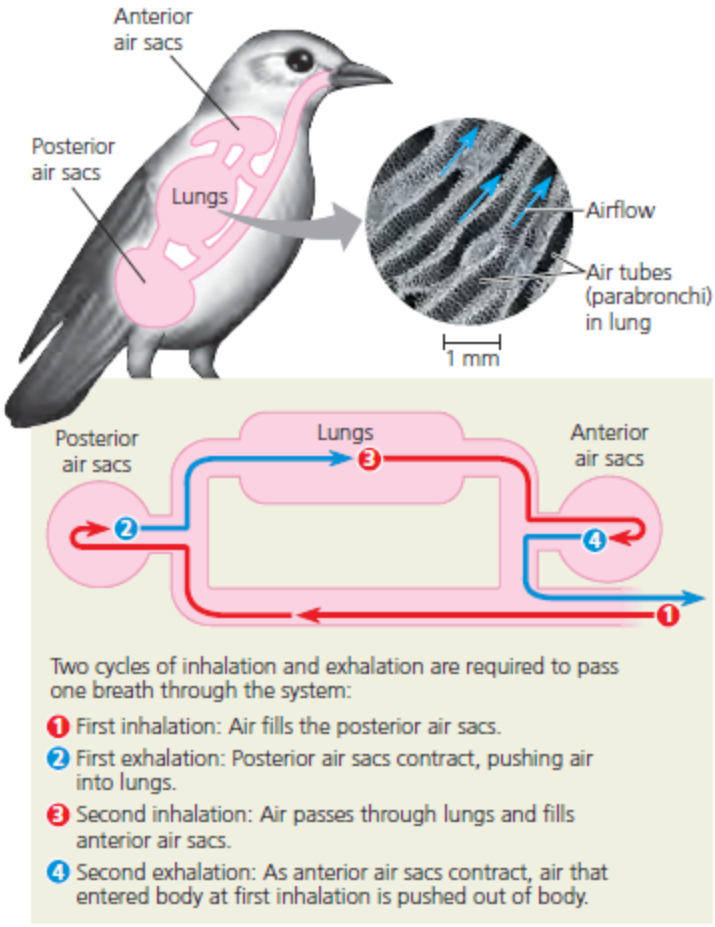
Cheat Sheet



▲ **Figure 42.27 The avian respiratory system.** This diagram traces a breath of air through the respiratory system of a bird. As shown, two cycles of inhalation and exhalation are required for the air to pass all the way through the system and out of the bird.

Chapter 42 Questions

1. **What is diffusion?**
2. **Why is diffusion slow over long distances?**
3. **What is the heart?**
4. **What is an open circulatory system?**
5. **What is a closed circulatory system?**
6. **Compare and contrast open and closed circulatory systems.**
7. **What is the cardiovascular system?**
8. **What are arteries?**
9. **What are arterioles?**
10. **What are capillaries?**
11. **What are venules?**
12. **What are veins?**
13. **What are portal veins?**
14. **What are atria?**
15. **What are ventricles?**
16. **What is single circulation?**
17. **What is double circulation?**
18. **How do many intermittent breathers bypass the lungs?**
19. **How does double circulation in mammals and birds differ from other vertebrates?**
20. **Describe the mammalian cardiovascular system.**
21. **Describe the structure of the human heart.**
22. **What is the cardiac cycle?**
23. **What is the cardiac output?**
24. **What is heart rate?**
25. **What is stroke volume?**
26. **Describe the structure of valves in the heart.**
27. **What is an atrioventricular (AV) valve?**
28. **What are semilunar valves?**
29. **What are the two noises that a heart makes?**
30. **What is a heart murmur?**
31. **What is rheumatic fever?**
32. **What is the sinoatrial (SA) node?**
33. **How are signals from the SA node transmitted?**
34. **What is an electrocardiogram (ECG/EKG)?**
35. **Describe the pathway of SA node impulses.**
36. **What two portions of the nervous system regulate SA node function?**
37. **How does temperature affect heart rate?**
38. **What is an endothelium?**
39. **Describe the structure of capillaries.**

