CHAPTER 18 READING QUESTIONS

These reading questions are designed to help you focus your reading on the most important points in the chapter. They are arranged using chapter section headers so that the file can be easily edited to reflect the material covered in class.

- 1. Identify the main components of exchange and transport of O₂ and CO₂. (Fig. 18.1)
- 2. What three variables of arterial blood composition are monitored and regulated to prevent hypoxia and hypercapnia? (Tbl. 18.2)

18.1 Gas Exchange in the Lungs and Tissues

- 3. Give the following partial pressures for P_{O2} and P_{CO2} in a normal person at sea level: atmospheric air, alveoli, arterial blood, resting cells, venous blood (Fig. 18.2; Tbl. 18.2)
- 4. If the alveolar P_{02} is 98 mm Hg, what will the arterial P_{02} be? Why?

Lower Alveolar P₀₂ Decreases Oxygen Uptake

Composition of the Inspired Air

5. Explain the relationship between altitude and P_{O2} .

Alveolar Ventilation

6. What are the pathological factors that cause hypoventilation? (Fig. 18.3c)

Diffusion Problems Cause Hypoxia

- 7. What two cell layers must gases cross to go from the alveoli to the plasma? (Fig. 18.3b)
- 8. Write the mathematical expression that relates diffusion rate to surface area, concentration gradient, barrier permeability, and diffusion distance.
- 9. List the pathological changes that adversely affect gas exchange.

Surface Area

10. Explain how emphysema can result in a high-compliance, low-elastance lung with reduced alveolar surface area. (Fig. 18.3c)

Diffusion Barrier Permeability

11. How much of the exchange epithelium must be incapacitated before arterial P_{02} drops significantly?

Diffusion Distance

- 12. What causes pulmonary edema and how does it alter gas exchange? (Fig. 18.3b, c)
- 13. Explain alveolar flooding and adult respiratory distress syndrome (ARDS).

Gas Solubility Affects Diffusion

- 14. When a gas is placed in contact with a liquid, what three factors determine how much gas will dissolve in the liquid?
- 15. True or false: If a liquid is exposed to a P_{CO2} of 100 mm Hg and a P_{O2} of 100 mm Hg, equal amounts of oxygen and carbon dioxide will dissolve in the liquid. Defend your answer. (Fig. 18.4)
- 16. The more soluble a gas is in a particular liquid, the _____ (higher or lower?) the partial pressure required to force the gas into solution.
- 17. Gases move between liquid and gaseous phases until is reached. (Fig. 18.4)
- 18. True or false: At equilibrium, the concentration of O_2 in the gaseous phase will be equal to the concentration of O_2 in the liquid phase. Defend your answer. (Fig. 18.4)

18.2 GAS TRANSPORT IN THE BLOOD

19. Where is most of the arterial O_2 found? (Fig. 18.5)

20.	If mass flow = concentration \square vo	olume flow, then show how	you would calculate the
mas	ss flow of oxygen traveling from the	e lungs to the cells. (Fig. 18.	.6)
21.	Relate oxygen consumption (Q ₀₂)	, cardiac output (CO), and b	blood oxygen content
usir	ng the Fick equation. (Fig. 18.6)		
Hemoglo	obin Binds to Oxygen		
22.	Complete the following equation ((Fig. 18.5):	
	Total blood O ₂ content =	+	
23.	Hemoglobin molecules are compo	osed of (how many?)	protein subunits.
Eac	ch subunit contains a	group that can bind wea	akly to oxygen.
24.	Hb bound to O ₂ is called	, written as	HbO_2 , or $Hb(O_2)_{1-4}$.
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	30.	What is the physiological significance of the shape of the oxyhemoglobin saturation		
	curv	ve at P _{O2} values between 40 and 100 mm Hg? (Fig. 18.9)		
	31.	Below $P_{\rm O2}$ of 40 mm Hg, where the curve is steeper, small changes in $P_{\rm O2}$ cause		
	rela	tively (small or large?) releases of O_2 from hemoglobin. (Fig. 18.9)		
Sev	eral l	Factors Affect O ₂ -Hb Binding		
	32.	An increase in pH (increases or decreases?) Hb's affinity for oxygen.		
	Wh	at is the Bohr effect? (Fig. 18.9c)		
	33.	An increase in temperature (increases or decreases?) Hb's affinity for		
	oxy	gen. (Fig. 18.9d)		
	34.	An increase in P_{CO2} (increases or decreases?) Hb's affinity for oxygen.		
	(Fig	g. 18.9e)		
	35.	The metabolite 2,3-BPG (increases or decreases?) Hb's affinity for		
	oxy	gen. What triggers an increase in 2,3-BPG production? (Fig. 18.9f)		
	36.	Fetal Hb has a/an (increased or decreased?) affinity for oxygen relative		
	to th	ne maternal hemoglobin. (Fig. 18.9b)		
	37.	A left shift in the curve indicates (increased or decreased?) binding		
	affir	nity.		
	38.	A right shift in the curve indicates (increased or decreased?) binding		
	affir	nity.		
Carbon Dioxide Is Transported in Three Ways				
	39.	Why is it important that CO ₂ be removed from the body?		
	40.	List the three ways CO ₂ is transported in the blood. (Fig. 18.11)		

