

13

Blood Vessels and Circulation

FOCUS: Blood flows from the heart through the arterial blood vessels to capillaries, and from capillaries back to the heart through veins. The pulmonary circulation transports blood from the heart to the lungs and back to the heart, whereas the systemic circulation carries blood from the heart to the body and back to the heart. Blood

pressure is responsible for the movement of blood through the blood vessels, and it is regulated by nervous reflexes and hormones. The kidneys, by controlling blood volume, are the most important long-term regulators of blood pressure.

CONTENT LEARNING ACTIVITY

General Features of Blood Vessel Structure

“*The peripheral circulation consists of systemic and pulmonary blood vessels.*”

A. Match these terms with the correct statement or definition:

Artery
Capillary
Pulmonary vessels
Systemic vessels

Tunica adventitia
Tunica intima
Tunica media
Vein

1. Vessels that carry blood from the heart to the body (not the lungs) and back to the heart.
2. Type of vessel that carries blood away from the heart.
3. Type of vessel where exchange occurs between the blood and tissue fluid.
4. Innermost layer of a blood vessel consisting of endothelium.
5. Middle layer of a blood vessel consisting of varying amounts of smooth muscle, elastic fibers, and collagen fibers.
6. Outer connective tissue layer of a blood vessel.

B. Match these terms with the correct statement or definition:

Arterioles
Arteriosclerosis
Atherosclerosis
Capillary
Elastic arteries

Muscular arteries
Precapillary sphincters
Valves
Venules

1. Largest arteries; stretch and recoil when blood enters them.
2. Transport blood from small arteries to capillaries; adapted for vasodilation and vasoconstriction.
3. Vessel that consists of only endothelium.
4. Regulates blood flow through capillaries.
5. Carry blood from capillaries to small veins.
6. Structures in veins that prevent the backflow of blood.
7. Degenerative changes in arteries that make them less elastic.

Blood Vessels of the Pulmonary Circulation

“Pulmonary circulation is the flow of blood from the right ventricle to the lungs and back to the left atrium.”

Match these terms with the correct statement or definition:

Pulmonary arteries
Pulmonary trunk

Pulmonary veins

1. Vessel arising from the right ventricle.
2. Carry deoxygenated blood to the lungs; these two vessels arise from the pulmonary trunk.
3. Carry oxygenated blood from the lungs to the left atrium.

Blood Vessels of the Systemic Circulation: Arteries

“Oxygenated blood passes from the left ventricle to the aorta and is distributed to the body.”

A. Match these terms with the correct statement or definition:

Abdominal aorta
Aortic arch
Ascending aorta

Descending aorta
Thoracic aorta

1. Gives rise to the coronary arteries, which supply the heart.
2. Gives rise to the brachiocephalic, the left common carotid, and the left subclavian arteries.
3. Longest part of the aorta, running from the aortic arch to the common iliac arteries.
4. Portion of the aorta between the aortic arch and diaphragm.

B. Match these arteries with the correct parts labeled in figure 13.1:

- Brachiocephalic artery
- Left common carotid artery
- Left subclavian artery
- Right common carotid artery
- Right subclavian artery

