CHAPTER

10 Blood

Blood, the vital "life fluid" that courses through the body's blood vessels, provides the means by which the body's cells receive vital nutrients and oxygen and dispose of their metabolic wastes. As blood flows past the tissue cells, exchanges continually occur between the blood and the tissue cells, so that vital activities can go on continuously.

In this chapter, the student has an opportunity to review the general characteristics of whole blood and plasma, to identify the various formed elements (blood cells), and to recall their functions. Blood groups, transfusion reactions, clotting, and various types of blood abnormalities are also considered.

COMPOSITION AND FUNCTIONS OF BLOOD

1. Complete the following description of the components of blood by writing the missing words in the answer blanks.

In terms of its tissue classification, blood is classified as a __(1)__ because it has living blood cells, called __(2)__, suspended in a nonliving fluid matrix called __(3)__. The "fibers" of blood only become visible during __(4)__.

If a blood sample is centrifuged, the heavier blood cells become packed at the bottom of the tube. Most of this compacted cell mass is composed of __(5)__, and the volume of blood accounted for by these cells is referred to as the __(6)__. The less dense __(7)__ rises to the top and constitutes about 45% of the blood volume. The so-called "buffy coat" composed of __(8)__ and __(9)__ is found at the junction between the other two blood elements. The buffy coat accounts for less than __(10)__ % of blood volume.

Blood is scarlet red in color when it is loaded with __(11)__; otherwise, it tends to be dark red.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____

2. Using key choices, identify the cell type(s) or blood elements that fit the following descriptions. Insert the correct term or letter response in the spaces provided.

Key Choices

A. Red blood cell	D. Basophil	G. lymphocyte
B. Megakaryocyte	E. Monocyte	H. Formed elements
C. Eosinophil	F. Neutrophil	I. Plasma

_____ 1. Most numerous leukocyte

_____ 2. _____ 3. _____ 4. Granular leukocytes

_____ 5. Also called an erythrocyte; anucleate

_____ 6. _____ 7. Actively phagocytic leukocytes

_____ 8. _____ 9. Agranular leukocytes

_____ 10. Fragments to form platelets

_____ 11. (A) through (G) are examples of these

_____ 12. Increases during allergy attacks

_____ 13. Releases histamine during inflammatory reactions

_____ 14. After originating in bone marrow, may be formed in lymphoid tissue

_____ 15. Contains hemoglobin

_____ 16. Primarily water, noncellular; the fluid matrix of blood

_____ 17. Increases in number during prolonged infections

_____ 18. Least numerous leukocyte

_____ 19. _____ 20. Also called white blood cells (#19–23)

_____ 21. _____ 22. _____ 23.

3. Figure 10–1 depicts in incomplete form the erythropoietin mechanism for regulating the rate of erythropoiesis. Complete the statements that have answer blanks, and then choose colors (other than yellow) for the color-coding circles and corresponding structures on the diagram. Color all arrows on the diagram yellow. Finally, indicate the normal life span of erythrocytes.

