

Name _____ Period _____

Chapter 42: Circulation and Gas Exchange

Concept 42.1 Circulatory systems link exchange surfaces with cells throughout the body

1. Gaining O₂ and nutrients while shedding CO₂ and other waste products occurs with every cell in the body. However, diffusion is rapid only over small distances. Describe the two general solutions to this problem.
2. Remember from Chapter 41 that you should look at how various animal groups solve the same problem. *Cnidarians*, which include the hydras and jellyfish, do not have a distinct circulatory system. How have they solved the problem of exchange?
3. *Flatworms* (phylum Platyhelminthes) such as planaria have a slightly different solution to this problem. What is it?
4. Larger animals must have a circulatory system to move fluid between cells and the outside environment. What are the three basic components of a circulatory system?
5. Contrast *open circulatory systems* with *closed circulatory systems*.
6. Which type of system does each of the following organisms have?
lobster
earthworm
clam
squid
dog

7. What is *hemolymph*?

8. Complete the following chart. You will find the anatomical descriptions at the beginning of Concept 42.3, Blood Vessel Structure and Function.

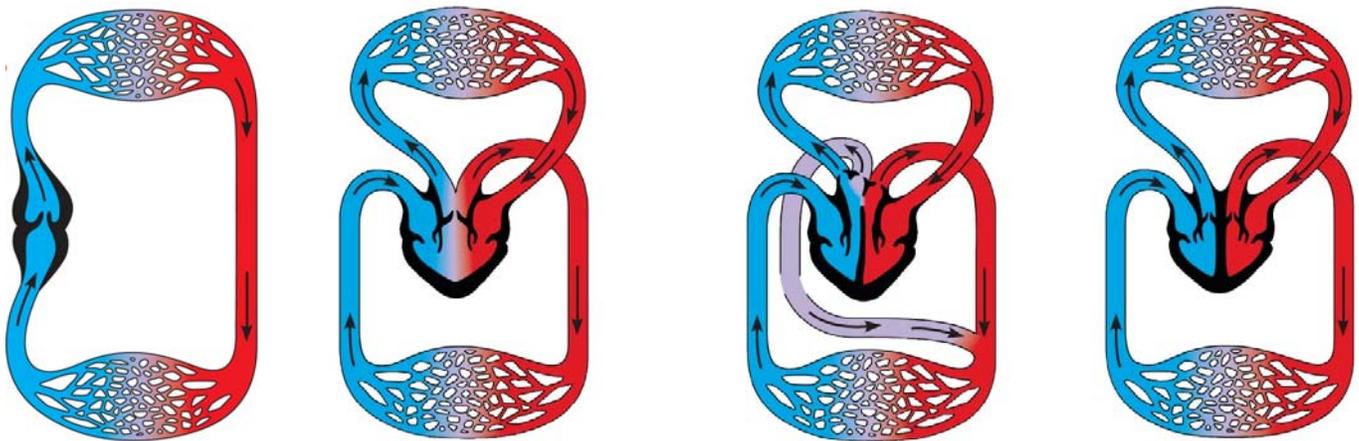
Blood Vessel	Function	Anatomical Description
<i>artery</i>		
<i>arteriole</i>		
<i>vein</i>		
<i>venule</i>		
<i>capillary</i>		

9. What is the function of the *atria*?

10. What is the function of the *ventricles*?

11. In a circulatory system, exchange occurs in two general places. Blood goes to a respiratory surface (lungs, gills, skin) or to the organs and tissues of the body (systemic circulation). At which type of blood vessels does exchange actually occur?