1. _____
2. _____
3. _____
4. _____
5. _____

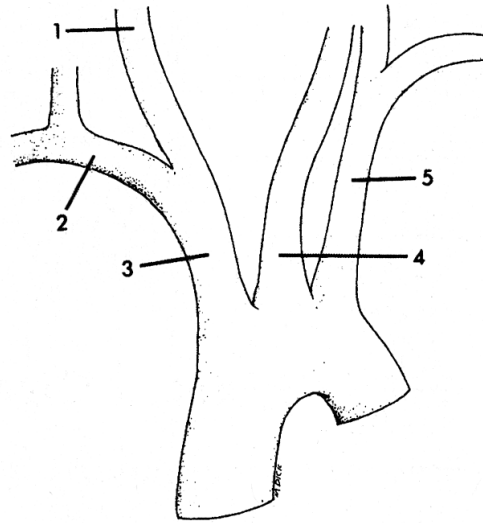


Figure 13.1

C. Match these arteries with the correct parts labeled in figure 13.2:

- Axillary artery
- Brachial artery
- Radial artery
- Ulnar artery

1. _____
2. _____
3. _____
4. _____

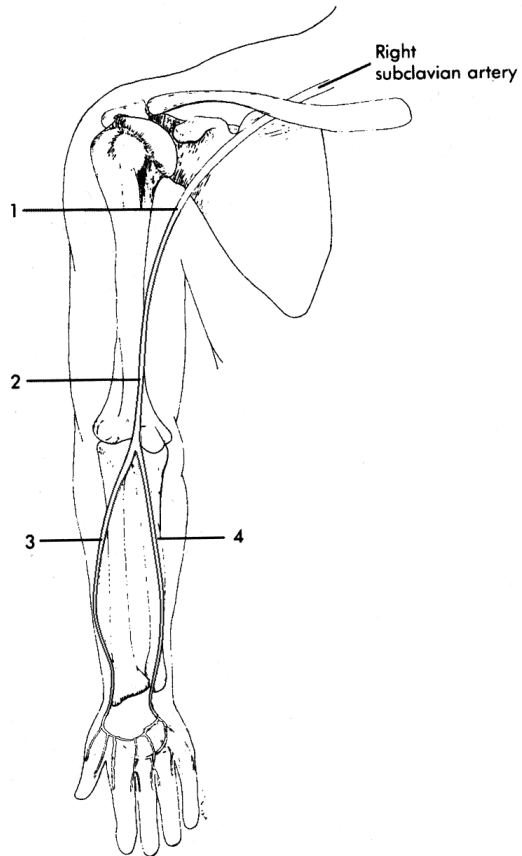


Figure 13.2

D. Match these arteries with the correct parts labeled in figure 13.3:

- Celiac trunk
- Common iliac artery
- Inferior mesenteric artery
- Testicular artery
- Renal artery
- Superior mesenteric artery
- Suprarenal artery

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

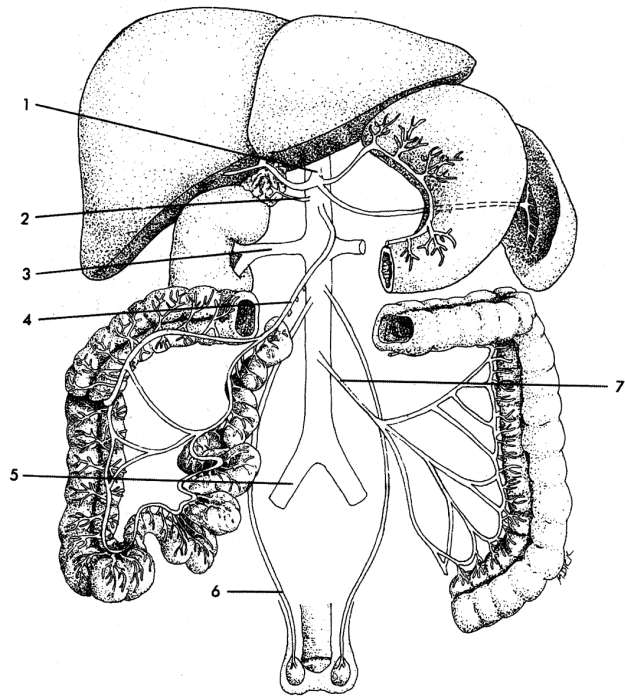


Figure 13.3

E. Match these arteries with the correct parts labeled in figure 13.4:

- Anterior tibial artery
- External iliac artery
- Femoral artery
- Internal iliac artery
- Popliteal artery
- Posterior tibial artery