◯ Kidney ◯ Red bone marrow ◯ RBCs

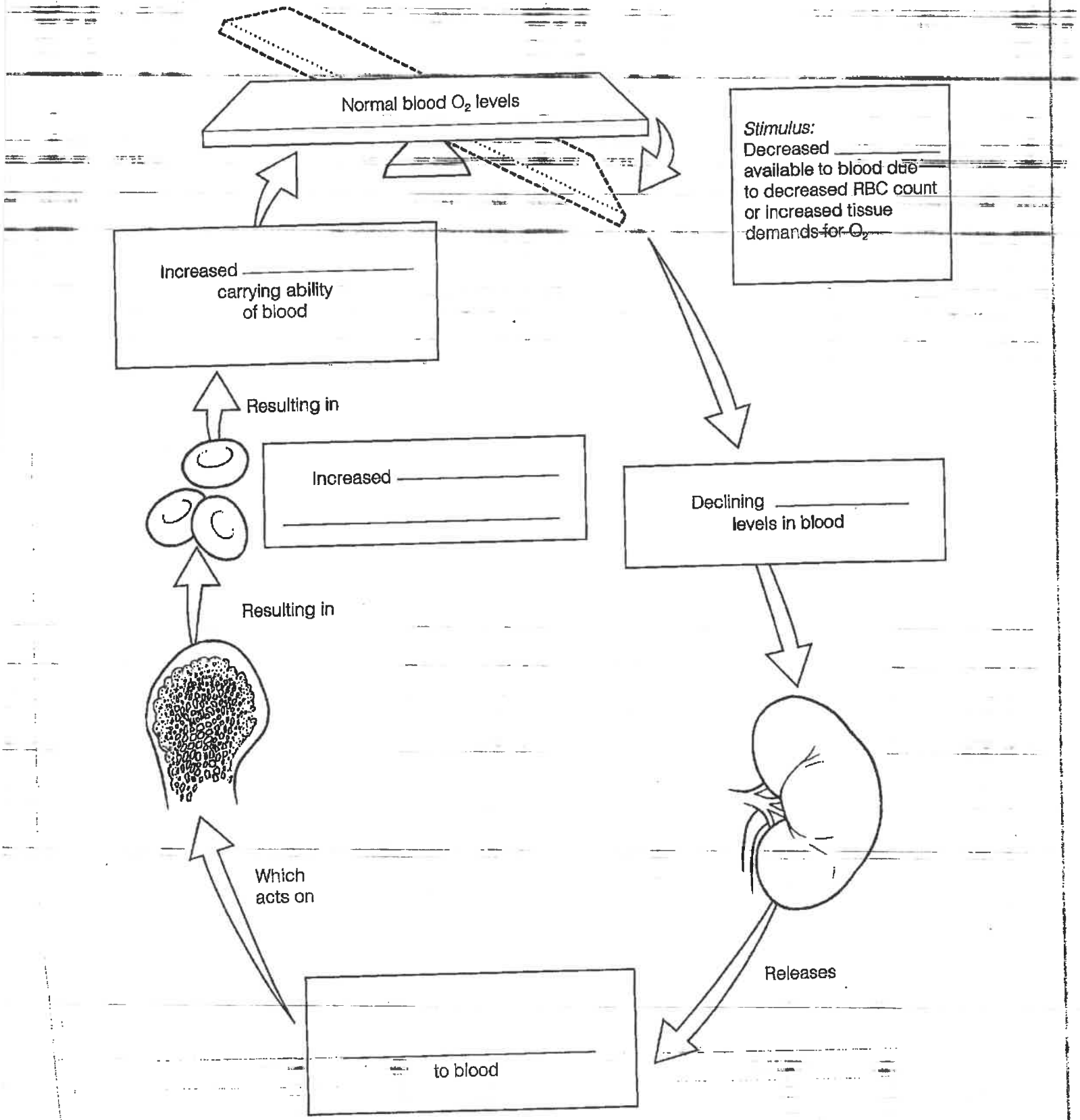

Normal blood O_2 levels
Stimulus:
Decreased _____ available to blood due to decreased RBC count or increased tissue demands for O_2
Increased _____ carrying ability of blood
Resulting in
Increased _____
Declining _____ levels in blood
Resulting in
Which acts on
Releases
_____ to blood

Figure 10-1

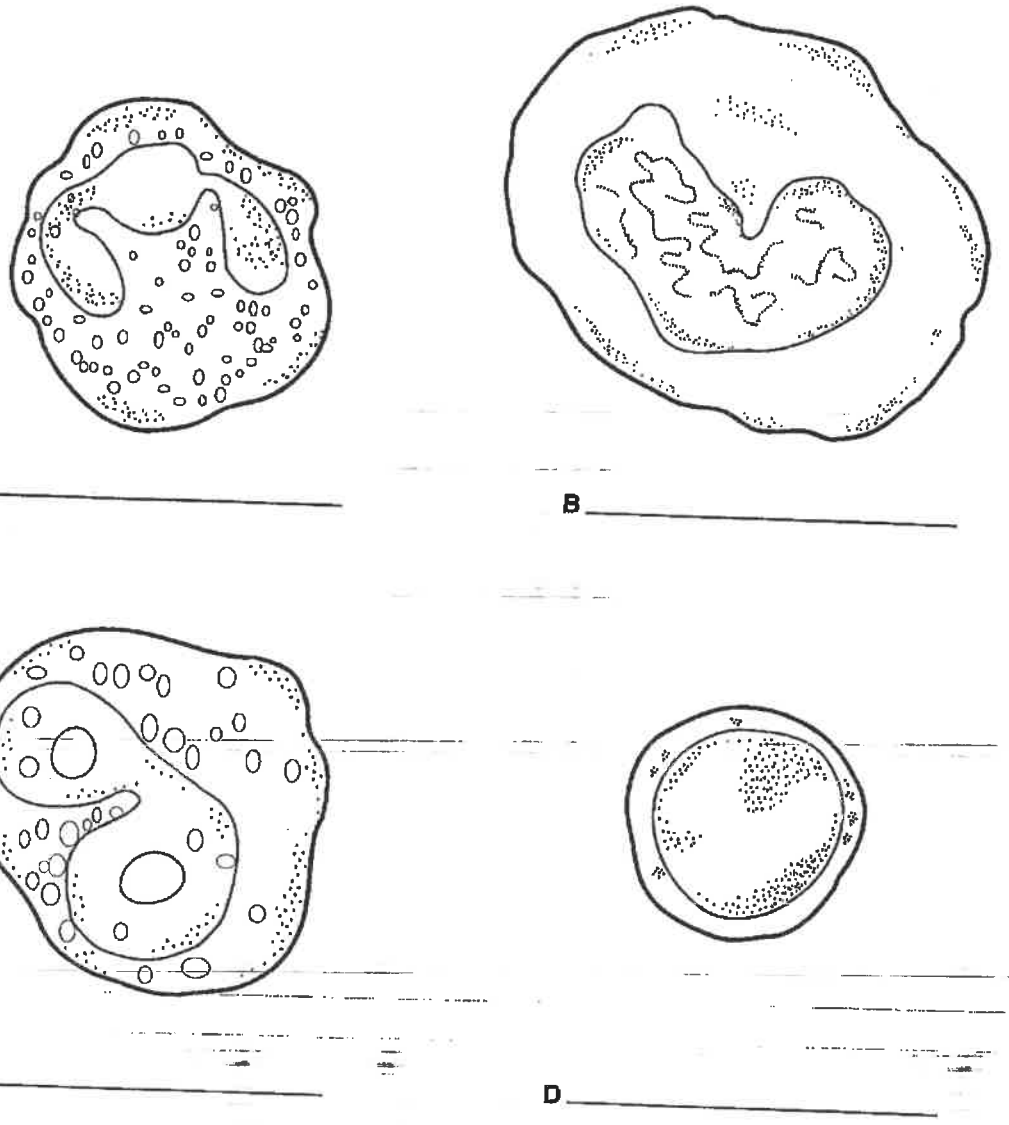
4. Four leukocytes are diagrammed in Figure 10–2. First, follow directions (given below) for coloring each leukocyte as it appears when stained with Wright's stain. Then, identify each leukocyte type by writing in the correct name in the blank below the illustration.