40. Describe the structures of arteries and veins.
41. When does blood speed change?
42. When is arterial blood pressure the highest?
43. What is systolic pressure?
44. What is pulse?
45. What is diastolic pressure?
46. What are vasoconstriction and vasodilation?
47. What is the typical blood pressure of a 20-year-old human in the systemic circuit?
48. What causes fainting?
49. How is blood pressure measured?
50. How is blood flow to capillaries regulated?
51. What is histamine?
52. What two forces control movement of fluid between capillaries and surroundings?
53. What is the lymphatic system?
54. What is lymph?
55. What is edema?
56. What is elephantiasis?
57. What are lymph nodes?
58. What is plasma?
59. What do plasma proteins do?
60. What role do inorganic salts play in plasma?
61. What are immunoglobulins (antibodies)?
62. What are apolipoproteins?
63. What are fibrinogens?
64. What are platelets?
65. What are erythrocytes?
66. What happens in sickle cell disease?
67. What are leukocytes?
68. What are the 5 types of leukocytes?
69. Describe the structure of platelets.
70. What is a stem cell?
71. What two types of cells do bone marrow stem cells give rise to?
72. Describe the mechanism that controls erythrocyte production.
73. What is anemia?
74. Describe the process of blood clotting.
75. What is a thrombus?
76. What is atherosclerosis?
77. What is a low-density lipoprotein (LDL)?
78. What is a high-density lipoprotein (HDL)?
79. What does the ratio of LDL:HDL indicate?
80. What is inflammation?
81. What occurs in atherosclerosis?
82. What is a heart attack?

83. What is stroke?
84. What is angina pectoris?
85. What is a stent?
86. What are statins?
87. What does aspirin do?
88. What is hypertension?
89. What is partial pressure?
90. How efficient is human breathing?
91. What is the concentration of oxygen in water?
92. What are gills?
93. What is ventilation?
94. What is countercurrent exchange?
95. What are lamellae?
96. What are parapodia?
97. What is the tracheal system?
98. What are lungs?
99. How does the use of lungs vary among vertebrates?
100. What is the thoracic cavity?
101. What is the larynx?
102. What is the trachea?
103. What keeps the larynx and trachea open?
104. What are vocal folds?
105. What are bronchi?
106. What are bronchioles?
107. What cleanses the respiratory system?
108. What are alveoli?
109. How are alveoli protected from contamination?
110. What is surfactant?
111. What is respiratory distress syndrome (RDS)?
112. What is breathing?
113. What is positive pressure breathing?
114. What are parabronchi?
115. How does ventilation in birds work?
116. What is negative pressure breathing?
117. What is the diaphragm?
118. How does inhalation occur in mammals?
119. Why do the volumes of the lungs and the thoracic cavity change in unison?
120. What is tidal volume?
121. What is the vital capacity?
122. What is the residual volume?
123. Which neurons are responsible for regulating breathing?
124. What effect does blood O_2 level have on breathing control centers?
125. What other part of the brain modulates breathing?

126. **What are respiratory pigments?**
127. **What is hemocyanin?**
128. **What is the respiratory pigment in many invertebrates and almost all vertebrates?**
129. **What is the Bohr shift?**
130. **What enzyme assists the reaction of CO_2 with H_2O?**
131. **What is myoglobin?**

Chapter 42 Answers

1. Random thermal motion
2. It is proportional to the square of the distance
3. Muscular pump that powers circulation, uses metabolic energy to elevate circulatory fluid hydrostatic pressure (pressure fluid exerts on surrounding vessels)
4. Hemolymph is the interstitial fluid/circulatory fluid that bathes body cells, present in arthropods and some molluscs, heart pumps hemolymph through circulatory vessels into sinuses (spaces surrounding organs)
5. Blood = circulatory fluid, confined to vessels and distinct from interstitial fluid. Heart pumps blood into branching vessels that infiltrate tissues, exchange occurs between blood and interstitial fluid and interstitial fluid and body cells. In annelids, cephalopods, and all vertebrates
6. Open - lower hydrostatic pressures, less energy used, can serve additional functions (in spiders used to extend legs)
   Closed - Blood pressure high enough to enable delivery of nutrients in larger/more active animals
7. Heart and blood vessels in vertebrates
8. Carry blood from heart to organs throughout body
9. Branches of arteries within organs
10. Microscopic vessels with thin porous walls, networks form capillary beds that infiltrate tissues (pass within a few cell diameters of every cell in body), get blood from arterioles
11. Convergence at downstream end of capillaries
12. Convergence of venules, vessels that carry blood back to heart
13. Vessels that carry blood between capillary beds in the liver
14. Chambers that receive blood entering heart
15. Chambers responsible for pumping blood out of heart
16. In sharks, rays, and bony fishes, blood travels through body, returns to starting point in single loop. Heart has one atrium, one ventricle. After pumped from heart, blood goes to gills, then sent to rest of body
17. Two circuits of blood flow, in amphibians, reptiles, and mammals. Pumps for two circuits combined into one heart. Right side of heart pumps oxygen poor blood to capillary beds for gas exchange (pulmocutaneous for amphibians cuz uses skin, pulmonary circuit for most vertebrates). Systemic circuit begins with left of heart, pumps oxygen-enriched

blood from gas exchange tissues to capillary beds in organs. Has more blood pressure than single circulation cuz blood slows down in capillary beds