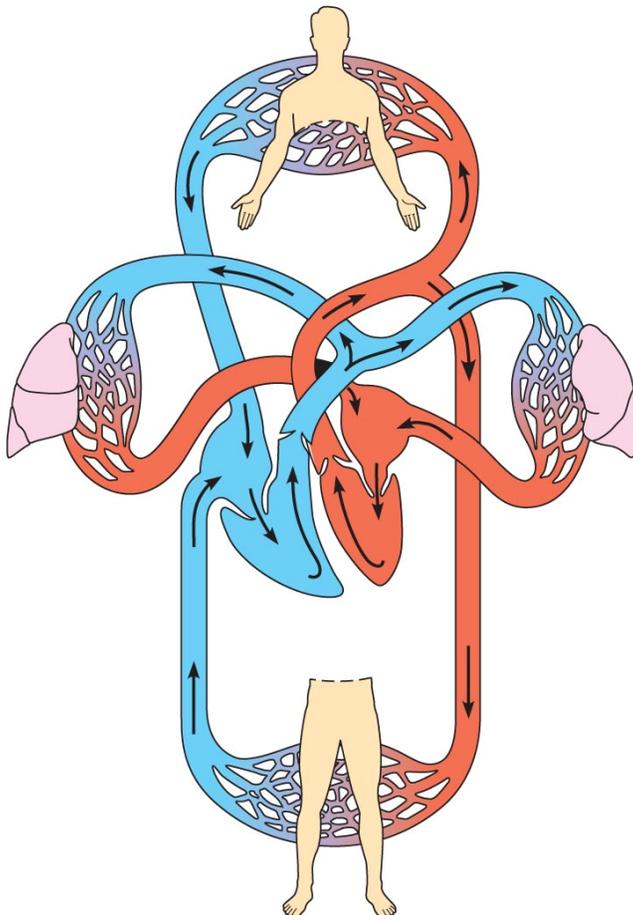
12. Look at the figure below. Label the sketches *fish*, *amphibians*, *reptiles*, and *mammals/birds* respectively. Note that each shows blood going to two places, as described above. Below each sketch, discuss the differences between the groups.



13. Why is a four-chambered heart a key adaptation required for *endothermy*?
14. Explain why the four-chambered hearts of birds and mammals are considered an example of convergent evolution.

Concept 42.2 Coordinated cycles of heart contraction drive double circulation in mammals

15. The figure below is vital to your overall understanding of mammalian circulation. Label the following: *aorta*, *pulmonary artery*, *left lung*, *right lung*, *left atrium*, *left ventricle*, *aorta*, *inferior vena cava*, *superior vena cava*, *systemic circulation*, and *pulmonary circulation*. Then reread this section in your book, and trace what is happening from **Point 1** to **Point 11**. Be prepared to discuss this system in an essay.



16. Study Figure 42.7 in your text. It is a nice artist's sketch of a mammalian heart. Below you will see a simple box. Divide it into four compartments, label each one as a chamber of the heart, show and label all blood vessels in and out, and locate the four valves of the heart. Finally, use a colored line with arrows to trace the flow of blood through the heart.



17. Now that you have the anatomy down, it is time to look at how the heart works. Explain each of the following terms.

cardiac cycle

systole

diastole

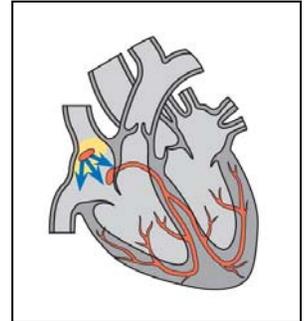
cardiac output (Include the two factors that determine it.)

18. Heartbeat rhythm is maintained by electric impulses that are generated from modified cells found in the wall of the right atrium, called the *sinoatrial (SA) node*. What is the common name for the *SA node*?

19. Electrical impulses from the SA node cause the atria to contract and are conducted to a relay station, the *atrioventricular (AV) node*. When an impulse is generated by the *AV node*, what contracts?

20. On this sketch, label the *SA node* and the *AV node*.

21. Explain how the *sympathetic* and *parasympathetic nerves* affect the pacemaker.



Concept 42.3 Patterns of blood pressure and flow reflect the structure and arrangement of blood vessels

22. As you begin this concept, you may wish to refine the chart you completed for question 8. Why is it important that the *arteries* are so much thicker than the *veins*?