A. Color the granules pale violet, the cytoplasm pink, and the nucleus dark purple.

B. Color the nucleus deep blue and the cytoplasm pale blue.

C. Color the granules bright red, the cytoplasm pale pink, and the nucleus red/purple.

D. For this smallest white blood cell, color the nucleus deep purple/blue and the sparse cytoplasm pale blue.



A _____

B _____

C _____

D _____

Figure 10–2

5. For each true statement, insert *T*. If any of the statements are false, correct the underlined term by inserting the correction in the answer blank.

_____ 1. White blood cells (WBCs) move into and out of blood vessels by the process of chemotaxis.

_____ 2. An abnormal decrease in the number of white blood cells is leukopenia.

_____ 3. When blood becomes too acid or too basic, both the respiratory system and the liver may be called into action to restore it to its normal pH range.

_____ 4. The normal pH range of blood is 7.00 to 7.45.

_____ 5. The cardiovascular system of an average adult contains approximately 4 liters of blood.

_____ 6. Blood is circulated through the blood vessels by the pumping action of the heart.

_____ 7. An abnormal increase in the number of white blood cells is leukocytosis.

_____ 8. The normal RBC count is 3.5–4.5 million/mm^3.

_____ 9. Normal hemoglobin values are in the area of 42%–47% of the volume of whole blood.

_____ 10. An anemia resulting from a decreased RBC number causes the blood to become more viscous.

_____ 11. Phagocytic agranular WBCs are eosinophils.

_____ 12. The leukocytes particularly important in the immune response are monocytes.

6. Circle the term that does not belong in each of the following groupings.

1. Erythrocytes Lymphocytes Monocytes Eosinophils
2. Neutrophils Monocytes Basophils Eosinophils
3. Hemoglobin Lymphocyte Oxygen transport Erythrocytes
4. Platelets Monocytes Phagocytosis Neutrophils
5. Thrombus Aneurysm Embolus Clot
6. Plasma Nutrients Hemoglobin Wastes
7. Myeloid stem cell Lymphocyte Monocyte Basophil

7. Check (✓) all the factors that would serve as stimuli for erythropoiesis.

_____ 1. Hemorrhage

_____ 2. Aerobic exercise

_____ 3. Living at a high altitude

_____ 4. Breathing pure oxygen

HEMOSTASIS

8. Using key choices, correctly complete the following description of the blood-clotting process. Insert the key term or letter in the answer blanks.

Key Choices

A. Break	D. Fibrinogen	G. Serotonin
B. Erythrocytes	E. Platelets	H. Thrombin
C. Fibrin	F. Prothrombin	I. Tissue factor

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.

Clotting begins when a (1) occurs in a blood vessel wall. Almost immediately, (2) cling to the blood vessel wall and release (3), which helps to decrease blood loss by constricting the vessel. (4) is also released by damaged cells in the area. This chemical substance causes (5) to be converted to (6). Once present, thrombin acts as an enzyme to attach (7) molecules together to form long, threadlike strands of (8), which then traps (9) flowing by in the blood.

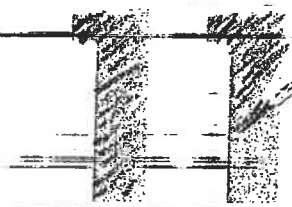
9. For each true statement, write *T*. If any statements are false, correct the underlined term by inserting the correction in the answer blank.

_____ 1. Normally, blood clots within 5–10 minutes.

_____ 2. The most important natural body anticoagulant is histamine.

_____ 3. Hemostasis means stoppage of blood flow.

CHAPTER



The Cardiovascular System

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.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.
_____ 10.
_____ 11.