18. Amphibians have one ventricle, ridge in ventricle diverts 90% of oxygen-poor blood to pulmocutaneous circuit, when frog is submerged blood flow to lungs is shut off

    Most reptiles have incomplete septum divides ventricle. Two aortas (major arteries) lead to systemic circulation (control of amount of blood flowing to lungs)

    Crocodilians, ventricles divided by complete septum, pulmonary/systemic connect where arteries exit heart
19. two completely divided ventricles, cannot vary blood flow to lungs without varying blood flow to body
20. Right ventricle pumps blood to lungs by pulmonary arteries. Blood flows through capillary beds in lungs, oxygen rich blood returns from lungs via pulmonary veins to left atrium. Oxygen-rich blood pumped from left ventricle to body tissues through systemic circuit via aorta (conveys blood to arteries leading throughout body, first branches = coronary arteries, supply blood to heart muscle). Branches lead to capillary beds in head and forelimbs. Aorta descends into abdomen, supplys blood to abdominal organs and hind limbs. Venules convey blood to veins that are channeled into vena cavae (superior from head/forelimbs, inferior from trunk/hind limbs) that lead to right atrium
21. Behind sternum (breastbone, size of clenched fist, mostly cardiac muscle). Blood from atria flow into ventricles while all chambers are relaxed, remainder transferred by contraction of atria before ventricular contraction. Ventricles have thicker walls than atria and contract more forcefully (left ventricle especially)
22. Sequence of pumping and filling. Contraction phase = systole, relaxation phase = diastole
23. Volume of blood each ventricle pumps per minute
24. Rate of contraction, number of beats per minute
25. Amount of blood pumped by ventricle in single contraction (average is 70 mL)
26. Flaps of connective tissue, open when pushed from one side and close when pushed from other
27. Lies between atrium and ventricle (closed by contraction of ventricle)
28. Located at two exits of the heart (pulmonary artery and aorta), opened by contraction of ventricle
29. First is recoil of blood against closed AV valves, second is vibrations caused by closing of semilunar valves
30. Irregular sound when blood squirts backward through defective valve
31. Inflammation of heart or other tissues caused by infection with bacteria
32. Cluster of cells near superior vena cava, autorhythmic (contract/relax without signal from nervous system), in wall of right atrium, pacemaker (sets rate and timing at which all cardiac muscle contract
33. Node produces electrical impulses, impulses spread through gap junctions between cardiac cells, generate currents

34. Electrodes placed on skin record currents, measure electrical activity of heart
35. Impulses from SA node first spread through atria (causing contraction), impulses from SA reach other autorhythmic cells in wall between left and right (atrioventricular node). Impulses delayed for 0.1 second, spread to heart apex by bundle of his, splits into bundle branches and spread through ventricles by Purkinje fibers
36. Sympathetic (speeds up pacemaker) and parasympathetic (slows down pacemaker)
37. Increase of 1^{o} C raises heart rate 10 bpm
38. Single layer of flattened epithelial cells that lines lumen of blood vessels
39. Thin walls of an endothelium and surrounding extracellular layer called basal lamina
40. Outer layer is connective tissue that contains elastic fibers (recoil) and collagen (strength). Smooth muscles and elastic fibers in middle layer

    Arterial: Thick, strong, elastic, smooth muscles regulate path of blood flow
    Veins: Third as thick as artery, have valves (maintain unidirectional flow despite low blood pressure
41. Slows down from arteries to capillaries, (travels 500 times slower in capillaries (0.1 cm/s) than aorta (48 cm/s)), speeds up from capillaries to veins/venules
42. Heart contracts during ventricular systole
43. Pressure at ventricular systole
44. Rhythmic bulging of artery walls
45. Pressure when ventricles relaxed, substantial because elastic walls of arteries snap back
46. Contraction of smooth muscles in arteriole walls, increases blood pressure upstream of arteries, most induced by endothelin (peptide)
    Dilation of arterioles, causes blood pressure to fall, induced by nitric oxide (NO) gas
47. 120 mm Hg at systole, 70 Hg at diastole (120/70), pulmonary pressure 6-10x lower
48. When nervous system detects that blood pressure in brain is below level needed for adequate blood flow (places head at level of heart)
49. Using a sphygmomanometer (inflatable cuff attached to pressure gauge, measure blood pressure in artery). Cuff inflated until pressure closes artery. Cuff allowed to deflate gradually. When pressure by cuff falls below that in artery, blood pulses into forearm generating sounds that can be heard by stethoscope (pressure measured at this point is the systolic pressure). Cuff allowed to deflate further until blood flows freely, pressure is diastolic pressure
50. Constriction/dilation of arterioles that supply bed. Precapillary sphincters (rings of smooth muscle.
51. REleased by cells at a wound site, causes vasodilation, increasing blood flow and access of wb cells to invading microorganisms
52. Blood pressure drives out fluid, blood protein presence pulls fluid back, blood pressure greater so net loss
53. Recovers and returns lost fluids and proteins
54. Fluid recovered from capillaries, circulates within lymphatic system then drains into large veins of cardiovascular system at base of neck
55. Fluid accumulation

