The Cardiovascular System: The Heart

Student Objectives

When you have completed the exercises in this chapter, you will have accomplished the following objectives:

Heart Anatomy

1. Describe the size, shape, location, and orientation of the heart in the thorax.
2. Name the coverings of the heart.
3. Describe the structure and function of each of the three layers of the heart wall.
4. Describe the structure and functions of the four heart chambers. Name each chamber and provide the name and general route of its associated great vessel[s].
5. Trace the pathway of blood through the heart.
6. Name the major branches and describe the distribution of the coronary arteries.
7. Name the heart valves and describe their location, function, and mechanism of operation.

Cardiac Muscle Fibers

8. Describe the structural and functional properties of cardiac muscle, and explain how it differs from skeletal muscle.
9. Briefly describe the events of cardiac muscle cell contraction.

Heart Physiology

10. Name the components of the conduction system of the heart, and trace the conduction pathway.
11. Draw a diagram of a normal electrocardiogram tracing. Name the individual waves and intervals, and indicate what each represents.
12. Name some of the abnormalities that can be detected on an ECG tracing.
13. Describe normal heart sounds, and explain how heart murmurs differ.
14. Describe the timing and events of the cardiac cycle.
15. Name and explain the effects of various factors regulating stroke volume and heart rate.
16. Explain the role of the autonomic nervous system in regulating cardiac output.

Developmental Aspects of the Heart

17. Describe fetal heart formation, and indicate how the fetal heart differs from the adult heart.
18. Provide examples of age-related changes in heart function.
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”
4. Figure 18.3 is an anterior view of the heart. Identify each numbered structure and write its name in the corresponding numbered answer blank. Then, select different colors for each structure with a coding circle and color the structures on the figure.

○ ___________ 1. ○ ___________ 6. ○ ___________ 11.
○ ___________ 2. ○ ___________ 7. ___________ 12.
○ ___________ 5. ___________ 10. ○ ___________ 15.

![Figure 18.3](image-url)
Heart Physiology

1. Complete the following statements concerning the cells of the nodal system of the heart. Write the missing terms in the answer blanks.

   1. The nodal cells of the heart, unlike cardiac contractile muscle fibers, have an intrinsic ability to depolarize __[1]__. This reflects their unstable __[2]__, which drifts slowly toward the threshold for firing, that is, __[3]__. These spontaneously changing membrane potentials, called __[4]__, are probably due to reduced membrane permeability to __[5]__, while __[6]__ continues to diffuse __[7]__ the cell at a slow rate. Ultimately, when threshold is reached, gated __[8]__ channels open, allowing that ion to rush into the cells and reverse the membrane potential.

2. Figure 18.7 is a diagram of the frontal section of the heart. Follow the instructions below to complete this exercise, which considers both anatomical and physiological aspects of the heart.

   1. 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.

   2. Identify each of the elements of the intrinsic conduction system (numbers 1–5 on the figure) by writing the appropriate terms in the numbered answer blanks. Then, indicate with green arrows the pathway that impulses take through this system.

   3. Identify each of the heart valves (numbers 6–9 on the figure) by writing the appropriate terms in the numbered answer blanks. Draw and identify by name the cordlike structures that anchor the flaps of the atrioventricular (AV) valves.

   4. Use the numbers from the figure to identify structures (A–H).
A. B. Prevent backflow into the ventricles when the heart is relaxed

C. D. Prevent backflow into the atria when the ventricles are contracting

E. AV valve with three flaps

F. AV valve with two flaps

G. The pacemaker of the Purkinje system

H. The point in the Purkinje system where the impulse is temporarily delayed

Figure 18.7
3. Respond to the questions below concerning the nodal system.

1. What name is given to the rate set by the heart's pacemaker? 

2. What are the observed contraction rates of the different components of the intrinsic conduction system?

   SA node _______ beats/min  
   AV node _______ beats/min  
   AV bundle _______ beats/min  
   Purkinje fibers _______ beats/min

3. The intrinsic conduction system enforces a faster rate of impulse conduction across the heart—at the rate of several meters per second in most parts of the conduction system. What would be the natural speed of impulse transmission across the heart in the absence of such a system?

   _______ m/s

4. What is the total time for impulse conduction across the healthy heart, on average? _______ seconds

4. Part of an electrocardiogram is shown in Figure 18.8. On the figure, identify the QRS complex, the P wave, and the T wave. Using a green pencil, bracket the P-Q interval and the Q-T interval. 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 18.8](image)

5. Examine the abnormal EGG tracings shown in Figure 18.9.

   1. Which shows extra P waves?
   2. Which shows tachycardia?
   3. Which has an abnormal QRS complex?
6. The events of one complete heartbeat are referred to as the cardiac cycle. Complete the following statements that describe these events by writing the missing terms in the answer blanks.

1. 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.
Student Objectives

When you have completed the exercises in this chapter, you will have accomplished the following objectives:

PART 1: OVERVIEW OF BLOOD VESSEL STRUCTURE AND FUNCTION
1. Describe the three layers that typically form the wall of a blood vessel, and state the function of each.
2. Define vasoconstriction and vasodilation.
3. Compare and contrast the structure and function of the three types of arteries.
4. Describe the structure and function of a capillary bed.
5. Describe the structure and function of veins, and explain how veins differ from arteries.

PART 2: PHYSIOLOGY OF CIRCULATION
6. Define blood flow, blood pressure, and resistance, and explain the relationships between these factors.
7. List and explain the factors that influence blood pressure, and describe how blood pressure is regulated.
9. Explain how blood flow is regulated in the body in general and in its specific organs.
10. Outline factors involved in capillary dynamics, and explain the significance of each.
11. Define circulatory shock. List several possible causes.

PART 3: CIRCULATORY PATHWAYS: BLOOD VESSELS OF THE BODY
12. Trace the pathway of blood through the pulmonary circuit, and state the importance of this special circulation.
13. Describe the general functions of the systemic circuit.
14. Name and give the location of the major arteries and veins in the systemic circulation.
15. Describe the structure and special function of the hepatic portal system.

Developmental Aspects of Blood Vessels
16. Explain how blood vessels develop in the fetus.
17. Provide examples of changes that often occur in blood vessels as a person ages.
PART 3: CIRCULATORY PATHWAYS:
BLOOD VESSELS OF THE BODY

1. Figure 19.4 shows the pulmonary circuit. Identify all vessels that have leader lines. Color the vessels (and heart chambers) transporting oxygen-rich blood red; color those transporting carbon dioxide-rich blood blue.

2. Figures 19.5 and 19.6 illustrate the locations of the major systemic arteries and veins of the body. These figures are highly simplified and will serve as a "warm-up" for the more detailed vascular diagrams to come. The arteries are shown in Figure 19.5. Color the arteries red, then identify those indicated by leader lines on the figure. The veins are shown in Figure 19.6. Color the veins blue, then identify each vein that has a leader line on the figure. Or, if you wish, color the individual vessels with different colors to help you to identify their extent.
Figure 19.5
Arteries
Figure 19.6
Veins
11. Figure 19.14 is a diagram of the hepatic portal circulation. Select different colors for the structures listed below and color the structures on the illustration.

- Inferior mesenteric vein
- Superior mesenteric vein
- Splenic vein
- Gastric vein
- Hepatic portal vein
22. Figure 11-11 illustrates the special fetal structures listed below. Select different colors for each and use them to color coding circles and corresponding structures in the diagram.

- Foramen ovale
- Ductus arteriosus
- Ductus venosus
- Umbilical arteries
- Umbilical cord
- Umbilical vein

*Figure 11-11*