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 O_2-poor blood blue and regions transporting O_2-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.

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.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____

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"

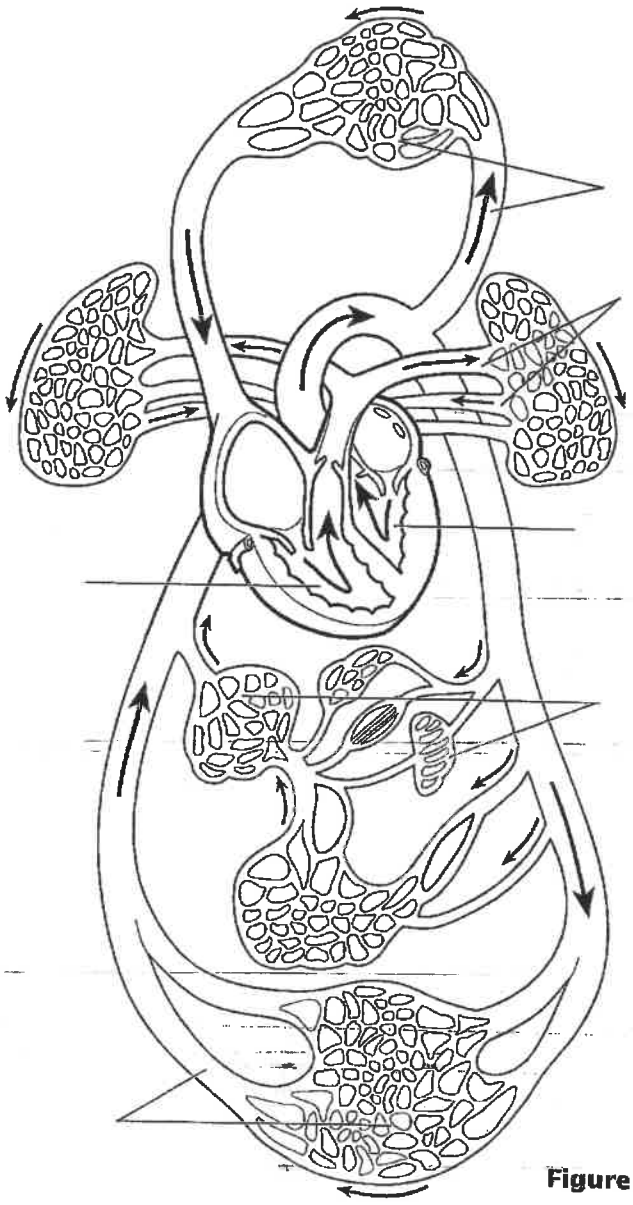


Figure 11–1

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.

