Chapter 13

The Heart and Heart Disease
X-Ray of Human Heart
Objectives

• Discuss the location, size, and position of the heart in the thoracic cavity and identify the heart chambers, sounds, and valves

• Describe the major types of cardiac valve disorders

• Trace blood through the heart and compare the functions of the heart chambers on the right and left sides
Objectives

- Explain how a myocardial infarction might occur
- List the anatomical components of the heart conduction system
- Describe the major types of cardiac dysrhythmia
- List and describe the possible causes of heart failure
Location, Size, and Position of the Heart

• Triangular organ located in mediastinum with two thirds of the mass to the left of the body midline and one third to the right; the apex is on the diaphragm

• Shape and size of a closed fist
Location, Size, and Position of the Heart

• Cardiopulmonary resuscitation (CPR)—rhythmic compression of the heart between the sternum and vertebrae can maintain blood flow during cardiac arrest; if combined with artificial respiration procedure, it can be lifesaving
Anatomy of the Heart

• Heart chambers
  – Two upper chambers are called atria (receiving chambers)—right and left atria
  – Two lower chambers called ventricles (discharging chambers)—right and left ventricles
Anatomy of the Heart

• Heart chambers
  – Wall of each heart chamber is composed of cardiac muscle tissue called myocardium
  – Endocardium—smooth lining of heart chambers
    • Inflammation of endocardium is called endocarditis
    • Inflamed endocardium can become rough and abrasive and thereby cause a thrombus
Anatomy of the Heart

• The pericardium and pericarditis
  – Pericardium—two-layered fibrous sac with a lubricated space between the two layers
    • Inner layer is called *visceral pericardium* or *epicardium*
    • Outer layer called *parietal pericardium*
  – Pericarditis—inflammation of the pericardium
Anatomy of the Heart

• Heart action
  – Contraction of the heart is called *systole*
  – Relaxation of the heart is called *diastole*
Anatomy of the Heart

• Heart valves and valve disorders
  – Valves keep blood flowing through the heart; prevent backflow
  – Atrioventricular (AV) valves
    • Tricuspid: at the opening of the right atrium into the ventricle
    • Bicuspid (mitral): at the opening of the left atrium into the ventricle
Anatomy of the Heart

• Heart valves and valve disorders
  – Semilunar (SL) valves
    • Pulmonary semilunar: at the beginning of the pulmonary artery
    • Aortic semilunar: at the beginning of the aorta
Anatomy of the Heart

– Valve disorders

• Incompetent valves “leak,” allowing some blood to flow backward into the chamber from which it came
• Stenosed valves are narrower than normal, reducing blood flow
• Rheumatic heart disease—cardiac damage resulting from a delayed inflammatory response to streptococcal infection
• Mitral valve prolapse (MVP)—edges extending back into the left atrium when the left ventricle contracts
Heart Sounds

- Two distinct heart sounds in every heartbeat or cycle—“lub-dup”
- First sound (lub) caused by the vibration and closure of AV valves during contraction of the ventricles
- Second sound (dup) caused by the closure of the semilunar valves during relaxation of the ventricles
- Heart murmurs—abnormal heart sounds often caused by abnormal valves
Blood Flow Through the Heart

• Heart acts as two separate pumps—the right atrium and ventricle performing different functions from the left atrium and ventricle.
Blood Flow Through the Heart

• Sequence of blood flow
  – Venous blood enters the right atrium through the superior and inferior venae cavae—passes from the right atrium through the tricuspid valve to the right ventricle
  – From the right ventricle through the pulmonary semilunar valve to the pulmonary artery to the lungs—blood from the lungs to the left atrium, passes through the bicuspid (mitral) valve to left ventricle
  – Blood in the left ventricle is pumped through the aortic semilunar valve into the aorta and is distributed to the body as a whole
Coronary Circulation and Coronary Heart Disease