56. Extreme swelling of body parts
57. Small, lymph-filtering organs, have honeycomb of connective tissue with spaces filled by white blood cells. During infections, wb cells multiply rapidly, causing nodes to become swollen/tender
58. Liquid matrix in which cells are suspended to make up blood (55%)
59. E.g. albumins, buffer against pH changes, maintain osmotic balance between blood/interstitial fluid.
60. Form of dissolved ions, som buffer blood, others maintain osmotic balance, all affect composition of interstitial fluid
61. Combat viruses and other foreign agents
62. Escort lipids (insoluble in water and need to be bound to proteins)
63. Clotting factors that help plug leaks when blood vessels are injured (serum = blood plasma without fibrinogens)
64. Cell fragments that are involved in the clotting process
65. Red blood cells, most numerous, mainly for O_2 transport, biconcave (thinner in center than edges), are small disks (7-8 μm in diameter), lack nuclei when mature (in mammals) for more space for hemoglobin (iron containing protein that transports O_2, about 250 million molecules per cell), lack mitochondria (use anaerobic metabolism)
66. Abnormal form of hemoglobin (Hb^S) polymerizes into aggregates, distort erythrocyte into elongated curved shape, lodge in arterioles, preventing delivery of O_2. Average life span of sickle is 20 days, normal 120 days
67. White blood cells, fight infection, some engulf/digest microorganisms/debris from body's own dead cells, others (lymphocytes) mount immune responses against foreign substances, 5000-10000 per μL
68. Basophils, Eosinophils, Neutrophils, Monocytes, and lymphocytes
69. Pinched-off cytoplasmic fragments of specialized bone marrow cells (2-3 μm in diameter, no nuclei
70. Indefinitely reproducing (one daughter cell remains stem cell other adopts specialized function), ones that produce cellular elements of blood cells are in red marrow of bones (i.e. ribs, vertebrae, sternum, pelvis)
71. Progenitor cells (more limited capacity for self-renewal)
    Lymphoid progenitors produce lymphocytes (B and T cells)
    Myeloid progenitors produce all other wbcs, rbcs, and platelets
72. If O_2 levels fall, kidneys synthesize and secrete a hormone called erythropoietin (EPO), stimulates generation of more erythrocytes
73. Lower-than-normal erythrocyte or hemoglobin levels that decreases oxygen-carrying capacity of blood
74. Coagulant circulates in inactive form (fibrinogen). When injury exposes protein in broken blood vessel wall to blood constituents, protein attracts platelets (gather at site of injury, release clotting factors). Clotting factors lead to formation of active thrombin from inactive prothrombin. Thrombin converts fibrinogen to fibrin (aggregates into threads that form framework of clot) and stimulates conversion of prothrombin to thrombin