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

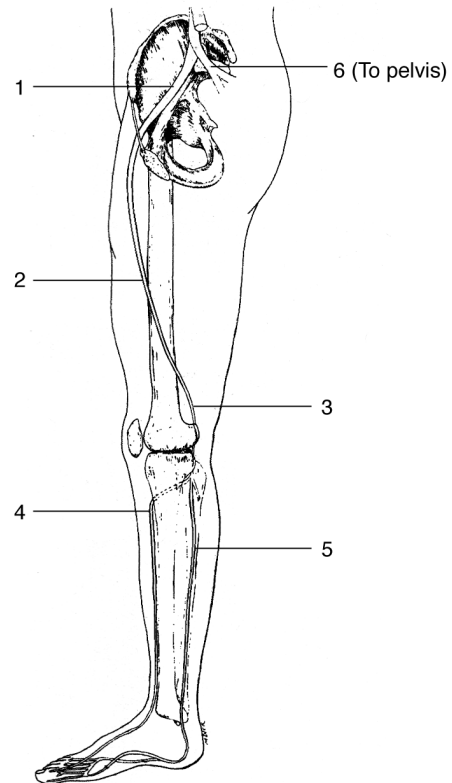


Figure 13.4

Blood Vessels of the Systemic Circulation: Veins

“Veins transport deoxygenated blood from the capillaries to the right atrium.”

A. Match these veins with the correct parts labeled in figure 13.5:

- Brachiocephalic vein
- External jugular vein
- Inferior vena cava
- Internal jugular vein
- Pulmonary veins
- Subclavian vein
- Superior vena cava

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

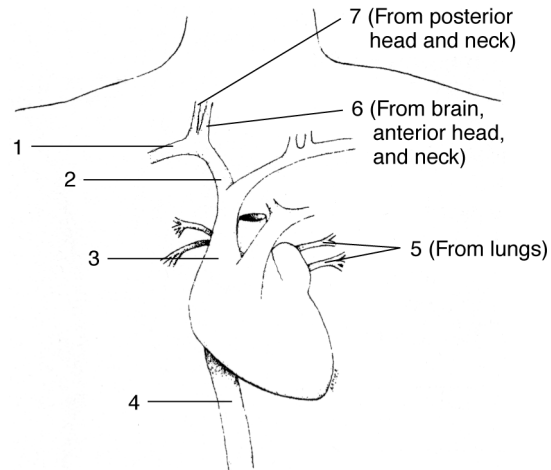


Figure 13.5

B. Match these veins with the correct parts labeled in figure 13.6:

- Axillary vein
- Basilic vein
- Brachial veins
- Cephalic vein
- Median cubital vein
- Venous arches

1. _____
2. _____
3. _____
4. _____
5. _____

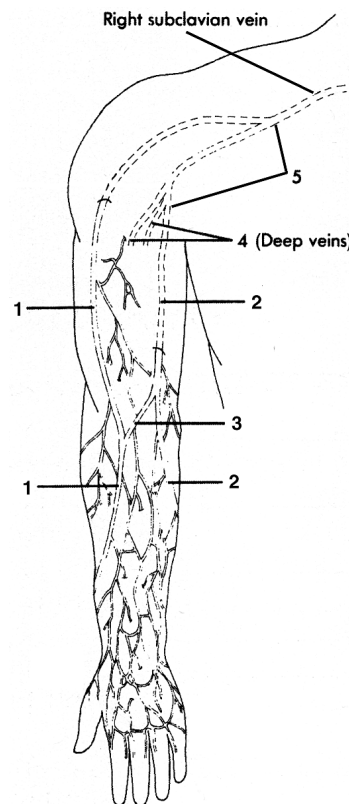


Figure 13.6

C. Match these veins with the correct parts labeled in figure 13.7:

- Common iliac vein
- External iliac vein
- Testicular vein
- Hepatic veins
- Internal iliac vein
- Renal vein
- Suprarenal vein

