The major structures of the cardiovascular system, the heart and blood vessels, play a vital role in human physiology. The major function of the cardiovascular system is transportation. Using blood as the transport vehicle, the system carries nutrients, gases, wastes, antibodies, electrolytes, and many other substances to and from body cells. Its propulsive force is the contracting heart.

The anatomy and location of the heart and blood vessels and the important understandings of cardiovascular physiology (for example, cardiac cycle, ECG, and regulation of blood pressure) are the major topics of this chapter.

CARDIOVASCULAR SYSTEM: THE HEART

1. Complete the following statements by inserting your answers in the answer blanks.

**THORAX** 1. The heart is a cone-shaped muscular organ located within the (1). Its apex rests on the (2), and its base is at the level of the (3) rib. The coronary arteries that nourish the myocardium arise from the (4). The coronary sinus empties into the (5). Relative to the roles of the heart chambers, the (6) are receiving chambers, whereas the (7) are discharging chambers. The membrane that lines the heart and also forms the valve flaps is called the (8). The outermost layer of the heart is called the (9). The fluid that fills the pericardial sac acts to decrease (10) during heart activity. The heart muscle, or myocardium, is composed of a specialized type of muscle tissue called (11).
2. The heart is called a double pump because it serves two circulations. Trace the flow of blood through both the pulmonary and systemic circulations by writing the missing terms in the answer blanks. Then, color regions transporting O₂-poor blood blue and regions transporting O₂-rich blood red on Figure 11–1. Finally, identify the various regions of the circulation shown in Figure 11–1 by labeling them using the key choices.

RT. VENTRICLE 1.
PULM. SEMILUNAR
PULM. ARTERIES
LUNGS 4.
RT. & LFT. PULM. VEINS
LFT. ATRIUM 6.
BICUSPID 7.
LFT. VENTRICLE
AORTIC 9.
AORTIA 10.
CAPILLARY BEDS
SUP. VENA CAVA 12.
INF. VENA CAVA

From the right atrium through the tricuspid valve to the (1), through the (2) valve to the pulmonary trunk to the right and left (3), to the capillary beds of the (4) to the (5), to the (6) of the heart through the (7) valve, to the (8) through the (9) semilunar valve, to the (10), to the systemic arteries, to the (11) of the body tissues, to the systemic veins, to the (12) and (13), which enter the right atrium of the heart.

Key Choices
A. Vessels serving head and upper limbs
B. Vessels serving body trunk and lower limbs
C. Vessels serving the viscera
D. Pulmonary circulation
E. Pulmonary "pump"
F. Systemic "pump"
3. Figure 11-2 is an anterior view of the heart. Identify each numbered structure and write its name in the corresponding numbered space below the figure. Then, select different colors for each structure provided with a color-coding circle, and use them to color the coding circles and corresponding structures on the figure.

- RT. ATRIUM 1.
- LFT. ATRIUM 2.
- RT. VENTRICLE 3.
- LFT. VENTRICLE 4.
- SUP. VENA CAVA 5.
- INF. VENA CAVA 6.
- AORTA 7.
- PULM. TRUNK 8.
- LFT. PULM. ARTERY 9.
- RT. PULM. ARTERY 10.
- RT. PULM. VEINS 11.
- LFT. PULM. VEINS 12.
- CORONARY CIRCULATION 13.
- APEX 14.
- LIGAMEN'TUM 15.

Figure 11-2
4. Figure 11–3 is a schematic drawing of the microscopic structure of cardiac muscle. Using different colors, color the coding circles of the structures listed below and the corresponding structures on the figure.

- Nuclei (with nucleoli)
- Muscle fibers
- Intercalated discs
- Striations

5. The events of one complete heartbeat are referred to as the cardiac cycle. Complete the following statements that describe these events. Insert your answers in the answer blanks.

1. **Systole**
2. **Diastole**
3. **Lub-Dup**
4. **Atrioventricular**
5. **Semi-lunar**
6. **Ventricles**
7. **Atria**
8. **Murmurs**
9. **Ventricles**

The contraction of the ventricles is referred to as **(1)** and the period of ventricular relaxation is called **(2)**. The monosyllables describing heart sounds during the cardiac cycle are **(3)**. The first heart sound is a result of closure of the **(4)** valves; closure of the **(5)** valves causes the second heart sound. The heart chambers that have just been filled when you hear the first heart sound are the **(6)**, and the chambers that have just emptied are the **(7)**. Immediately after the second heart sound, the **(8)** are filling with blood, and the **(9)** are empty. Abnormal heart sounds, or **(10)**, usually indicate valve problems.
6. Figure 11–4 is a diagram of the frontal section of the heart. Follow the instructions below to complete this exercise.