CO₂ and Bicarbonate Ions

- 41. What two purposes does the conversion of CO₂ to HCO₃⁻ serve?
- 42. Write the equation in which CO₂ is converted into bicarbonate ion (HCO₃⁻) and H⁺.

What enzyme catalyzes this reaction, and where in the blood is it found?

- 43. Why must H⁺ and HCO₃⁻ be removed from RBC cytoplasm?
- 44. What is the chloride shift and what does it accomplish?

Hemoglobin and H+

- 45. What is respiratory acidosis?
- 46. How does Hb help prevent this condition?

Hemoglobin and CO₂

47. What facilitates the formation of carbaminohemoglobin? How? (Fig. 18.9)

CO₂ Removal at the Lungs

48. Diagram CO₂ removal at the lungs and how this removal influences other CO₂ transport mechanisms to effectively remove CO₂ from the body. (Fig. 18.11, bottom)

18.3 REGULATION OF VENTILATION

- 49. Contrast the rhythmicity and control of breathing to that of the heartbeat.
- 50. What is a central pattern generator?
- 51. Based on the contemporary model, describe what we currently know about neural control of breathing. (Fig. 18.13)

Neurons in the Medulla Control Breathing

52. Diagram the complex interactions of medullary neurons that exert influence on respiration. Your diagram should include the following terms: nucleus tractus solitarius,

dorsal respiratory group (DRG), phrenic nerves, intercostal nerves, intercostal muscles, vagus and glossopharyngeal nerves, pontine respiratory groups, ventral respiratory group (VRG), pre-Bötzinger complex, quiet breathing, forced breathing. (Figs. 18.13, 18.14, 18.15)

53. In the context of respiratory neurophysiology, what is ramping? (Fig. 18.15)

CO2, Oxygen, and pH Influence Ventilation

- 54. What is the primary chemical stimulus for changes in ventilation?
- 55. Explain the strategic significance of the location of the peripheral chemoreceptors. (Fig. 18.13)

Peripheral Chemoreceptors

- 56. What chemical signals activate the carotid and aortic bodies?
- 57. Diagram the basic mechanism by which the carotid and aortic bodies respond to stimuli. (Fig. 18.16) What area of the brain integrates this sensory information? What is the homeostatic response that is initiated?

Central Chemoreceptors

- 58. Diagram how the central chemoreceptors respond to elevated blood P_{CO2} . (Fig. 18.17)
- 59. If a person has chronic hypercapnia and hypoxia, is CO_2 the primary chemical drive for ventilation? Why? What will happen to ventilation if this person with chronic hypercapnia and hypoxia is given pure O_2 to breathe? Explain.

Protective Reflexes Guard the Lungs

- 60. Describe the reflex response to an inhaled irritant.
- 61. Describe the Hering-Breuer inflation reflex.

Higher Brain Centers Affect Patterns of Ventilation

62.	Give two examples of how higher brain centers can influence ventilation.