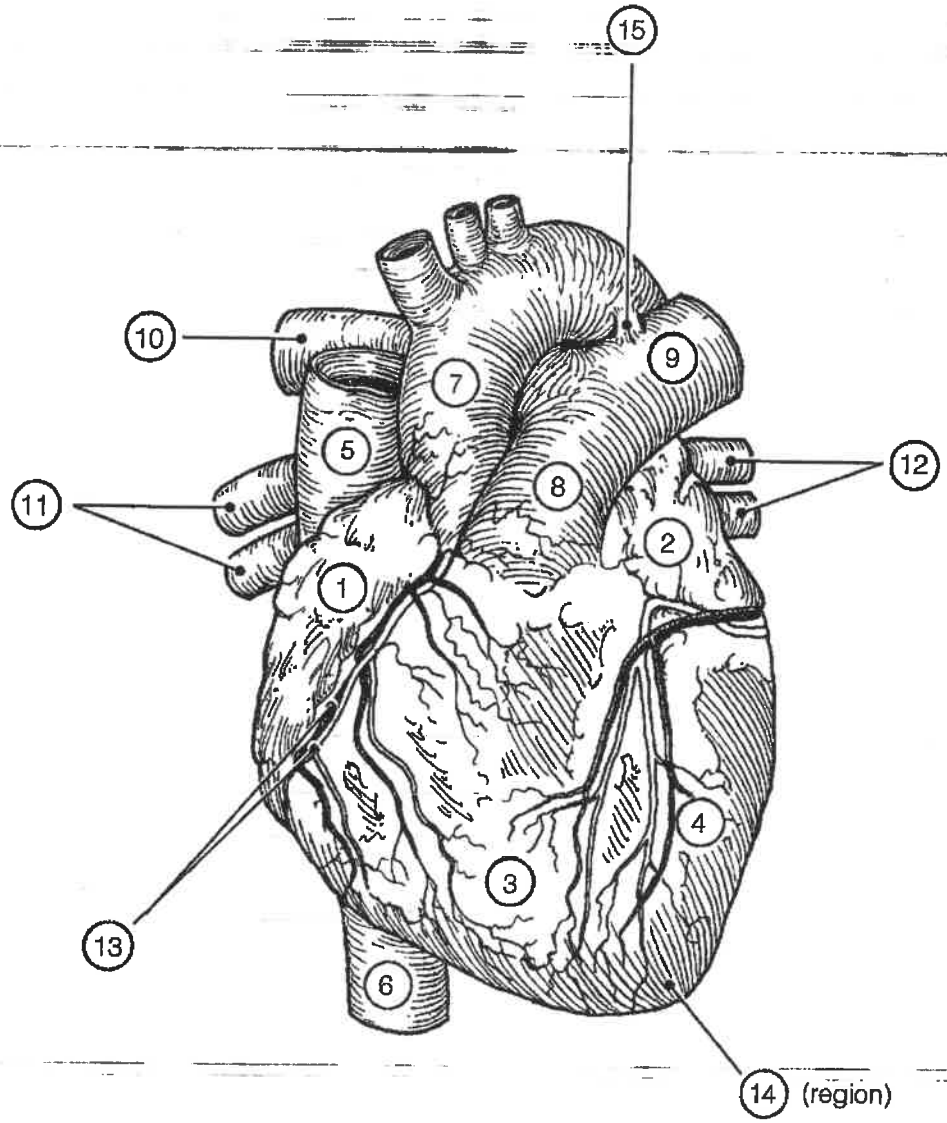


Figure 11–2

○ _____ 1.
○ _____ 2.
○ _____ 3.
○ _____ 4.
_____ 5.
○ _____ 6.
○ _____ 7.
○ _____ 8.
_____ 9.
_____ 10.
○ _____ 11.
_____ 12.
_____ 13.
_____ 14.
○ _____ 15.

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

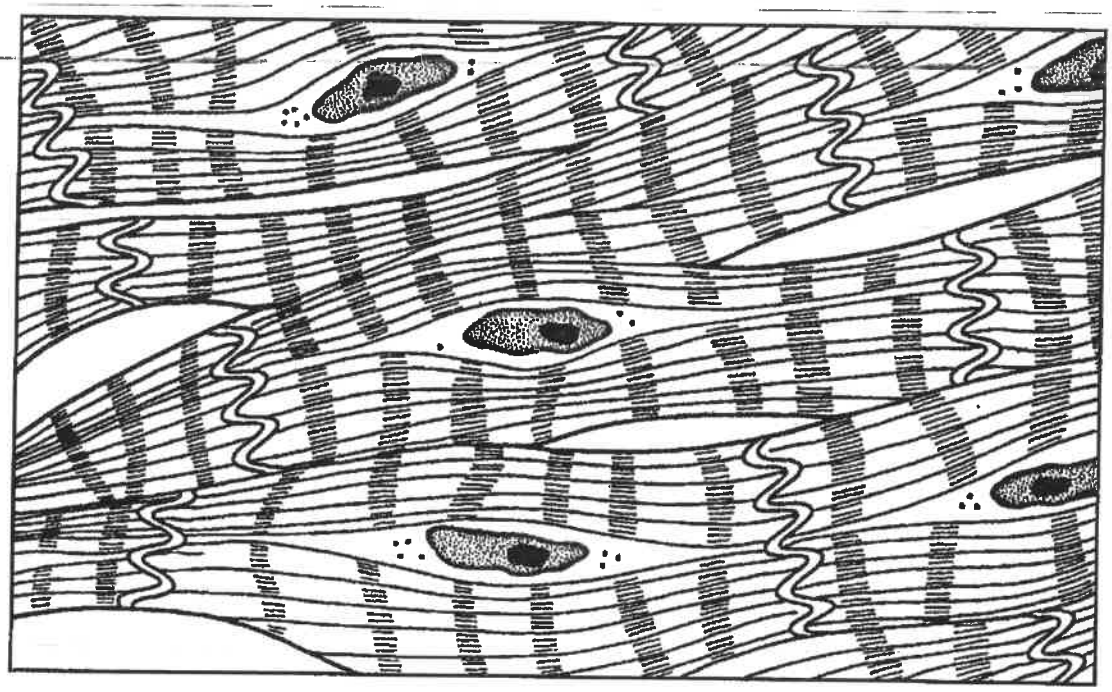


Figure 11–3

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.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.
_____ 9.
_____ 10.

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.