- Blood, which supplies oxygen and nutrients to the myocardium of the heart, flows through the right and left coronary arteries.
- Blockage of blood flow through the coronary arteries can cause myocardial infarction (heart attack).
Coronary Circulation and Coronary Heart Disease

- Atherosclerosis (type of “hardening of arteries” in which lipids build up on the inside wall of blood vessels) can partially or totally block coronary blood flow

- Angina pectoris—chest pain caused by inadequate oxygen to the heart
Cardiac Cycle

• Heartbeat is regular and rhythmic—each complete beat called a *cardiac cycle*—average is about 72 beats per minute

• Each cycle, about 0.8 seconds long, subdivided into systole (contraction phase) and diastole (relaxation phase)
Cardiac Cycle

• Stroke volume is the volume of blood ejected from one ventricle with each beat
• Cardiac output is amount of blood that one ventricle can pump each minute—average is about 5 L per minute at rest
Conduction System of the Heart

• Normal structure and function
  – SA (sinoatrial) node, the pacemaker—located in the wall of the right atrium near the opening of the superior vena cava
  – AV (atrioventricular) node—located in the right atrium along the lower part of the interatrial septum
  – AV bundle (bundle of His)—located in the septum of the ventricle
  – Purkinje fibers—located in the walls of the ventricles
Conduction System of the Heart

• Electrocardiography
  – Specialized conduction system structures generate and transmit the electrical impulses that result in contraction of the heart
  – These tiny electrical impulses can be picked up on the surface of the body and transformed into visible tracings by a machine called an *electrocardiograph*
  – The visible tracing of these electrical signals is called an *electrocardiogram* or *ECG*
Conduction System of the Heart

• Electrocardiography
  – The normal ECG has three waves
    • P wave—associated with depolarization of the atria
    • QRS complex—associated with depolarization of the ventricles
    • T wave—associated with repolarization of the ventricles
1. The heart wall is completely relaxed, with no change in electrical activity, so the ECG remains constant.

2. P wave occurs when the AV node and atrial walls depolarize.

3. Atrial walls are completely depolarized, and thus no change is recorded in the ECG.

4. The QRS complex occurs as the atria repolarize and the ventricular walls depolarize.

5. The atrial walls are no completely repolarized, the ventricular walls are now completely depolarized, and thus no change is seen in the ECG.

6. The T wave appears on the ECG when the ventricular walls repolarize.

7. Once the ventricles are completely repolarized, we are back at the baseline of the ECG—essentially back where we began.
Conduction System of the Heart

• Cardiac dysrhythmia—abnormality of heart rhythm
  – Heart block—conduction of impulses is blocked
    • Complete heart block—impaired AV node conduction, producing complete dissociation of P waves from QRS complexes
    • Can be treated by implanting an artificial pacemaker
A Complete heart block

B Bradycardia

C Tachycardia

D Sinus dysrhythmia

E Premature ventricular contractions (PVCs)

F Atrial fibrillation

G Ventricular fibrillation
Conduction System of the Heart

- **Bradycardia**—slow heart rate (less than 60 beats/min)
- **Tachycardia**—rapid heart rate (more than 100 beats/min)
- **Sinus dysrhythmia**—variation in heart rate during breathing cycle
- **Premature contraction (extrasystole)**—contraction that occurs sooner than expected in a normal rhythm
- **Fibrillation**—condition in which cardiac muscle fibers are “out of step,” producing no effective pumping action
Heart Failure

• Heart failure—inaability to pump enough returned blood to sustain life; it can be caused by many different heart diseases

• Right-sided heart failure—failure of the right side of the heart to pump blood, usually because the left side of the heart is not pumping effectively
Heart Failure

- Left-sided heart failure (congestive heart failure)—inability of the left ventricle to pump effectively, resulting in congestion of the systemic and pulmonary circulations

- Diseased hearts can be replaced by donated living hearts (transplants) or by artificial hearts (implants), although both procedures have yet to be perfected