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

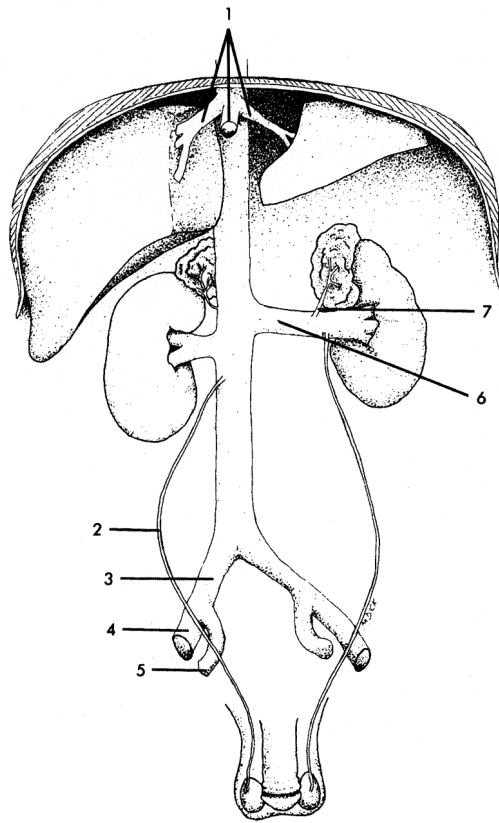


Figure 13.7

D. Match these veins with the correct parts labeled in figure 13.8:

- Gastric vein
- Hepatic portal vein
- Hepatic veins
- Inferior mesenteric vein
- Inferior vena cava
- Splenic vein
- Superior mesenteric vein

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

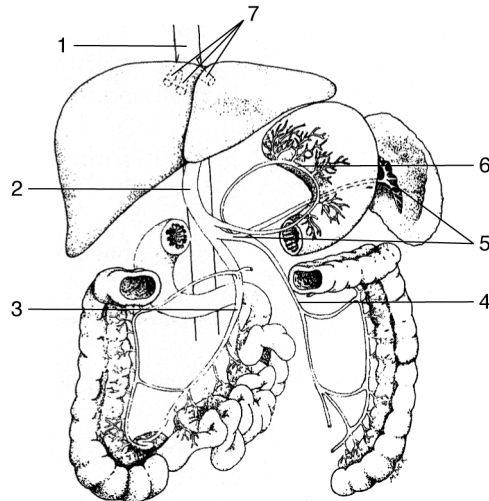


Figure 13.8

E. Match these veins with the correct parts labeled in figure 13.9:

- Femoral vein
- Great saphenous vein
- Popliteal vein
- Small saphenous vein

- 1. _____
- 2. _____
- 3. _____
- 4. _____

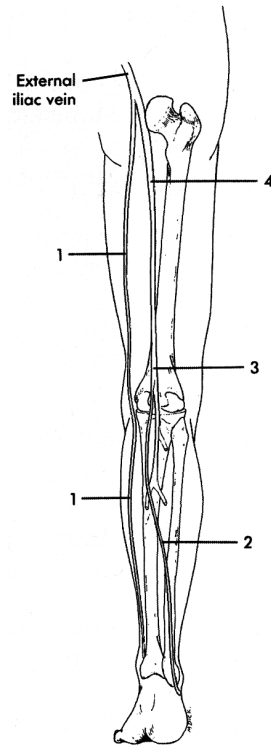


Figure 13.9

The Physiology of Circulation

“The function of the circulatory system is to maintain adequate blood flow to all tissues.”

A. Match these terms with the correct statement or definition:

- Auscultatory
- Blood pressure
- Diastolic pressure

- Korotkoff sounds
- Systolic pressure

- _____
- _____
- _____
- _____
- _____
- _____
- _____

- 1. A measure of the force blood exerts against the blood vessel walls; responsible for the movement of blood through blood vessels.
- 2. Maximum blood pressure; caused by ventricular systole.
- 3. Minimum blood pressure; caused by ventricular diastole.
- 4. The most common clinical method of determining blood pressure; uses a stethoscope and a sphygmomanometer.
- 5. Result from vibrations caused by turbulent blood flow through a constricted artery.
- 6. The pressure when the first Korotkoff sound is heard.
- 7. The 80 in a blood pressure measurement of 120/80.

