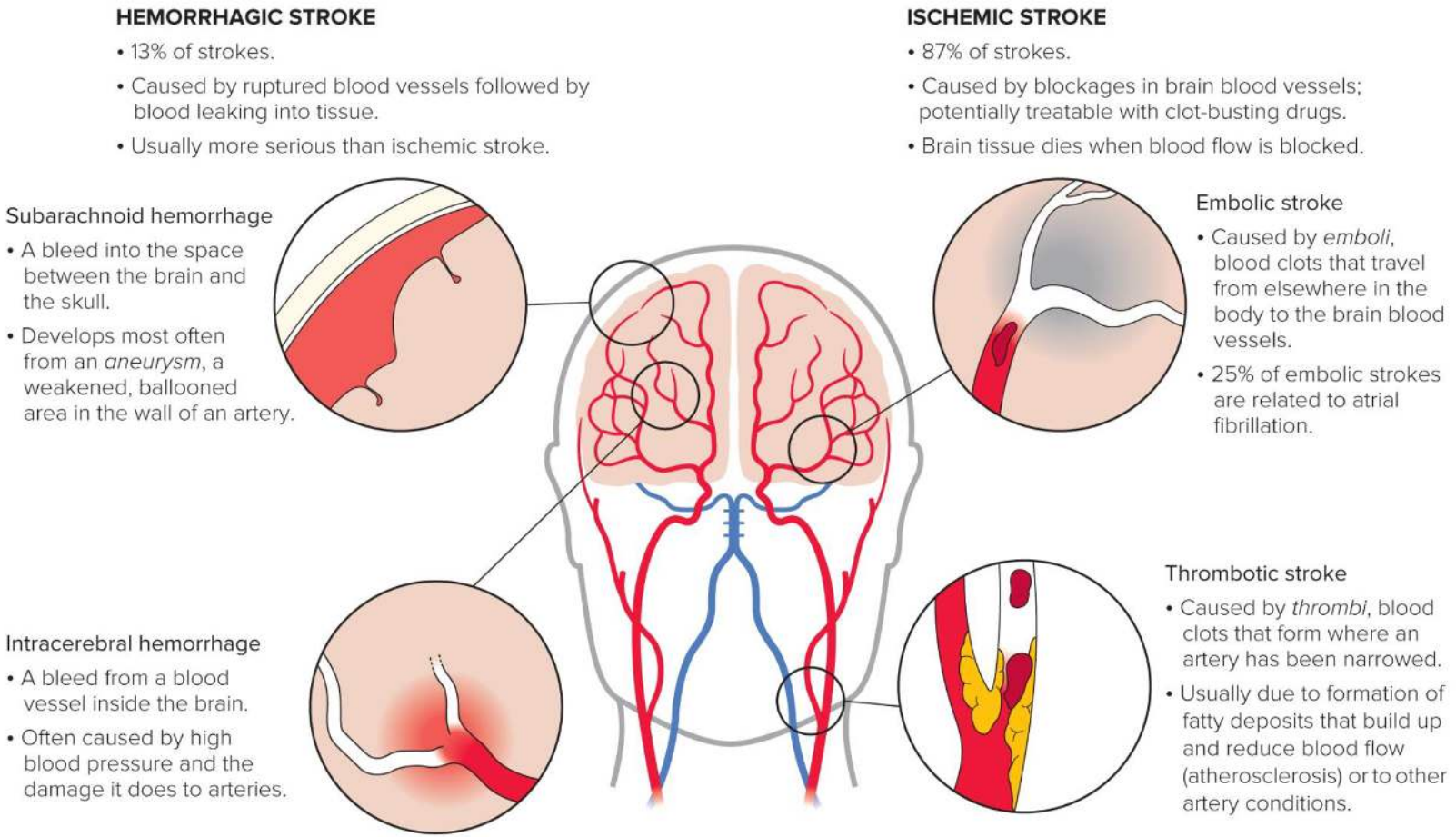

Figure 15.10 Types of Stroke

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SOURCE: Adapted from Harvard Health Letter, April 2000. Harvard University. Artwork by Harriet Greenfield, reprinted with permission.

Stroke (2)

- Effects of a stroke

  Interruption of the blood supply to any area of the brain prevents the nerve cells from functioning, in some cases causing death

  Those who survive have some lasting disability

  - Paralysis
  - Walking disability
  - Speech impairment
  - Memory loss
  - Changes in behavior

Stroke (3)

- Recognizing a stroke:
  1. Ask the person to smile. Unevenness is a sign of a possible stroke.
  2. Ask the person to hold his limbs out. If only one can be moved or only one can be held still, there is a stroke possibility.
  3. Trouble speaking may be a sign that a stroke has occurred.
  4. Decreased sensation, numbness or tingling in limbs can indicate stroke.