First, draw arrows to indicate the direction of blood flow through the heart. Draw the pathway of the oxygen-rich blood with red arrows, and trace the pathway of oxygen-poor blood with blue arrows.

Second, identify each of the elements of the intrinsic conduction system (numbers 1–5 on the figure) by inserting the appropriate terms in the blanks left of the figure. Then, indicate with green arrows the pathway that impulses take through this system.

Third, correctly identify each of the heart valves (numbers 6–9 on the figure) by inserting the appropriate terms in the blanks left of the figure, and draw in and identify by name the cordlike structures that anchor the flaps of the atrioventricular (AV) valves.

Fourth, use the numbers from the figure to identify the structures described below. Place the numbers in the lettered answer blanks.

6. A. 7. B. Prevent backflow into the ventricles when the heart is relaxed
9. C. 9. D. Prevent backflow into the atria when the ventricles are contracting
9. E. AV valve with three flaps
8. F. AV valve with two flaps
1. G. The pacemaker of the intrinsic conduction system
2. H. The point in the intrinsic conduction system where the impulse is temporarily delayed

\textbf{SA NODE} 1. Superior vena cava
\textbf{AV NODE} 2.
\textbf{AV BUNDLE (BUNDLE OF HIS)} 3.
\textbf{BUNDLE BRANCHES} 4.
\textbf{PURKINJE FIBERS} 5.
\textbf{PULM. SEMILUNAR} 6.
\textbf{AORTIC SEMILUNAR} 7.
\textbf{BICUSPID} 8.
\textbf{TRICUSPID} 9.

Figure 11–4
7. Match the terms provided in Column B with the statements given in Column A. Place the correct term or letter response in the answer blanks.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A recording of the electrical activity of the heart</td>
<td>A. Angina pectoris</td>
</tr>
<tr>
<td>2. The period during which the atria are depolarizing</td>
<td>B. Bradycardia</td>
</tr>
<tr>
<td>3. The period during which the ventricles are repolarizing</td>
<td>C. Electrocardiogram</td>
</tr>
<tr>
<td>4. The period during which the ventricles are depolarizing, which precedes their contraction</td>
<td>D. Fibrillation</td>
</tr>
<tr>
<td>5. An abnormally slow heartbeat, that is, below 60 beats per minute</td>
<td>E. Heart block</td>
</tr>
<tr>
<td>6. A condition in which the heart is uncoordinated and useless as a pump</td>
<td>F. P wave</td>
</tr>
<tr>
<td>7. An abnormally rapid heartbeat, that is, over 100 beats per minute</td>
<td>G. QRS wave</td>
</tr>
<tr>
<td>8. Damage to the AV node, totally or partially releasing the ventricles from the control of the sinoatrial (SA) node</td>
<td>H. T wave</td>
</tr>
<tr>
<td>9. Chest pain, resulting from ischemia of the myocardium</td>
<td>I. Tachycardia</td>
</tr>
</tbody>
</table>

8. A portion of an electrocardiogram is shown in Figure 11–5. On the figure identify the QRS complex, the P wave, and the T wave. Then, using a red pencil, bracket a portion of the recording equivalent to the length of one cardiac cycle. Using a blue pencil, bracket a portion of the recording in which the ventricles would be in diastole.

![Figure 11–5](image)
9. Complete the following statements relating to cardiac output by writing the missing terms in the answer blanks.

**Cardiac Output**

1. In the relationship \( CO = HR \times SV \), \( CO \) stands for (1)_blank_, \( HR \) stands for (2)_blank_, and \( SV \) stands for (3)_blank_. For the normal resting heart, the value of \( HR \) is (4)_blank_ and the value of \( SV \) is (5)_blank_. The normal average adult cardiac output, therefore, is (6)_blank_. The time for the entire blood supply to pass through the body is once each (7)_blank_.

**Heart Rate**

2. According to Starling's law of the heart, the critical factor that determines force of heartbeat, or (8)_blank_, is the degree of (9)_blank_ of the cardiac muscle just before it contracts. Consequently, the force of heartbeat can be increased by increasing the amount of (10)_blank_ returned to the heart.