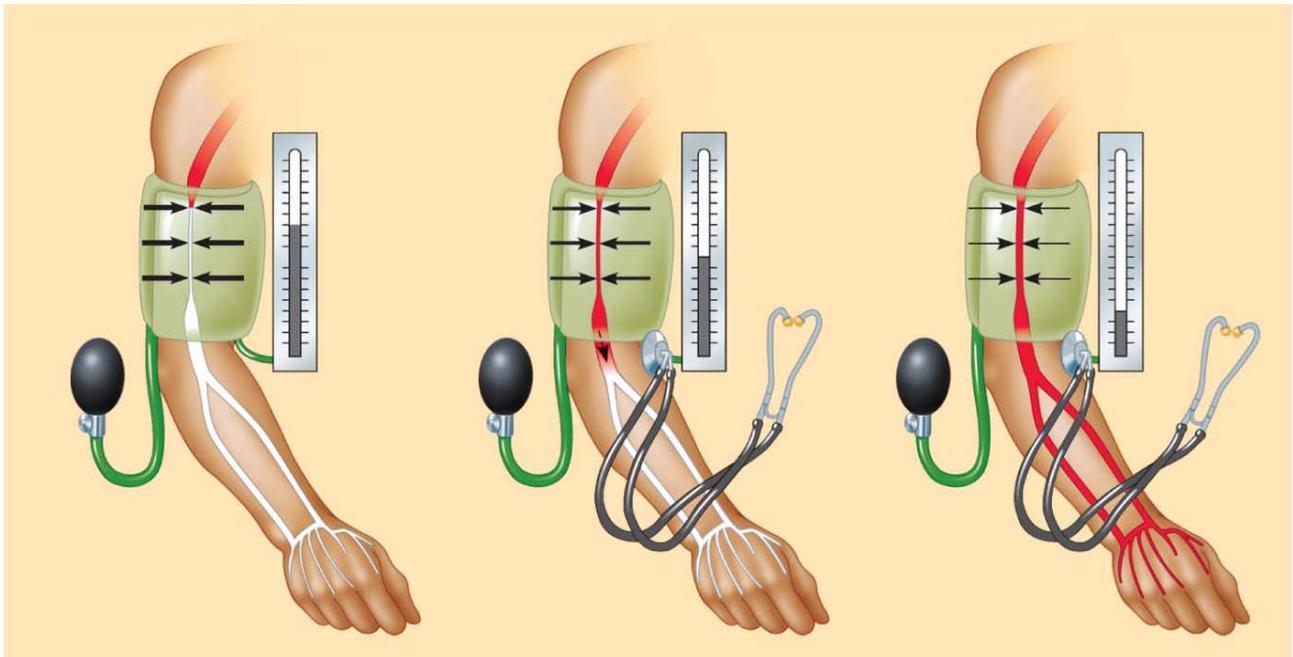
23. How do structure and function correlate in the *capillaries*?

24. What anatomical feature of the *veins* maintains a unidirectional flow of blood back toward the heart?

25. As blood vessel diameter decreases, *blood velocity* will _____.

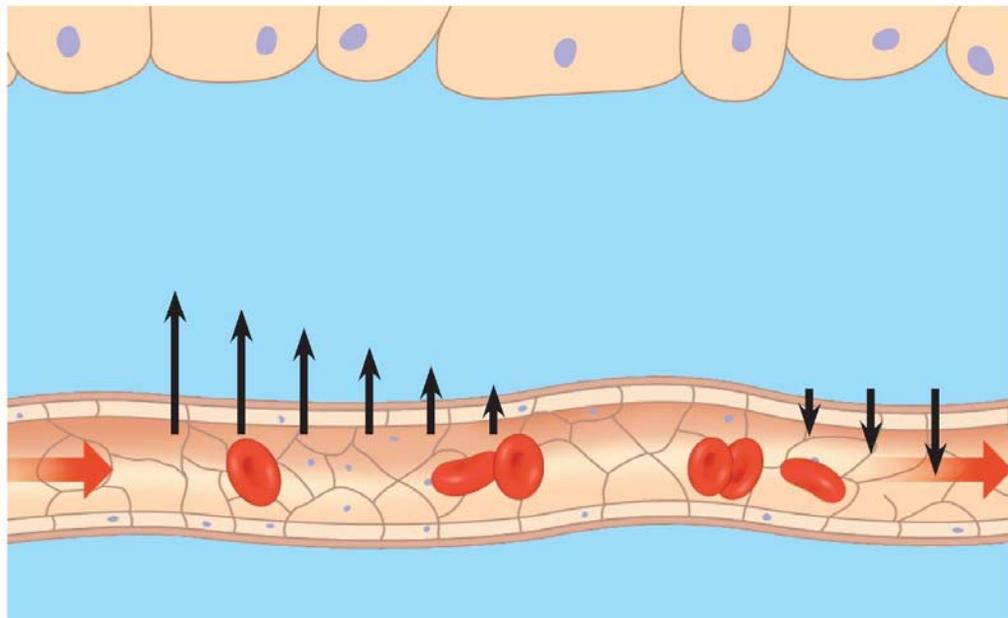
26. Why does blood *slow* as it moves from arteries to arterioles to capillaries? Why is this important?