Stroke (4)

- Detecting strokes
  - Transient ischemic attack (TIA) is a mini-stroke with temporary stroke-like symptoms
  - Computed tomography (CT), MRIs, and ultrasound are used for diagnosis
- Treatment
  - Various drug therapies
  - Carotid endarterectomy surgery: plaque is removed from the artery
  - Rehabilitation: physical therapy; speech and language therapy; occupational therapy

Peripheral Arterial Disease

- Atherosclerosis in the arteries of the limbs, which can limit or block blood flow
- Patients typically also have CAD
- Risk factors: smoking, diabetes, hypertension, high cholesterol
- Symptoms:

    Claudication: aching or fatigue in limb

    Rest pain: occurs even when not physically active

Congestive Heart Failure

- Damage to the heart's pumping mechanism
  - Cannot maintain regular pumping; fluid backs up
- Pulmonary edema: fluid accumulates in the lungs
- Controlled by:
  - Reducing cardiac load
  - Eliminating excess fluid
  - Restriction of salt
  - Drug therapy
  - Cardiac rehabilitation

Other Forms of Heart Disease

- Congenital heart defects
  - Malformation of the heart or major blood vessel
  - Hypertrophic cardiomyopathy
- Rheumatic heart disease
  - Streptococcal infection causes damage to the heart muscle and valves
- Heart valve disorders
  - Abnormalities in valves between chambers of the heart
  - Mitral valve prolapse

Protecting Yourself Against Cardiovascular Disease

- Eat heart-healthy
  - Decrease fat and cholesterol
  - Eat a high-fiber diet
  - Decrease sodium and increase potassium
  - Avoid excessive alcohol consumption
  - Eat foods rich in omega-3 fatty acids

Protecting Yourself Against Cardiovascular Disease (2)

- Additional dietary options:
  - Plant stanols and sterols
  - Folic acid, vitamin B-6, and vitamin B-12
  - Calcium
  - Vitamin D
  - Soy protein
  - Healthy carbohydrates
  - Reduced daily caloric intake
- DASH: Dietary Approaches to Stop Hypertension

Protecting Yourself Against Cardiovascular Disease (3)

- Exercise regularly
- Avoid tobacco products
- Know and manage your blood pressure
- Know and manage your cholesterol levels
- Develop effective ways to handle stress and anger

Do More

- Eat a diet rich in fruits, vegetables, whole grains, and low-fat or fat-free dairy products. Eat five to nine servings of fruits and vegetables each day.
- Eat several servings of high-fiber foods each day.
- Eat two or more servings of fish per week; try a few servings of nuts and soy foods each week.
- Choose unsaturated fats rather than saturated and trans fats.
- Be physically active; do both aerobic exercise and strength training on a regular basis.
- Achieve and maintain a healthy weight.
- Develop effective strategies for handling stress and anger. Nurture old friendships and family ties, and make new friends; pay attention to your spiritual side.
- Obtain recommended screening tests and follow your physician's recommendations.

Do Less

- Don't use tobacco in any form: cigarettes, spit tobacco, cigars and pipes, bidis and clove cigarettes.
- Limit consumption of trans fats and saturated fats.
- Limit consumption of salt to no more than 2300 mg of sodium per day (1500 mg if you have or are at high risk for hypertension).
- Avoid exposure to environmental tobacco smoke.
- Avoid excessive alcohol consumption—no more than one drink per day for women and two drinks per day for men.
- Limit consumption of added sugars and refined carbohydrates
- Avoid excess stress, anger, and hostility.

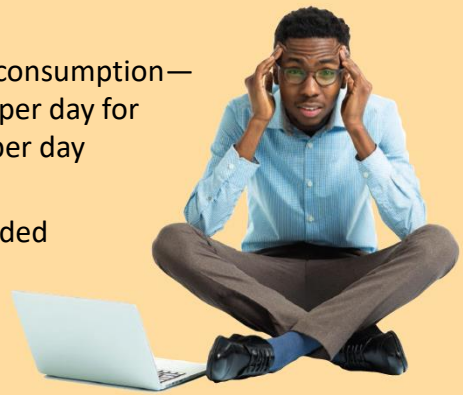

Figure 15.11 Strategies for Reducing Your Risk of Cardiovascular Disease

Review

- Identify the major components of the cardiovascular system
- Describe the risk factors associated with cardiovascular disease
- Discuss the major forms of cardiovascular disease
- List the steps you can take to protect yourself against cardiovascular disease

Long image descriptions

APPENDIX A

Figure 15.1 The Cardiorespiratory System Appendix

The basic elements of the cardiorespiratory system are the right lung and left lung; the heart; the jugular vein and carotid arteries; the aorta; the pulmonary veins and pulmonary arteries; the superior vena cava and inferior vena cava; the coronary arteries; and the femoral artery and femoral vein.

