Respiratory Physiology Powerpoint with Quiz questions and FEEDBACK

by Dr. Patricia Mansfield

Written Fall, 2006

Revised Fall, 2007

All figures from Silverthorn's Human Physiology

GENERAL OVERVIEW OF TOPICS CONSIDERED IN CHAPTER 18—

BUZZWORDS: EXCHANGE AND TRANSPORT

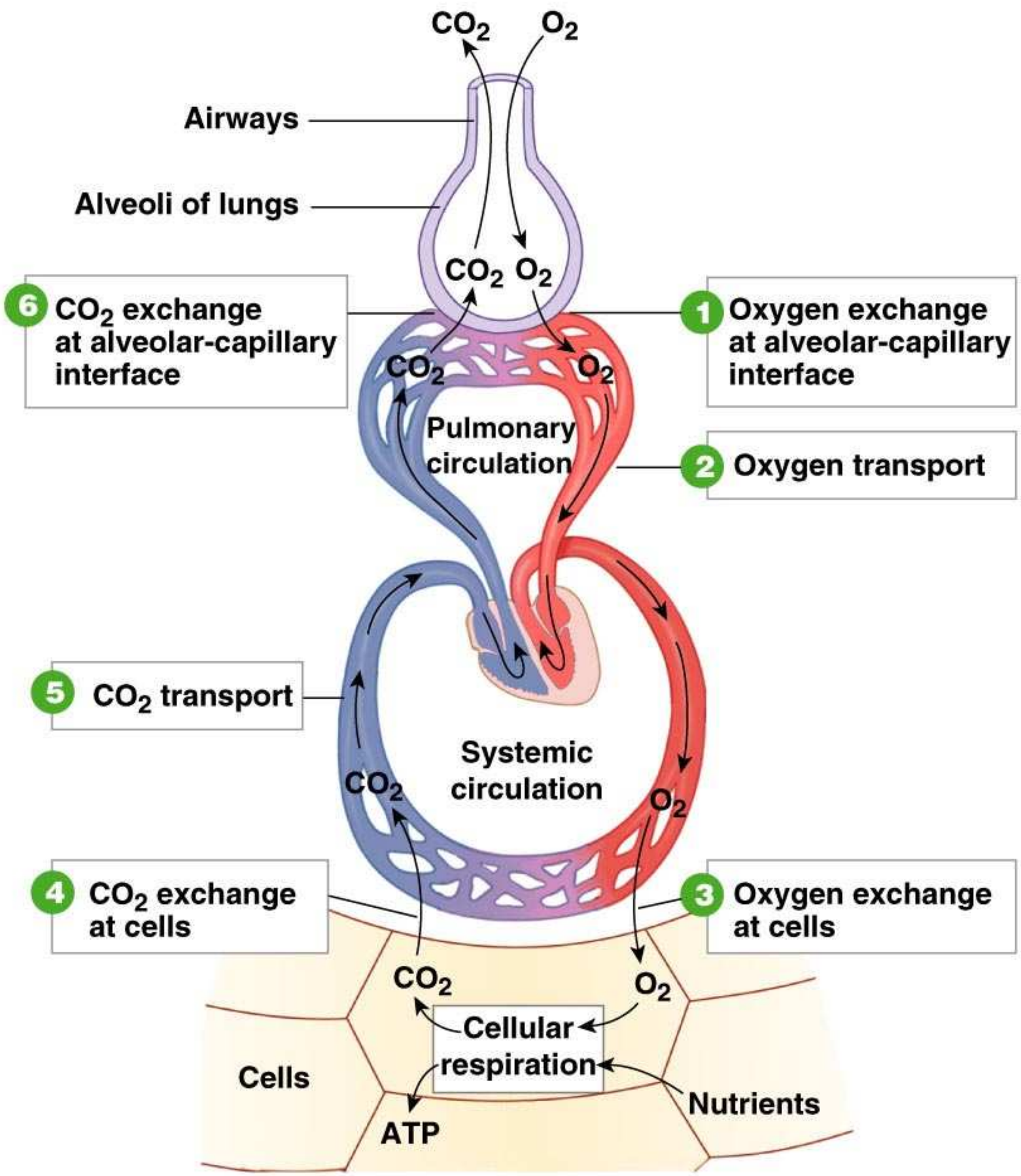

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Figure 18-1 - Overview

Question #1-#4

- List the 4 rules for diffusion of gasses in any order.