B. Match these terms with the correct statement or definition:

Arterioles and capillaries Veins
Muscular arteries

- _____ 1. The greatest drop in blood pressure occurs here.
_____ 2. Has the lowest resistance to blood flow.
_____ 3. Regulates blood flow through specific tissues.
_____ 4. Regulates blood flow to regions of the body.

C. Using the terms provided, complete these statements:

Decrease(s)
Increase(s)

Pulse
Pulse pressure

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

The difference between the systolic and diastolic pressure is called (1). During exercise, stroke volume (2), causing pulse pressure to (3). In arteriosclerosis, the pulse pressure (4) because arteries are less elastic than normal. The (5) is a pressure wave produced by ejection of blood from the left ventricle. If stroke volume (6), or constriction of the muscular arteries (7), a weak pulse results.

D. Match these terms with the correct statement or definition:

Blood pressure
Diffusion
Edema

Lymphatic capillaries
Osmosis

- _____ 1. Means by which nutrients and waste products move across the capillary walls into interstitial spaces.
_____ 2. Force that moves fluid out of blood into tissues.
_____ 3. Force that moves fluid out of tissues into blood.
_____ 4. At the arterial end of capillaries this force is the greatest.
_____ 5. At the venous end of capillaries this force is the greatest.
_____ 6. Removes excess fluid from tissues and returns the fluid to the blood.
_____ 7. Swelling caused by excess fluid accumulation.

Local and Nervous Control of Blood Vessels

“Local and nervous control mechanisms match blood flow to the needs of tissues for blood.”

Match these terms with the correct statement or definition:

Contraction
Local control
Nervous control

Relaxation
Vasomotor center
Vasomotor tone

1. Achieved by contraction and relaxation of the precapillary sphincters.
2. Effect of decreased oxygen or increased carbon dioxide on the precapillary sphincters.
3. Regulates most blood vessels except for capillaries and precapillary sphincters.
4. Part of the sympathetic nervous system; continually stimulates most blood vessels.
5. Condition of partial constriction of blood vessels caused by sympathetic stimulation.
6. Control system that routes blood from the skin and viscera to exercising muscles.
7. Control system that allows more blood to flow through exercising muscle tissue.



The more metabolically active a tissue, the more capillaries it has, allowing greater delivery of blood to the tissue.

Regulation of Arterial Pressure

“An adequate blood pressure is required to maintain blood flow through the blood vessels.”

Match these terms with the correct statement or definition:

Cardiac output
Mean arterial pressure

Peripheral resistance

1. Slightly less than the average of the systolic and diastolic pressures in the aorta.
2. Equal to heart rate times stroke volume.
3. Total resistance to blood flow in all the blood vessels.
4. Equal to cardiac output times peripheral resistance.
5. Equal to heart rate times stroke volume times peripheral resistance.



If blood pressure suddenly drops, control systems attempt to reestablish blood pressure at a value consistent with life.

Baroreceptor Reflexes

“The baroreceptor reflexes are important in regulating blood pressure on a moment-to-moment basis.”

Using the terms provided, complete these statements:

Baroreceptors
Decrease(s)
Increase(s)

Vasoconstrict
Vasodilate

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

Pressure receptors that respond to stretch produced by blood pressure are called (1). They are located in the large arteries of the neck and thorax. Action potentials from the baroreceptors pass to the medulla oblongata, which produces responses in blood vessels and in the heart. A decrease in blood pressure is detected by these receptors and activates baroreceptor reflexes. As a result, blood vessels (2), and vasomotor tone (3). The change in blood vessel diameter causes peripheral resistance to (4), and this in turn causes blood pressure to (5). At the same time, baroreceptor reflexes cause heart rate and stroke volume to (6). These changes causes blood pressure to (7).

Chemoreceptor Reflexes

“The chemoreceptor reflexes function under emergency conditions and usually do not play an important role in the regulation of the cardiovascular system.”