27. Changes in blood pressure as the heart contracts and relaxes can be felt, such as a gentle throb at the wrist or neck. What is this called?
28. How does *vasoconstriction* affect blood pressure?
29. Use this figure to explain how a *sphygmomanometer* is used to measure blood pressure.



30. If the blood pressure is reported as 110/80, what is the diastolic pressure?
31. What are two mechanisms that regulate blood flow in capillaries?

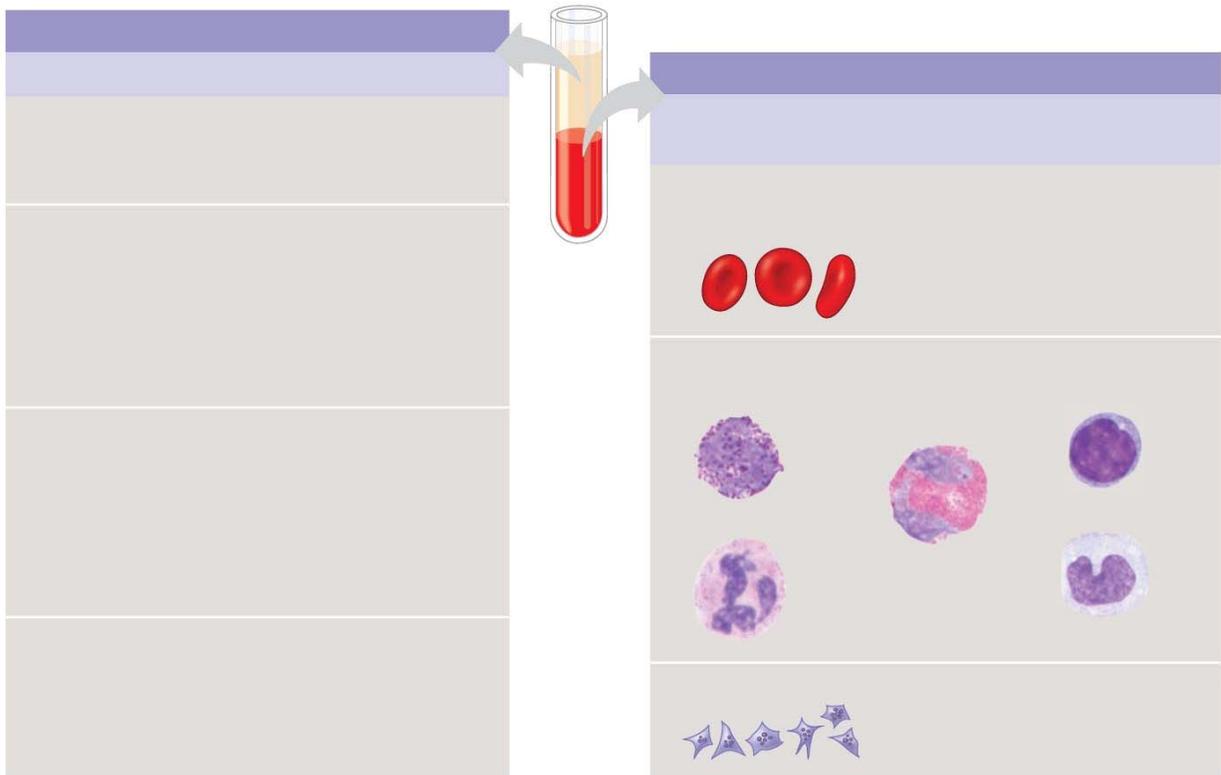
32. Explain the exchange of fluid at the two ends of a capillary by annotating this figure. Include these terms in your discussion: *interstitial fluid*, *osmotic pressure*, and *blood pressure*.