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- Surface area
- Thickness
- Concentration
- Distance

TABLE 5-1 Rules for Diffusion of Uncharged Molecules

General Properties of Diffusion

1. Diffusion uses the kinetic energy of molecular movement and does not require an outside energy source.
2. Molecules diffuse from an area of higher concentration to an area of lower concentration.
3. Diffusion continues until concentrations come to equilibrium. Molecular movement continues, however, after equilibrium has been reached.
4. Diffusion is faster
   - with higher concentration gradients.
   - over shorter distances.
   - at higher temperatures.
   - for smaller molecules.
5. Diffusion can take place in an open system or across a partition that separates two systems.

Simple Diffusion Across a Membrane

6. The rate of diffusion through a membrane is faster if
   - the membrane's surface area is larger.
   - the membrane is thinner.
   - the concentration gradient is larger.
   - the membrane is more permeable to the molecule.
7. Membrane permeability to a molecule depends on
   - the molecule's lipid solubility.
   - the molecule's size.
   - the lipid composition of the membrane.

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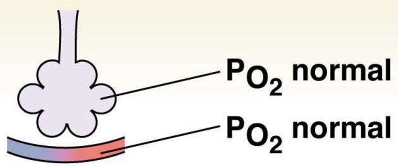
Table 5-1

UNDERSTANDING DIFFUSION CAN HELP YOU IN PATHOPHYSIOLOGY

(a) Normal lung



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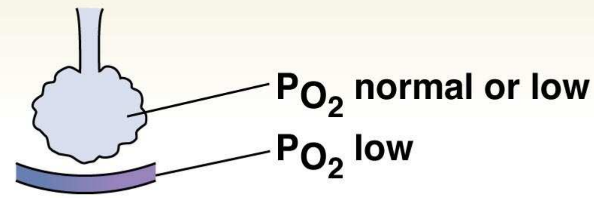
(b) Emphysema: destruction of alveoli reduces surface area for gas exchange.



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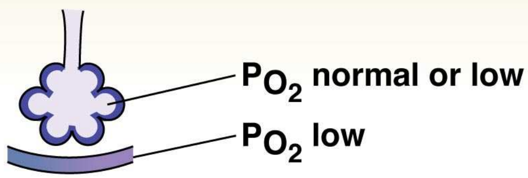
(c) Fibrotic lung disease: thickened alveolar membrane slows gas exchange. Loss of lung compliance may decrease alveolar ventilation.



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(d) Pulmonary edema: fluid in interstitial space increases diffusion distance. Arterial P_{CO_2} may be normal due to higher CO_2 solubility in water.

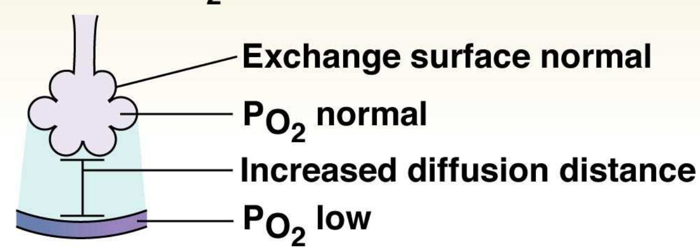

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Figure 18-4a

What effect does increased airway resistance have on the concentration gradient for diffusion?