_____ 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 intrinsic conduction system

_____ H. The point in the intrinsic conduction system where the impulse is temporarily delayed

_____ 1.

_____ 2.

_____ 3.

_____ 4.

_____ 5.

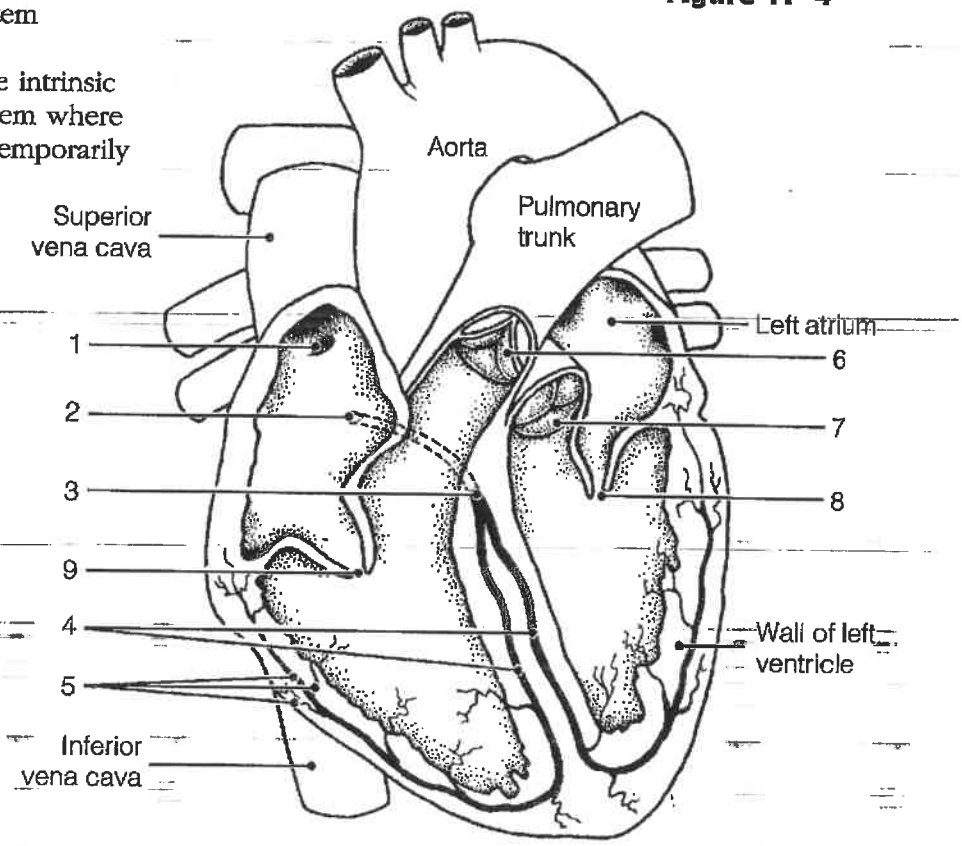
_____ 6.

_____ 7.

_____ 8.

_____ 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.

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

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.

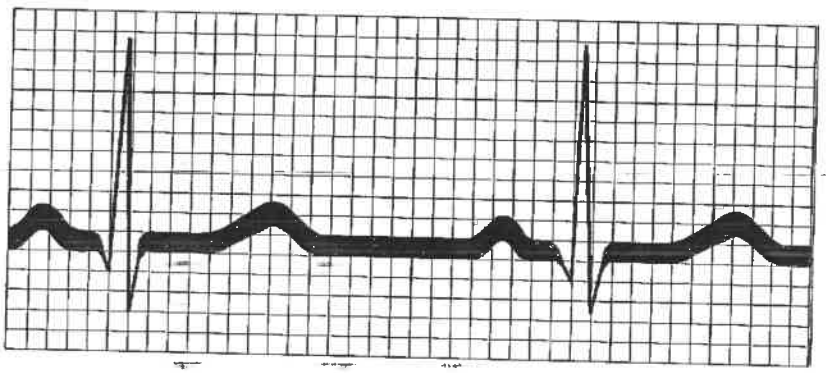


Figure 11–5

9. Complete the following statements relating to cardiac output by writing the missing terms in the answer blanks.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.
_____ 8.

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

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

_____ 9. _____ 10.

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.

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

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

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

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

_____ 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.

_____ 1.
_____ 2.
_____ 3.
_____ 4.
_____ 5.
_____ 6.
_____ 7.

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).

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

_____

_____

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

_____ and _____

16. First, select different colors for each of the three blood vessel tunics listed in the key choices and illustrated in Figure 11–6 on p. 185. Color the color-coding circles and the corresponding structures in the three diagrams. In the blanks beneath the illustrations correctly identify each vessel type. In the additional spaces provided, list the structural details that allowed you to make the identifications. Then, using the key choices, identify the blood vessel tunics

described in each of the following descriptions. Insert the term or letter of the key choice in the answer blanks.