33. Why does the presence of blood proteins tend to pull fluid back into the capillaries?
34. The capillaries “leak” about 4 liters of fluid each day. How is this returned to the blood?
35. What is *lymph*? Is it more like blood or more like interstitial fluid?
36. We don’t have a second heart to pump lymph. What keeps it moving along?
37. Name three places you have *lymph nodes*. What are two functions of these nodes?

Concept 42.4 Blood components function in exchange, transport, and defense

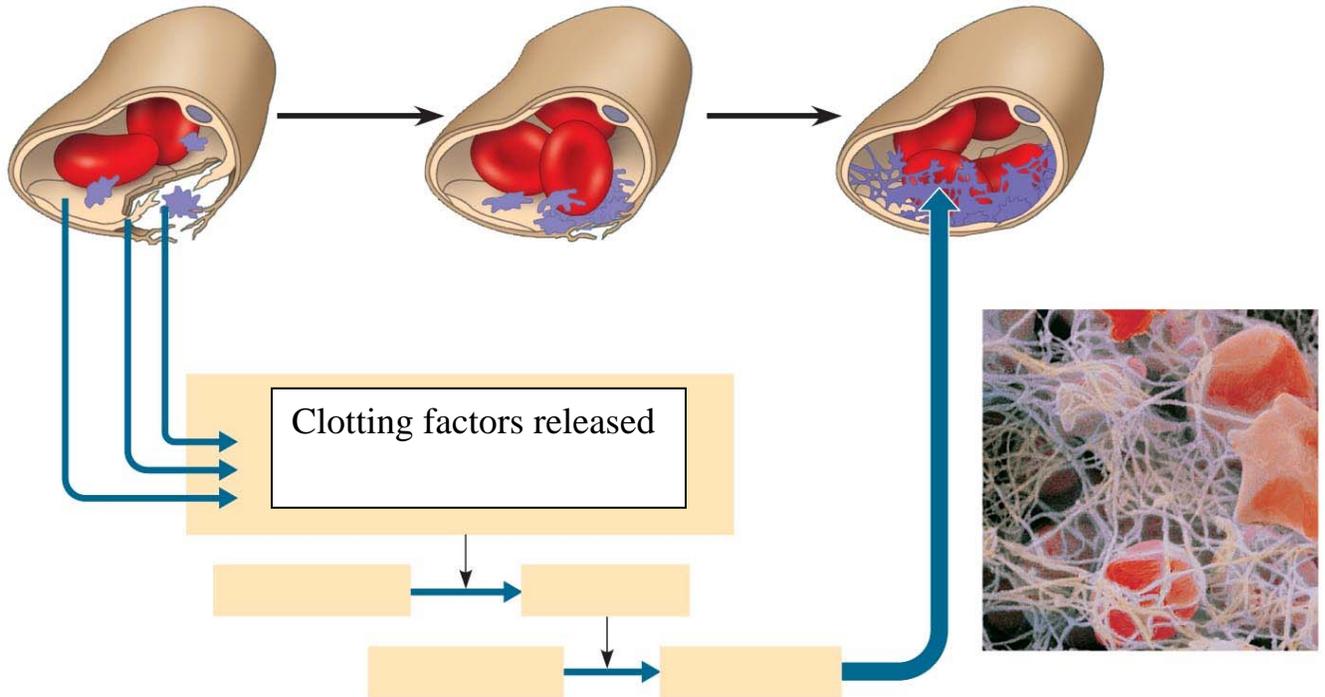
38. Blood separates into two components, a liquid matrix called _____ and the *cellular elements*.
39. Label *plasma* and *cellular elements* on the figure below. What is the relative percentage of each? Note this on the figure. Then, name each type of cell and give its function. Finally, list the four major constituents of plasma. What are their functions?