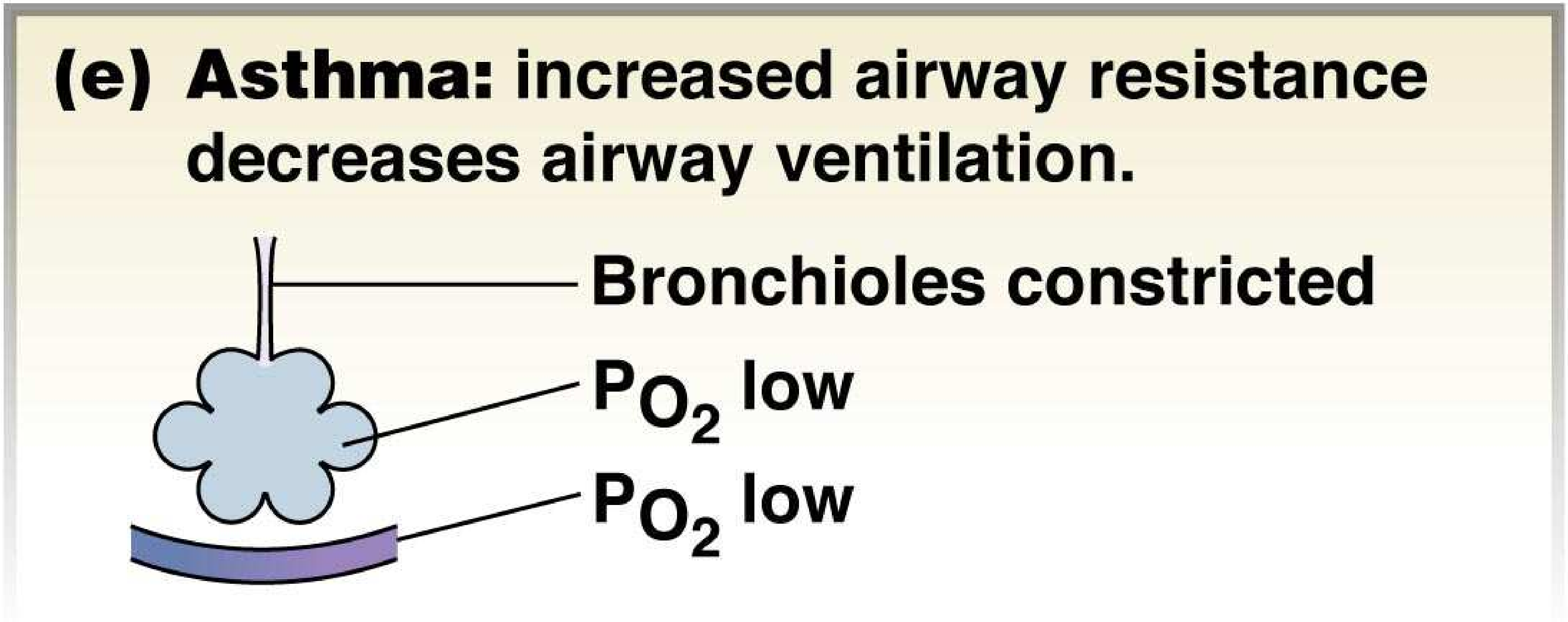

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Figure 18-4e

Question #5.

- The more soluble a gas is in a particular liquid, the (HIGHER OR LOWER) the partial pressure required to force the gas into solution.

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- LOWER

Solubilities or Bunsen's solubility coefficients for gasses in body-warm blood. ***Ignore units at standard measurement conditions.***

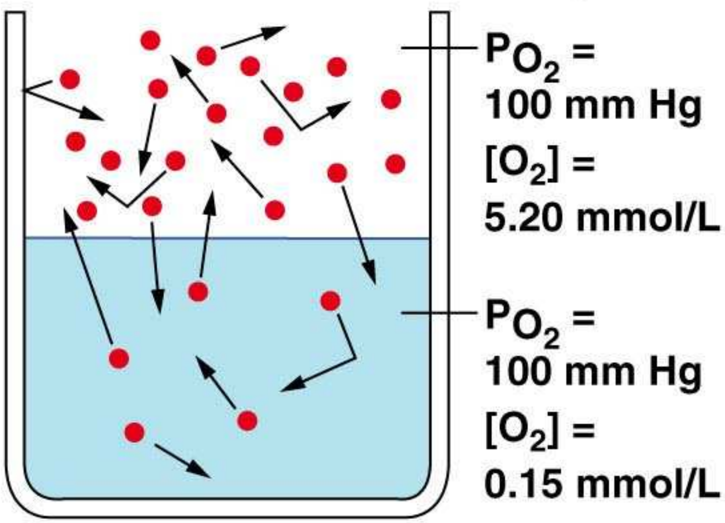
Carbon dioxide:0.52

Carbon monoxide:0.018

Nitrogen: 0.012 (Water: 0.013; Fat: 0.065)

Oxygen:0.022

(c) At equilibrium, P_{O_2} in air and water is equal. Low O_2 solubility means concentrations are not equal.



(d) When CO_2 is at equilibrium at the same partial pressure, more CO_2 dissolves.

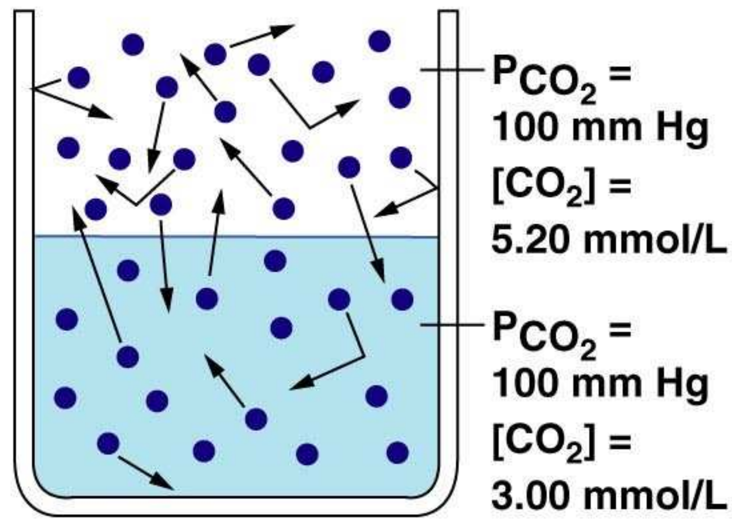


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Figure 18-2c–d

Question #6-7.

