Chapter 14

The Circulation of the Blood
Objectives

• Describe the structure and function of each major type of blood vessel: artery, vein, and capillary

• List the major disorders of blood vessels and explain how they develop

• Trace the path of blood through the systemic, pulmonary, portal, and fetal circulations
Objectives

• Identify and discuss the factors involved in the generation of blood pressure and how they relate to each other
• Define pulse and locate the major pulse points on the body
• Explain what is meant by the term circulatory shock and describe the major types
Blood Vessels

• Types
  – Arteries—carry blood away from the heart and toward capillaries
  – Veins—carry blood toward the heart and away from capillaries
  – Capillaries—carry blood from the arterioles to the venules
Blood Vessels

• Functions
  – Arteries—distribution of nutrients, gases, etc., with movement of blood under high pressure; assist in maintaining the arterial blood pressure
  – Capillaries—serve as exchange vessels for nutrients, wastes, and fluids
  – Veins—collect blood for return to the heart; low-pressure vessels
Disorders of Blood Vessels

• Disorders of arteries—arteries must withstand high pressure and remain free of blockage
  – Arteriosclerosis—hardening of arteries
    • Reduces flow of blood, possibly causing ischemia that may progress to necrosis (or gangrene)
    • Atherosclerosis: lipids and other matter block arteries
    • May be corrected by vasodilators (vessel-relaxing drugs) or angioplasty (mechanical widening of vessels), or surgical replacement
Disorders of Blood Vessels

• Disorders of arteries
  – Aneurysm—abnormal widening of arterial wall
    • Aneurysms promote formation of thrombi that may obstruct vital tissues
    • Aneurysms may burst, resulting in life-threatening hemorrhaging
    • Cerebrovascular accident (CVA) or stroke—ischemia of brain tissue caused by embolism or hemorrhage
Disorders of Blood Vessels

- Disorders of veins—veins are low-pressure vessels
  - Varicose veins (varices)—enlarged veins in which blood pools
    - Hemorrhoids are varicose veins in the rectum
    - Treatments include supporting affected veins and surgical removal
  - Thrombophlebitis—vein inflammation (phlebitis) accompanied by clot (thrombus) formation; may result in fatal pulmonary embolism
Circulation of Blood

• Systemic and pulmonary circulation
  – Blood circulation—refers to the flow of blood through all the vessels, which are arranged in a complete circuit or circular pattern
  – Systemic circulation
    • Carries blood throughout the body
    • Path goes from left ventricle through aorta, smaller arteries, arterioles, capillaries, venules, venae cavae, to right atrium
Circulation of Blood

– Pulmonary circulation
  • Carries blood to and from the lungs
  • Arteries deliver deoxygenated blood to the lungs for gas exchange
  • Path goes from right ventricle through pulmonary arteries, lungs, pulmonary veins, to left atrium

– Hepatic portal circulation
  • Unique blood route through the liver
  • Vein (hepatic portal vein) exists between two capillary beds
  • Assists with homeostasis of blood glucose levels
Blood Pressure

• Defining blood pressure
  – “Push” or force of blood in the blood vessels
  – Exists in all blood vessels—highest in arteries, lowest in veins
  – Blood pressure gradient—causes blood to circulate; liquids can flow only from the area where pressure is higher to where it is lower
    • Low or nonexistent blood pressure gradient is fatal if not reversed quickly
    • Hypertension (high blood pressure) can cause a blood vessel to rupture
Blood Pressure

• Factors that influence blood pressure
  – Blood volume—the larger the volume, the more pressure is exerted on vessel walls
  – Strength of heart contractions—affect cardiac output; stronger heartbeat increases pressure; weaker beat decreases it
  – Heart rate—increased rate increases pressure; decreased rate decreases pressure
Blood Pressure

• Factors that influence blood pressure
  – Blood viscosity (thickness)—less than normal viscosity decreases pressure; more than normal viscosity increases pressure
  – Resistance to blood flow (peripheral resistance)—affected by many factors, including the vasomotor mechanism (vessel muscle contraction/relaxation)
Decreased resistance:

- Smooth muscle relaxation (diameter = 2)

Increased resistance:

- Smooth muscle contraction (diameter = 1/2)

Normal resting tone (diameter = 1)
Blood Pressure

• Fluctuations in blood pressure
  – Blood pressure varies within normal range from time to time
  – Central venous pressure—influences pressure in large peripheral veins
  – Venous return of blood to the heart depends on five mechanisms
    • A strongly beating heart
    • An adequate arterial blood pressure
    • Valves in the veins
    • Pumping action of skeletal muscles as they contract
    • Changing pressures in the chest cavity caused by breathing
Pulse

- Definition—alternate expansion and recoil of the blood vessel wall
- Nine major pulse points named after arteries over which they are felt
Circulatory Shock

- Circulatory shock—failure of the circulatory system to deliver oxygen to the tissues adequately, resulting in cell impairment

- When the cause is known, shock can be classified by this scheme:
  - Cardiogenic shock—caused by heart failure
Hypertension (HTN)

- Occurs when blood pressure exceeds 140/90 mmHg (Figure 14-13)
- 90% of HTN cases are primary-essential (idiopathic—disease of undetermined cause); secondary HTN can be caused by kidney disease or other causes
- Many risk factors for HTN, including genetics, age, stress, obesity, and more
- Untreated HTN may contribute to heart disease, kidney failure, and stroke
## Blood Pressure (BP) Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Systolic BP</th>
<th>Diastolic BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>less than 120</td>
<td>and less than 80</td>
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<tr>
<td>Prehypertension</td>
<td>120-139</td>
<td>or 80-89</td>
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</table>

### High blood pressure

<table>
<thead>
<tr>
<th>Stage 1 hypertension</th>
<th>Systolic BP</th>
<th>or</th>
<th>Diastolic BP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>140-159</td>
<td>or</td>
<td>90-99</td>
</tr>
<tr>
<td>Stage 2 hypertension</td>
<td>greater than or equal to 160</td>
<td>or</td>
<td>greater than or equal to 100</td>
</tr>
</tbody>
</table>
Circulatory Shock

- Circulatory shock—failure of the circulatory system to deliver oxygen to the tissues adequately, resulting in cell impairment

- When the cause is known, shock can be classified as follows:
  - Cardiogenic shock—caused by heart failure
Circulatory Shock

- Hypovolemic shock—drop in blood volume that causes blood pressure (and blood flow) to drop
- Neurogenic shock—caused by nerve condition that relaxes (dilates) blood vessels and thus reduces blood flow
- Anaphylactic shock—caused by a severe allergic reaction characterized by blood vessel dilation
- Septic shock—results from complications of septicemia (toxins in blood from infection)