Key Choices

A. ◯ Tunica intima B. ◯ Tunica media C. ◯ Tunica externa

_____ 1. Single thin layer of endothelium

_____ 2. Bulky middle coat, containing smooth muscle and elastin

_____ 3. Provides a smooth surface to decrease resistance to blood flow

_____ 4. The only tunic of capillaries

_____ 5. Also called the adventitia

_____ 6. The only tunic that plays an active role in blood pressure regulation

_____ 7. Supporting, protective coat

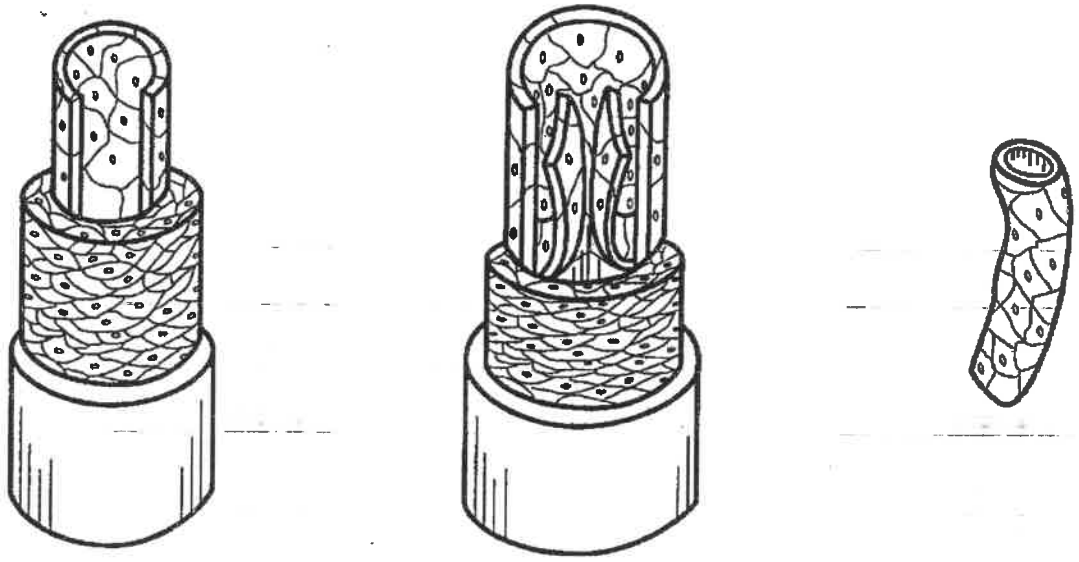


Figure 11–6

A _____ B _____ C _____

_____ _____ _____

_____ _____ _____

17. Figures 11–7 and 11–8 on pp. 186 and 187 illustrate the location of the most important arteries and veins of the body. The veins are shown in Figure 11–7. Color the veins blue and then identify each vein provided with a leader line on the figure. The arteries are shown in Figure 11–8. Color them red and then identify those indicated by leader lines on the figure. NOTE: If desired, the vessels identified may be colored differently to aid you in their later identification.

