Chapter 8
Heart and Blood Vessels

• Three Types of Blood Vessels Transport Blood
  • Arteries
    — Carry blood away from the heart
    — Transport blood under high pressure
  • Capillaries
    — Exchange solutes and water with cells of the body
  • Veins
    — Return blood to the heart
• Blood Vessels – Arteries
  • Structure
    — Thick-walled, three layers
      • Innermost layer: endothelium
      • Middle layer: smooth muscle
      • Outer layer: connective tissue
  • Function
    — Arteries carry blood away from heart
    — Carry blood under pressure
• Arterioles and Precapillary Sphincters
  • Blood flow
    • Heart → Arteries → Arterioles → Capillaries
Arterioles: smallest arteries

Precapillary sphincters: control blood flow into capillaries
- **Vasodilation**: increases blood flow to capillaries
- **Vasoconstriction**: decreases blood flow to capillaries

• Capillaries

• Structure
  - Smallest blood vessels
  - Thin-walled: one cell-layer thick
  - Porous

• Capillary beds: extensive networks of capillaries

• Function: selective exchange of substances with the interstitial fluid

• Blood Vessels – Veins

• Structure
  - Three layers, thin-walled
  - Larger lumen than arteries
  - High distensibility

• Functions
  - Carry blood toward the heart
  - Blood flow
    - Capillaries → Venules → Veins → Heart
Serve as blood volume reservoir

Three Mechanisms Assist Venous Return to the Heart

Mechanisms in blood return

- Contraction of skeletal muscles
- One-way valves
- Pressure changes associated with breathing

Lymphatic System

- Function
  - Maintains blood volume
  - Also functions in immune system

- Structure
  - Blind-ended capillaries
  - Lymphatic vessels
  - Lymph – derived from interstitial fluid

The Heart - Layers

Surrounded by fibrous sac – pericardium

- Layers of the heart
  - Epicardium: thin layer of epithelial and connective tissue
  - Myocardium: thick layer of cardiac muscle
  - Endocardium: thin layer of endothelial tissue
The Heart – Chambers and Valves

Four chambers
- Two atria
- Two ventricles

Valves – prevent backflow
- Two atrioventricular valves
  - Tricuspid valve
  - Bicuspid (mitral) valve
- Two semilunar valves
  - Pulmonary valve
  - Aortic valve

Pulmonary Circuit – Oxygenation of Blood
1. Deoxygenated blood from the body travels through the vena cava to the right atrium
2. Through the right atrioventricular valve to the right ventricle
3. Through the pulmonary semilunar valve to the pulmonary trunk and the lungs
4. Blood is oxygenated within pulmonary capillaries
5. Oxygenated blood travels through the pulmonary veins to the left atrium
6. Through the left atrioventricular valve to the left ventricle

Systemic Circuit – Delivery of Oxygenated Blood to Tissues
- Oxygenated blood travels from the left ventricle through the aortic semilunar valve to the aorta
- Through branching arteries and arterioles to tissues
- Through the arterioles to capillaries
- From capillaries into venules and veins
To the vena cava and into the right atrium

Cardiac Cycle – The heart contracts and relaxes

Atrial systole
   - Both atria contract
   - AV valves open, semilunar valves are closed
   - Ventricles fill

Ventricular systole
   - Both ventricles contract
   - AV valves close, semilunar valves open

Diastole
   - Both atria and ventricles relax
   - Semilunar valves close

Heart Sounds and Heart Valves

Lub-dub heart sound
   - Lub: closing of both AV valves during ventricular systole
   - Dub: closing of both semilunar valves during ventricular diastole

Heart murmurs
   - Caused when blood flow is disturbed
   - May be a sign of a defective valve

Cardiac Conduction System Coordinates Contraction

SA node
- Cardiac pacemaker
  - Initiates the heartbeat
  - Pace can be modified by nervous system

- AV node
  - Relays impulse

- AV bundle and Purkinje fibers
  - Carry impulse to ventricles

- Electrocardiogram (EKG/ECG)
- Tracks the electrical activity of the heart
- A healthy heart produces a characteristic pattern

- Three formations
  - P wave: impulse across atria
  - QRS complex: spread of impulse down septum, around ventricles in Purkinje fibers
  - T wave: end of electrical activity in ventricles

- EKGs can detect
  - Arrhythmias
  - Ventricular fibrillation

- Blood Pressure

- The force that the blood exerts on the wall of the blood vessels
  - Systolic pressure – highest pressure, as blood is ejected during ventricular systole
  - Diastolic pressure – lowest pressure, during ventricular diastole
Measurement
  - Sphygmomanometer
  - “Normal” readings
    - Systolic pressure <120 mmHg
    - Diastolic pressure <80 mmHg

Blood Pressure (cont.)

Hypertension: high blood pressure
  - The silent killer

Hypotension: blood pressure too low
  - Clinical signs – dizziness, fainting
  - Causes – orthostatic, severe burns, blood loss

Regulation of the Cardiovascular System: Baroreceptors

Baroreceptors: pressure receptors in aorta and carotid arteries

Steps in mechanism
  - Blood pressure rises, vessels stretched
  - Signals sent to the cardiovascular center in the brain
  - Heart signaled to lower heart rate and force of contraction
  - Arterioles vasodilate, increasing blood flow to tissues
  - Combined effect lowers blood pressure

Regulation: Nervous and Endocrine Factors

Medulla oblongata signals
  - Sympathetic nerves – constrict blood vessels, raising blood pressure
Parasympathetic nerves – dilate blood vessels, lowering blood pressure

- Hormones: epinephrine (adrenaline)
- Local requirements dictate local blood flow
- Exercise – increased blood flow and cardiac output
- Cardiovascular Disorders

- **Myocardial infarction/heart attack**: permanent cardiac damage due to blockage in a coronary artery
- **Congestive heart failure**: decrease in pumping efficiency
- **Embolism**: blockage of blood vessels
- **Stroke**: impaired blood flow to the brain
- **Heart Attack**

- Also known as **myocardial infarction**
  - Permanent damage to myocardium

- **Symptoms**
  - Intense chest pain, nausea, heaviness in the chest, difficulty breathing, pain radiating to left arm, jaw, back, upper abdomen

- **Diagnosis**
  - EKG
  - Blood test for cardiac enzymes

- **Prevention/Treatment**
  - Clot-busting medications
- **CABG**
  - Reducing the Risk of Cardiovascular Disease
  - Smoking – don’t
  - Blood lipids – monitor cholesterol levels
  - Exercise – regular and moderate
  - Blood pressure – treat hypertension
  - Reducing the Risk of Cardiovascular Disease
  - Weight – being overweight increases risk of heart attack and stroke
  - Control of diabetes mellitus – early diagnosis and treatment delays onset of related problems
  - Stress – avoid chronic stress