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40. Describe three ways in which the structure of an *erythrocyte* enhances its function, which is to transport oxygen.
41. What is the role of *hemoglobin*?

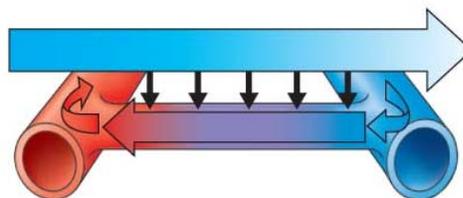
42. Blood clotting involves a pathway of several steps. It begins when *platelets* begin to form a plug in the blood vessel wall, and damaged platelets release a chemical that initiates a clotting cascade. Focus on what happens to the plasma proteins *prothrombin* and *fibrinogen* when this cascade begins. Complete the blocks on this figure, beginning with the release of clotting factors.



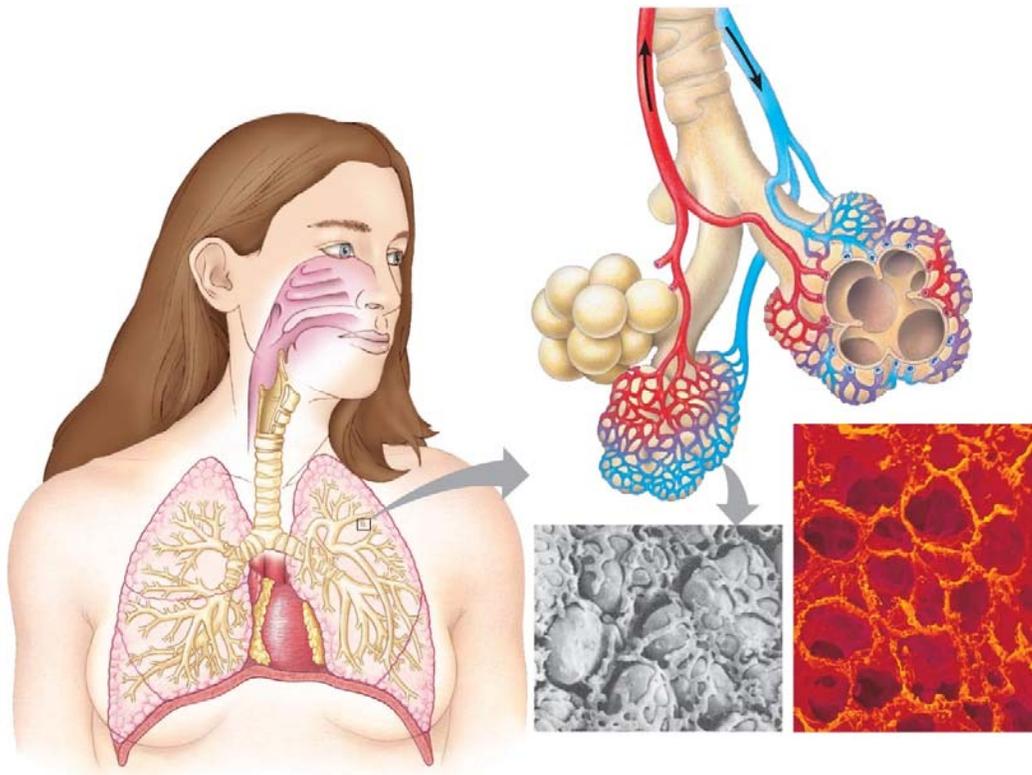
43. What is the name of the protein that actually forms a clot?
44. If a clot forms within a blood vessel and blocks the flow of blood, what is it called?
45. Where are blood *stem cells* found?
46. What is *erythropoietin (EPO)*? What will stimulate its production?
47. What causes the development of a *plaque* in *atherosclerosis*?
48. What are three known predictors of cardiovascular disease?