The heart itself consists of the right atrium and right ventricle; and the left atrium and left ventricle.

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Figure 15.2 Circulation in the Heart Appendix

Pulmonary circulation:

1. Oxygen-poor blood travels from the body into the right atrium via the superior vena cava and the inferior vena cava.
2. After the right atrium fills, it contracts and pumps blood into the right ventricle.
3. When the right ventricle is full, it contracts and pumps blood through the pulmonary arteries into the lungs.
4. In the lungs, blood picks up oxygen and discards carbon dioxide.

Systemic circulation:

5. Blood flows from the lungs to the left atrium via the pulmonary veins.
6. After the left atrium fills, it contracts, and pumps blood into the left ventricle.
7. When the left ventricle is full, it pumps blood through the aorta to the rest of the body.

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Figure 15.4 Cholesterol in the Body Appendix

1. The liver regulates the body's production of cholesterol, based in part on the types and amounts of fats that are consumed.
2. Trans and saturated fats in the diet may act on the liver to increase the amount of LDL circulating in the blood. (Dietary cholesterol doesn't significantly affect blood cholesterol in most people.)
3. The liver packages cholesterol with triglycerides (fat) and sends it into the bloodstream as very low-density lipoproteins (VLDLs).
4. As VLDLs travel through the bloodstream, they are broken down into triglycerides (fat) and cholesterol-rich low-density lipoproteins (LDLs). Triglycerides are used for energy or fat storage.
5. LDLs deliver cholesterol to cells throughout the body. High LDL levels cause an excess of cholesterol to be delivered to cells.
6. Cholesterol not used by the cells spills out and collects on artery walls. The resulting plaque buildup inhibits blood flow and may result in a heart attack.
7. High-density lipoproteins (HDLs) seek out excess cholesterol, reducing the amount available for buildup on artery walls. High HDL levels can help reverse heart disease.
8. HDLs return cholesterol to the liver, where it is converted into bile acids for elimination or recycling.

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Figure 15.5 The Effects of Stress and Emotions on the Cardiovascular System Appendix

With acute stress, the sympathetic nervous system is activated.

Physiologic effects include increased heart rate and increased blood pressure; narrowing of blood vessels; abnormal heart rhythms among those with CVD; and activation of blood cells.

The clinical consequence of increased heart rate, increased blood pressure, and narrowing of the blood vessels is increased stress on arteries.

The clinical consequence of abnormal heart rhythms is heart attack.

The clinical consequence of blood cell activation is blood clotting.

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Figure 15.8 Atherosclerosis: The Process of Cardiovascular Disease Appendix

1. A healthy artery allows blood to flow through freely.
2. Plaque buildup begins when endothelial cells lining the arteries are damaged by smoking, high blood pressure, oxidized LDL cholesterol, and other causes. Excess cholesterol particles collect beneath these cells.
3. In response to the damage, platelets and other types of cells collect at the site. A fibrous cap forms, isolating the plaque within the artery wall. An early-stage plaque is called a fatty streak.
4. Chemicals released by cells in and around the plaque cause further inflammation and buildup. An advanced plaque contains LDL cholesterol, white blood cells, connective tissue, smooth muscle cells, platelets, and other compounds.
5. The narrowed artery is vulnerable to blockage by blood clots. The risk of blockage and heart attack or stroke rises if the fibrous cap cracks, probably due to the action of destructive enzymes released by white blood cells within the plaque.
6. If a clot is traveling through the bloodstream, it may become trapped in the narrowed artery at the site of the plaque buildup, cutting off blood supply and oxygen to tissue.

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Figure 15.10 Types of Stroke Appendix

Hemorrhagic strokes account for 13% of strokes and are caused by ruptured blood vessels followed by blood leaking into tissue. They are usually more serious than ischemic strokes. There are two types of hemorrhagic stroke:

- A subarachnoid hemorrhage involves a bleed into the space between the brain and the skull. It develops most often from an aneurysm, a weakened, ballooned area in the wall of an artery.
- An intracerebral hemorrhage involves a bleed from a blood vessel inside the brain. It is often caused by high blood pressure and the damage it does to arteries.

Ischemic strokes account for 87% of strokes and are caused by blockages in brain blood vessels. This type of stroke is potentially treatable with clot-busting drugs. Brain tissue dies when blood flow is blocked. There are two types of ischemic stroke:

- An embolic stroke is caused by emboli, blood clots that travel from elsewhere in the body to the brain blood vessels. 25% of embolic strokes are related to atrial fibrillation.
- A thrombotic stroke is caused by thrombi, blood clots that form when an artery has been narrowed, usually due to formation of fatty deposits that build up and reduce blood flow (atherosclerosis) or to other artery conditions.

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