**Stroke Volume**

3. 75 bpm
4. 70 ml/BEAT
5. 5250 ml/BEAT
6. **STROKE VOLUME**

8. **STRETCH**
9. **BLOOD**

10. Check (✓) all factors that lead to an increase in cardiac output by influencing either heart rate or stroke volume.

   ✓ 1. Epinephrine
   ✓ 2. Thyroxine
   ✓ 3. Hemorrhage
   ✓ 4. Fear
   ✓ 5. Exercise
   ✓ 6. Activation of the sympathetic nervous system
   ✓ 7. Activation of the vagus nerves
   ✔ 8. Low blood pressure
   ✔ 9. High blood pressure
   ✔ 10. Fever

11. For each of the following statements that is true, write T in the answer blank. For any false statements, correct the underlined term by writing the correct term in the answer blank.

   **Fetal Rate of Contraction**

   1. The resting heart rate is fastest in adult life.

   **Rate of Contraction**

   2. Because the heart of the highly trained athlete hypertrophies, its stroke volume decreases.

   **Left**

   3. If the right side of the heart fails, pulmonary congestion occurs.

   4. In peripheral congestion, the feet, ankles, and fingers become edematous.

   **T**

   5. The pumping action of the healthy heart ordinarily maintains a balance between cardiac output and venous return.
12. Circle the term that does not belong in each of the following groupings.

1. Pulmonary trunk  Vena cava  Right side of heart  Left side of heart
2. QRS wave  T wave  **P wave**  Electrical activity of the ventricles
3. AV valves closed  AV valves opened  Ventricular systole  Semilunar valves open
4. Papillary muscles  Aortic semilunar valve  Tricuspid valve  Chordae tendineae
5. Tricuspid valve  Mitral valve  Bicuspid valve  Left AV valve
6. Ischemia  Infarct  Scar tissue repair  **Heart block**

**CARDIOVASCULAR SYSTEM: BLOOD VESSELS**

13. Complete the following statements concerning blood vessels.

Lumen 1. The central cavity of a blood vessel is called the (1). Reduction of the diameter of this cavity is called (2), and enlargement of the vessel diameter is called (3). Blood is carried to the heart by (4) and away from the heart by (5). Capillary beds are supplied by (6) and drained by (7).

Vasodilation

Vasoconstriction

Veins 4.

Arteries 5.

Arterioles 6.

Venules 7.

14. Briefly explain in the space provided why valves are present in veins but not in arteries.

**ACT. - HIGH PRESSURE, VEINS LOW PRESSURE. VEINS HAVE VALVES TO PREVENT BACK FLOW THAT MIGHT OTHERWISE OCCUR DUE TO LOW PRESSURE**

15. Name two events occurring within the body that aid in venous return. Place your responses in the blanks that follow.

Skeletal muscle and **Breathing** activity.
16. The following section relates to understandings concerning blood pressure and pulse. Match the items given in Column B with the appropriate descriptions provided in Column A. Place the correct term or letter response in the answer blanks.

**Column A**

<p>| | | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>H</td>
<td>B</td>
<td>C</td>
<td>F</td>
<td>E</td>
</tr>
</tbody>
</table>

1. Expansion and recoil of an artery during heart activity
2. Pressure exerted by the blood against the blood vessel walls
3. Event primarily responsible for peripheral resistance
4. Factors related to blood pressure
5. Blood pressure during heart contraction
6. Blood pressure during heart relaxation
7. Site where blood pressure determinations are normally made
8. Points at the body surface where the pulse may be felt
9. Sounds heard over a blood vessel when the vessel is partially compressed

**Column B**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over arteries</td>
<td>Blood pressure</td>
<td>Cardiac output</td>
<td>Constriction of arterioles</td>
<td>Diastolic blood pressure</td>
<td>Peripheral resistance</td>
<td>Pressure points</td>
<td>Pulse</td>
<td>Sounds of Korotkoff</td>
<td>Systolic blood pressure</td>
<td>Over veins</td>
</tr>
</tbody>
</table>

17. Indicate what effect the following factors have on blood pressure. Indicate an increase in pressure by I and a decrease in pressure by D. Place the correct letter response in the answer blanks.

<p>| | | | | |</p>
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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>D</td>
<td>D</td>
<td>D</td>
<td>E</td>
<td>D</td>
</tr>
</tbody>
</table>

1. Increased diameter of the arterioles
2. Increased blood viscosity
3. Increased cardiac output
4. Increased pulse rate
5. Anxiety, fear
6. Increased urine output
7. Sudden change in position from reclining to standing

<table>
<thead>
<tr>
<th>F</th>
<th>D</th>
<th>D</th>
<th>D</th>
<th>D</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical exercise</td>
<td>Physical training</td>
<td>Alcohol</td>
<td>Hemorrhage</td>
<td>Nicotine</td>
<td>Arteriosclerosis</td>
</tr>
</tbody>
</table>