Using the terms provided, complete these statements:

Chemoreceptors
Decrease(s)
Increase(s)

Vasoconstrict
Vasodilate

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

Receptors that respond to oxygen, carbon dioxide, and pH are called (1). They are located in the carotid bodies, aortic bodies, and medulla oblongata. A decrease in blood oxygen, an increase in blood carbon dioxide, or a decrease in blood pH activate chemoreceptor reflexes. As a result, blood vessels (2), and vasomotor tone (1). The change in blood vessel diameter causes peripheral resistance to (4), and this in turn causes blood pressure to (5). The change in blood pressure (6) blood flow to the lungs, which helps to increase blood oxygen levels and decrease blood carbon dioxide levels.

Hormonal Mechanisms

“The renin-angiotensin-aldosterone system and atrial natriuretic hormone are important in the long-term regulation of blood pressure.”

Match these terms with the correct statement or definition:

Antidiuretic hormone
Aldosterone
Angiotensin II

Atrial natriuretic hormone
Epinephrine
Renin

- _____ 1. Released by the adrenal medulla; increases blood pressure by increasing heart rate, stroke volume, and vasoconstriction.
- _____ 2. Released by the kidneys in response to a decrease in blood pressure; converts angiotensinogen into angiotensin I.
- _____ 3. Produced from angiotensin I by angiotensin-converting enzyme; increases blood pressure by causing vasoconstriction.
- _____ 4. Acts on the adrenal cortex to cause increased aldosterone secretion.
- _____ 5. Increases sodium and water uptake in the kidneys; maintains or increases blood pressure by maintaining or increasing blood volume.
- _____ 6. Secreted by the hypothalamus this hormone prevents water loss from the kidneys; maintains blood pressure by maintaining blood volume; also causes vasoconstriction.
- _____ 7. Released from the right atrium this hormone stimulates increased urine production; decreases blood pressure by decreasing blood volume.

QUICK RECALL

1. List five functions of peripheral circulation.
2. List the types of blood vessels, starting and ending at the heart.
3. Name the three layers or tunics of a blood vessel.

4. Name the two major forces responsible for moving fluids into and out of capillaries.

5. State three ways blood flow through tissues is controlled.

6. Write the formula that describes how heart rate, stroke volume, and peripheral resistance affect mean arterial pressure.

7. List two nervous mechanisms for regulating blood pressure.

8. List four hormonal mechanisms for regulating blood pressure.

WORD PARTS

Give an example of a new vocabulary word that contains each word part.

WORD PART	MEANING	EXAMPLE
sphin-	squeeze; strangle	1. _____
arteri-	an artery	2. _____
-sclero-	hard	3. _____
carot-	stupor; sleep	4. _____
brachio-	the arm	5. _____
pulmo-	a lung	6. _____

MASTERY LEARNING ACTIVITY

Place the letter corresponding to the correct answer in the space provided.

- _____ 1. Given the following blood vessels:
1. arteriole
 2. capillary
 3. elastic artery
 4. muscular artery
 5. vein
 6. venule

Choose the arrangement that lists the blood vessels in the order an erythrocyte passes through them as the erythrocyte leaves the heart, travels to a tissue, and returns to the heart.

- a. 3, 4, 2, 1, 5, 6
- b. 3, 4, 1, 2, 6, 5
- c. 4, 3, 1, 2, 5, 6
- d. 4, 3, 2, 1, 6, 5

- _____ 2. Comparing and contrasting veins,
- a. veins have thicker walls than arteries.
 - b. veins have a greater amount of smooth muscle than arteries.
 - c. veins have a tunica media and arteries do not.
 - d. veins have valves and arteries do not.
 - e. all of the above

- _____ 3. Given the following blood vessels:
1. aorta
 2. inferior vena cava
 3. pulmonary arteries
 4. pulmonary veins

Which of the vessels carries oxygen rich blood?

- a. 1, 3
- b. 1, 4
- c. 2, 3
- d. 2, 4

- _____ 4. Given the following vessels:
1. axillary artery
 2. brachial artery
 3. brachiocephalic artery
 4. radial artery
 5. subclavian artery

Choose the arrangement that lists the vessels in order going from the aorta to the right hand.