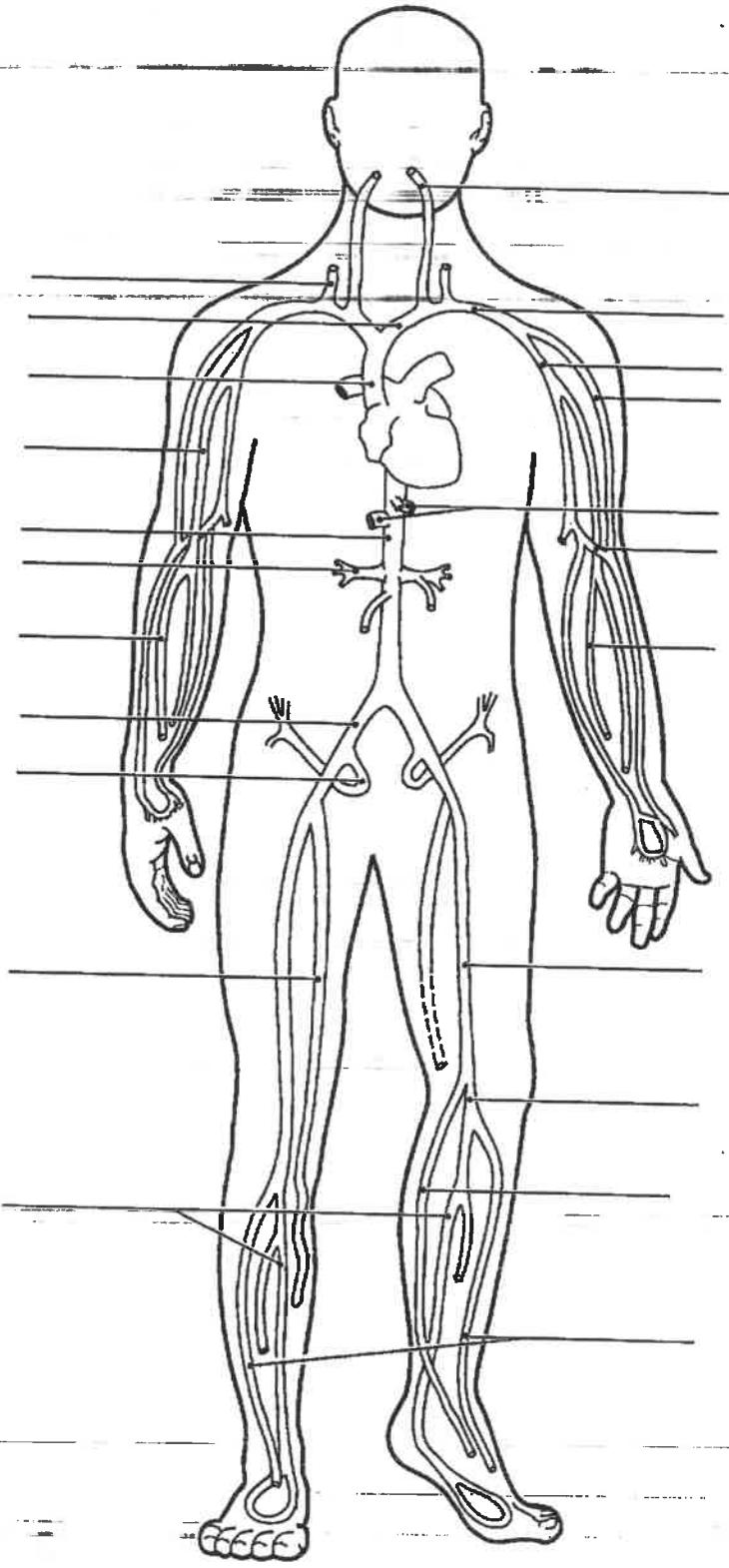


Figure 11–7 Veins

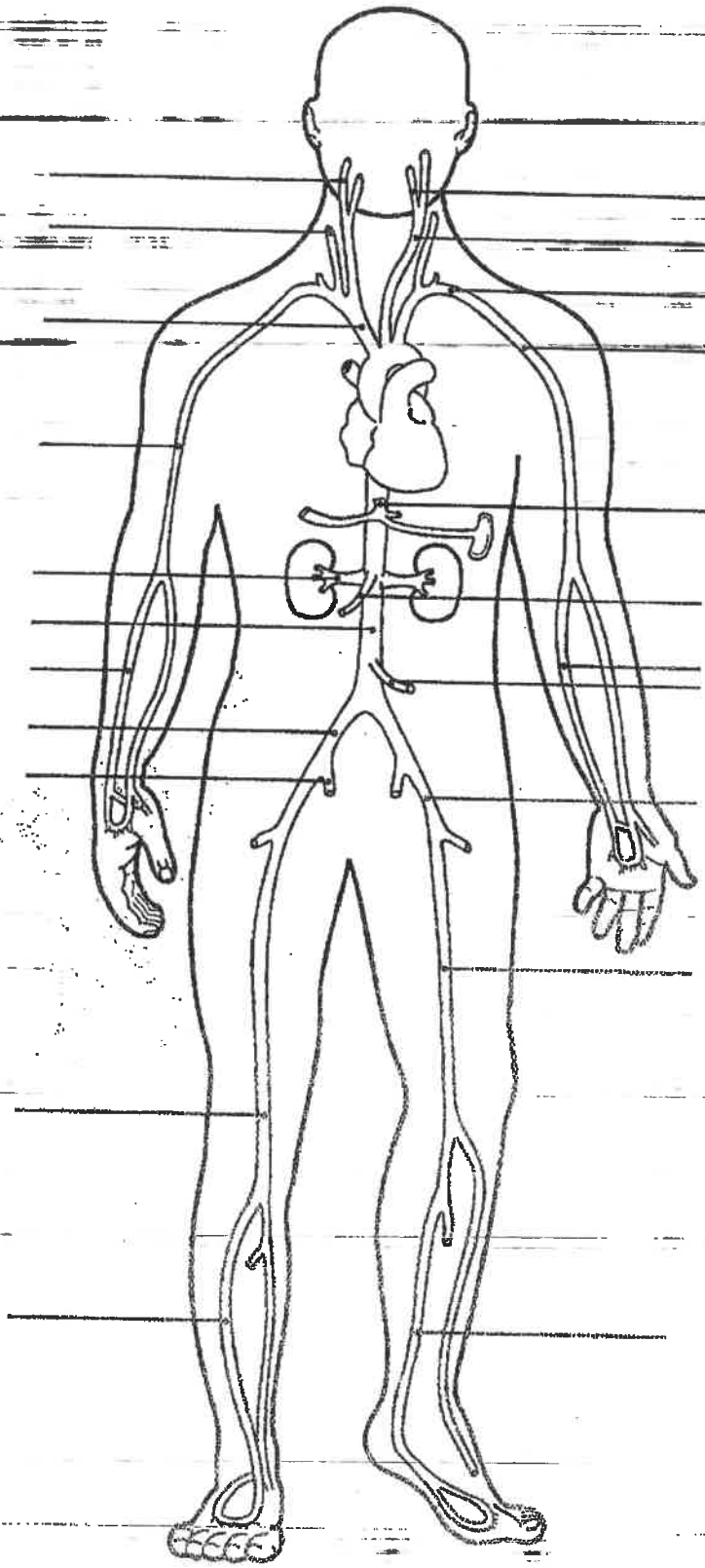


Figure 11-8 Arteries