Concept 42.5 Gas exchange occurs across specialized respiratory surfaces

49. What is meant by the *partial pressure* of a gas?
50. A gas always diffuses from a region of _____ partial pressure to a region of _____ partial pressure.
51. Gas exchange with water as the respiratory medium is much more demanding than exchange with the air. What are three reasons for this?
52. There are several requirements for a respiratory surface. The first is that it must be *moist*. The second is that it must have a *large surface area* and be *thin*. What four different organs satisfy these requirements?
53. What is *countercurrent exchange*?
54. *Gills* serve as the respiratory organ in many aquatic animals. Figure 42.22 in your text uses arrows to show the flow of water. The most significant part of this figure is the portion that shows the countercurrent flow of water and blood. Study carefully the paragraph that describes *countercurrent exchange*, and then label this figure to explain how oxygen is taken up over the length of a capillary.

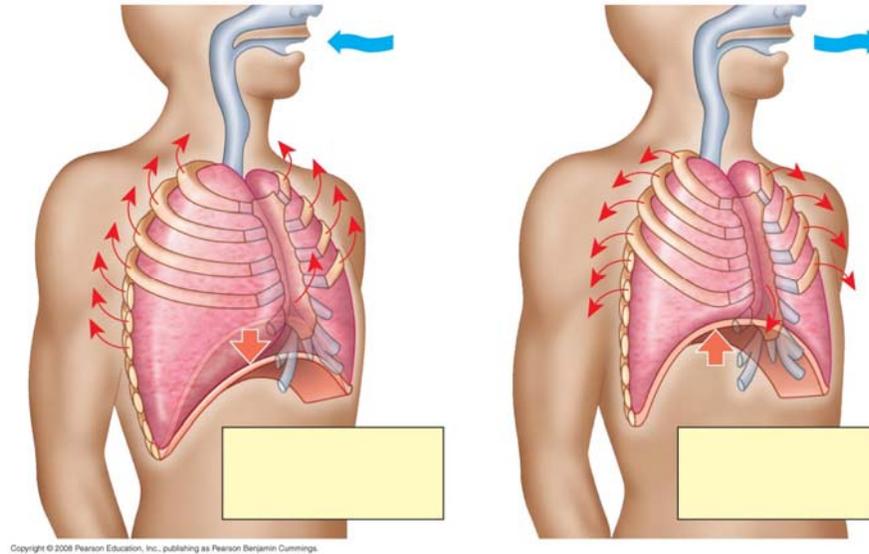


55. Consider this question to see if you understand the advantage of a *countercurrent exchange* system. Without countercurrent exchange, what would be the maximum absorption percentage if O_2 simply diffused from water to blood in the gills? (See figure 42.22.)
56. What is the most common respiratory structure among terrestrial animals? What group has this system?
57. Let's look at the anatomy of a mammalian respiratory system. On this figure, label each of the following features and explain its function or describe it: *pharynx*, *larynx*, *trachea*, *left and right lungs*, *left and right bronchi*, *bronchioles*, and *alveoli*.



Concept 42.6 Breathing ventilates the lung

58. Use the following sketch to explain how pressure is changed within the thoracic cavity to bring in air.



59. Where are the two *breathing control centers* located in the brain?
60. How does blood pH change as CO_2 increases?
61. What is a *bicarbonate ion*? How is it formed?
62. Read carefully to answer this question: What has greater effect on the rate of respiration, low levels of O_2 or high levels of CO_2 ?