- a. 2, 5, 4, 1
- b. 5, 2, 1, 4
- c. 5, 3, 1, 4, 2
- d. 3, 5, 1, 2, 4

- _____ 5. Artery most commonly used to take the pulse near the wrist?
- a. basilar
 - b. brachial
 - c. cephalic
 - d. radial
 - e. ulnar

- _____ 6. A major branch of the aorta that subdivides to supply the liver, stomach, and spleen?
- a. celiac trunk
 - b. common iliac artery
 - c. inferior mesenteric artery
 - d. superior mesenteric artery

- _____ 7. Given the following arteries:
1. common iliac
 2. external iliac
 3. femoral
 4. popliteal

Choose the arrangement that lists the arteries in order going from the aorta to the knee.

- a. 1, 2, 3, 4
- b. 1, 2, 4, 3
- c. 2, 1, 3, 4
- d. 2, 1, 4, 3

- _____ 8. Korotkoff sounds
- are caused by the closing of the AV valves.
 - are caused by the closing of the semilunar valves.
 - are caused by turbulence in the arteries.
 - equal the pulse rate multiplied by two.
- _____ 9. Pulse pressure
- is equal to mean arterial pressure.
 - is the difference between systolic and diastolic pressure.
 - decreases in arteriosclerosis.
 - decreases during exercise.
- _____ 10. Concerning fluid movement at the capillary level,
- the amount of fluid leaving the arterial end of a capillary is equal to the amount of fluid entering the venous end.
 - the major force moving fluid out of the arterial end of a capillary is blood pressure.
 - fluid moves out of the venous ends of a capillary by osmosis because there is a greater concentration of proteins in the tissues than in the blood.
 - all of the above
- _____ 11. Blood flow through a tissue
- results from relaxation and contraction of precapillary sphincters.
 - decreases in response to a decrease in blood oxygen.
 - decreases in response to an increase in blood carbon dioxide.
 - all of the above
- _____ 12. An increase in mean arterial blood pressure can result from an increase in
- peripheral resistance.
 - heart rate.
 - stroke volume.
 - all of the above
- _____ 13. Through the baroreceptor reflexes, if there is an increase in mean arterial pressure, the expected response is
- an increase in sympathetic nervous system activity.
 - a decrease in peripheral resistance.
 - stimulation of the vasomotor center.
 - an increase in heart rate.
 - vasoconstriction.
- _____ 14. A sudden release of epinephrine from the adrenal medulla
- decreases heart rate.
 - increases urine production.
 - causes vasoconstriction of visceral blood vessels.
 - causes vasoconstriction of blood vessels in skeletal muscle.
- _____ 15. In response to an increase in blood pressure, the secretion or production of which of the following increases?
- aldosterone
 - angiotensin
 - antidiuretic hormone
 - atrial natriuretic hormone
 - renin



FINAL CHALLENGES



Use a separate sheet of paper to complete this section.

1. For each of the following destinations, name all the blood vessels an erythrocyte passes through if it starts its journey in the left ventricle and returns to the right atrium.
 - A. Liver
 - B. Small intestine
 - C. Urinary bladder
 - D. Skin of the right lateral forearm.
 - E. Skin of the medial, posterior leg.
2. Ima Fan loves to go to movies. After sitting in a movie for several hours she often develops edema in her legs and feet. Explain how this occurs. (Hint: recall from your study of osmosis that a column of liquid has weight).
3. After a long and leisurely lunch at a restaurant, sometimes elderly people faint when they stand up to leave the restaurant. Explain how this happens (Hint: assume that a homeostatic mechanism is not working as well as when they were younger).
4. An adult grasps a child by her wrists and swings her around and around. What should happen to the child's heart rate. Give two reasons for this change.
5. Buster Hart has a myocardial infarct (heart attack) and his blood pressure drops. Explain why his blood pressure drops and describe the neural mechanisms that would attempt to compensate. In Buster's case blood pressure was abnormally low for a few days following the myocardial infarct. Gradually, however, it returned to normal. Explain how this happened.