75. Clot that form within a blood vessel and block flow of blood, usually prevented by anti clotting factors in blood
76. Hardening of arteries by accumulation of fatty deposits
77. Type of particle that consists of thousands of cholesterol molecules and other lipids bound to a protein. Delivers cholesterol to cells for membrane production.
78. thousands of cholesterol molecules and other lipids bound to a protein, scavenges excess cholesterol for return to the liver
79. High ratio means increased risk for atherosclerosis
80. Body's reaction to injury
81. Damaged arteries cause leukocytes attracted to area and take up lipids. Fatty deposit (plaque) grows by incorporating fibrous connective tissue and cholesterol (walls of artery become thick/stiff). If plaque ruptures, thrombus can form
82. Myocardial infarction, damage or death of cardiac muscle tissue from blockage of one or more coronary arteries (supply oxygen to heart muscle), coronary are small in diameter (especially vulnerable)
83. Death of nervous tissue in brain due to lack of O_2. Result from rupture/blockage of arteries in head.
84. Partial blockage of arteries (may cause occasional chest pain)
85. Mesh tube used to expand artery
86. Drugs that lower LDL levels
87. Inhibits inflammatory response, found to help prevent recurrence of heart attacks/stroke
88. High blood pressure, above 140 mm Hg / 90 mm Hg
89. Pressure exerted by a particular gas in a mixture of gases
90. Extracts 25% of O_2 in inhaled air
91. 7 mL/L
92. Outfoldings of the body surface that are suspended in water
93. Movement of respiratory medium over respirator surface, maintains partial pressure gradients of O_2 and CO_2 across gill necessary for gas exchange
94. Exchange of a substance or heat between two fluids flowing in opposite directions, causes 80% of O_2 to be absorbed
95. Flattened plates that make up gill filaments
96. Flattened appendages in polychaetes, serve as gills, function in crawling/swimming
97. Network of air tubes that branch throughout body in insects. Largest tubes (tracheae) open to outside, brings air within short distance of virtually every body cell in insect
98. Localized respiratory organs, typically subdivided into numerous pockets, gap between lungs and rest of body bridged by circulatory system
99. Amphibians rely heavily on diffusion across external body surfaces
    Most reptiles (all birds) and all mammals rely entirely on lungs
    Turtles supplement lung breathing with gas exchange across surfaces continuous with mouth/anus
100. Location of lungs, enclosed by ribs and diaphragm
101. Upper part of respiratory tract, moves upward and tips epiglottis over glottis (opening of windpipe) when food is swallowed

102. Windpipe
103. Reinforcement of walls by cartilage
104. Pair of elastic bands of muscle, exhaled air rushes past within larynx, sounds produced when muscles in larynx tense and stretch cords.
105. The two branches of trachea, one leads to each lung
106. Finer and finer tubes into which bronchi branch
107. Mucus traps particulate contaminants, beating of cilia move mucus to pharynx where it can be swallowed into esophagus
108. Air sacs clustered at tips of tiniest bronchioles, millions in lungs, together have surface area of 100 m^2
109. White blood cells patrol alveoli
110. Mixture of phospholipids and proteins produced by alveoli that coats alveoli and reduces surface tension to prevent collapse
111. Disease common in infants born 6 weeks or more before due dates, surfactant only appears in 33 weeks (average pregnancy is 38 weeks)
112. Alternating inhalation and exhalation of air that ventilates lungs
113. Inflating lungs with forced air flow, muscles lower floor of amphibians oral cavity, draws in air through nostrils. Nostrils/mouth closes, floor of oral cavity rises, forces air down trachea. Air expelled by elastic recoil of lungs/compression of body wall
114. Tiny channels in lungs that serve as sites of gas exchange in birds
115. see picture, very efficient (incoming fresh air does not mix with air that has already carried out gas exchange)
116. Pulling air into lungs, in mammals, muscle contraction expands thoracic cavity.
117. Sheet of skeletal muscle that forms bottom wall of cavity
118. Rib muscles pull ribs up and sternum out, expanding rib cage (front wall of cavity). Diaphragm contracts, expanding cavity down.
119. Double membrane (pleural sacs) surrounds lungs, thin space between membranes filled with fluid, surface tension causes layers to stick together (can slide smoothly, but can't be separated). Outer layer adheres to wall of thoracic cavity
120. Volume of air inhaled and exhaled with each breath (resting humans = 500 mL)
121. Tidal volume during maximal inhalation and exhalation (3.4/4.8 L college women/men)
122. Air that remains after a forced exhalation
123. Those in medulla oblongata (near base of brain), neural circuits form pair of breathing control centers that establish rhythm. Negative feedback mechanism prevents lungs from overexpanding. Uses pH of fluid in which it is bathed to determine CO_2 concentration in blood (main determinant of pH of cerebrospinal fluid (fluid surrounding brain/spinal cord))
124. Little effect, but when drops very low, sensors in aorta and carotid arteries in neck send signals to BCCs, respond by increasing breathing rates
125. The pons (part of brain next to medulla)

126. Proteins to which O_2 binds, circulate with blood or hemolymph, contained within specialized cells, increase amount of O_2 that can be carried, have color and consist of metal bound to protein
127. Blue pigment, has copper as oxygen-binding component, found in arthropods and many molluscs
128. Hemoglobin, in erythrocytes in vertebrates, four subunits, each of polypeptide and heme group (cofactor with iron atom at center, each binds to molecule of O_2). Cooperativity between subunits.
129. Low pH decreases the affinity of hemoglobin for O_2, where CO_2 production greater, hemoglobin releases more O_2
130. Carbonic anhydrase
131. Oxygen-storing protein at high concentrations in muscles of diving mammals