Concept 42.7 Adaptations for gas exchange include pigments that bind and transport gases

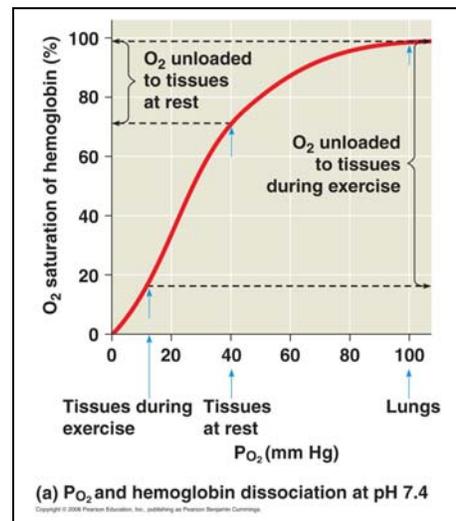
63. Remember that gases will diffuse from a region of high partial pressure to a region of low partial pressure. Study Figure 42.28 in your text, and you will see this process occurs, for both O_2 and CO_2 , between the body tissue cells and the alveoli. Where is the partial pressure of oxygen higher, in the alveoli or in the tissues?

64. What is the *respiratory pigment* in vertebrates?
65. *Hemoglobin* is a protein with quaternary structure. How many subunits does it have? What is the role of iron?
66. As pH of the blood decreases, the affinity of hemoglobin for oxygen decreases, and oxygen is released from hemoglobin. What is this called?

Your answer to the question above should have been the *Bohr shift*, which occurs as a result of *cooperativity* between the four hemoglobin subunits. When O₂ binds to one subunit, the others change shape slightly; this change increases their affinity for O₂ and makes it easier for O₂ to load onto hemoglobin.

67. Because of the effect of subunit cooperativity, a slight drop in P_{O₂} causes a(an) _____ in the amount of O₂ the blood unloads.

68. Study Figure 42.29 at the right. What is the % O₂ saturation level of hemoglobin in the lungs?



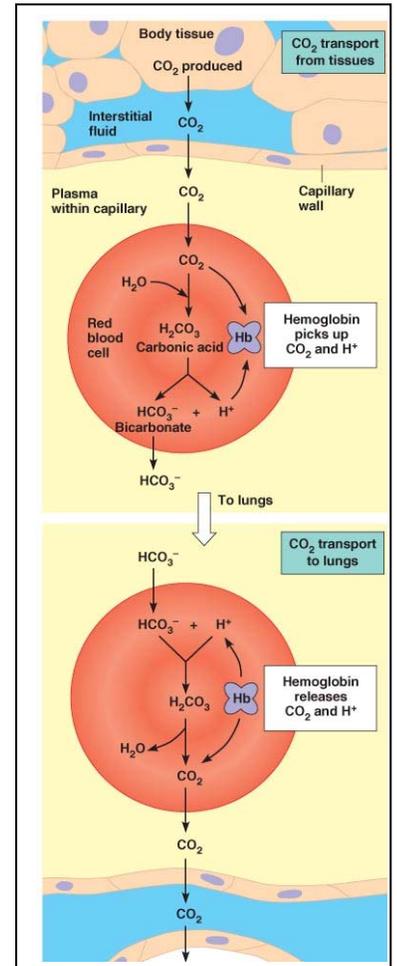
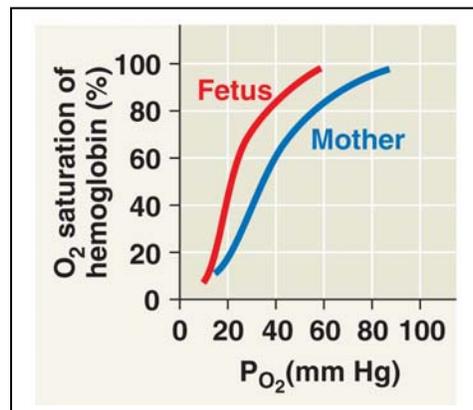
69. What is the % O₂ saturation level of hemoglobin in tissues at rest? _____ When exercising? _____

70. Carbon dioxide is carried in the blood in three ways. Name each of them, and give the relative percentage of CO₂ transported.

71. Where is *carbonic anhydrase* found? What is its role in CO₂ transport?

72. What is *myoglobin*?

73. Fetal hemoglobin and adult hemoglobin are different. Here are the dissociation curves for both. Explain the reason for this difference.



Testing Your Knowledge: Self-Quiz Answers

Now you should be ready to test your knowledge. Place your answers here:

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