- Which two **cell** layers must gases cross to go from the alveoli to the plasma? (any order)

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- Alveolar epithelium
- Capillary endothelium aka capillary simple squamous epithelium

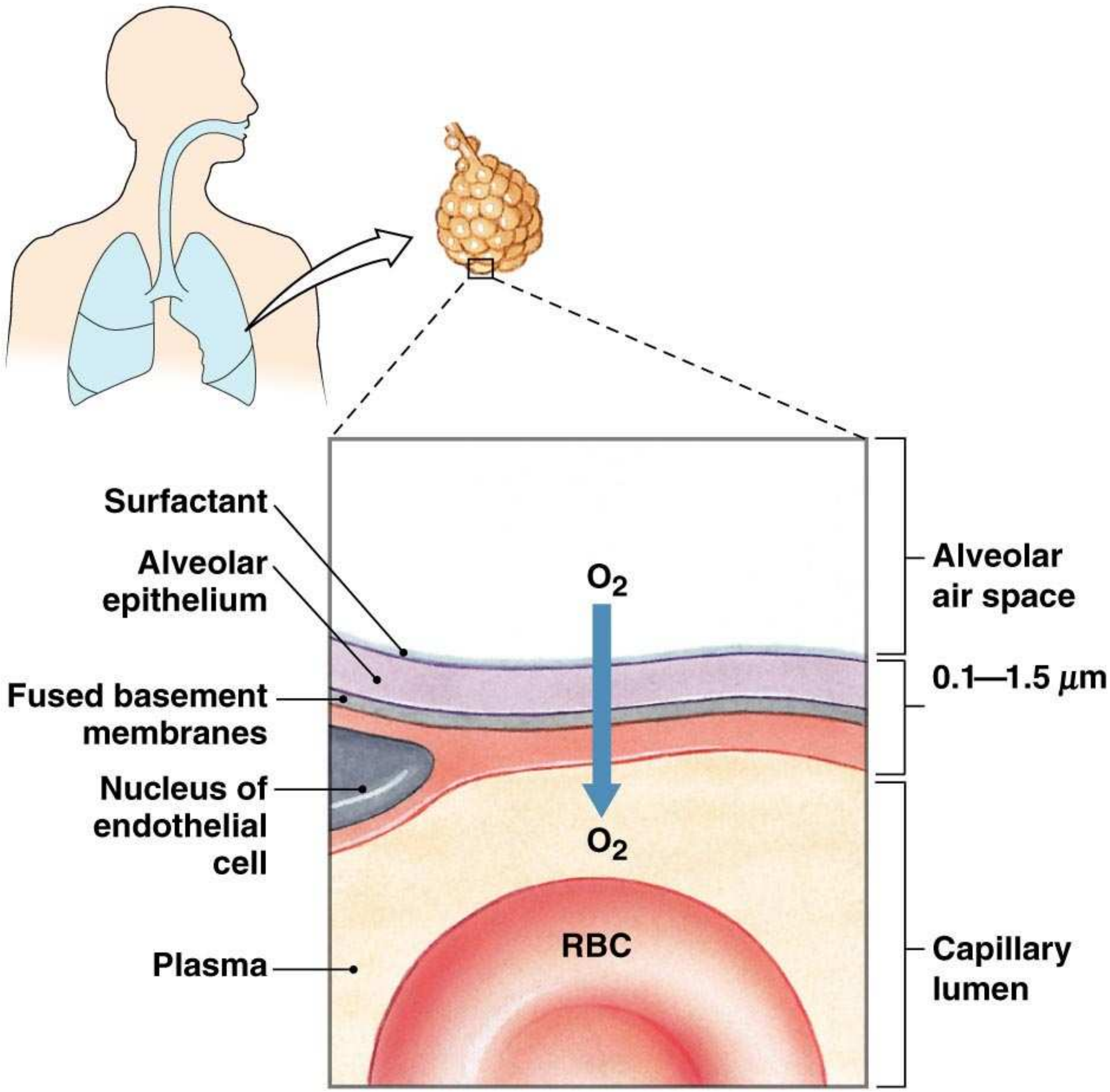

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Figure 18-5

Question #8.

- In some cases of pulmonary edema, arterial PO_2 is low but arterial PCO_2 is normal. What difference between the two gases explains this clinical phenomenon?

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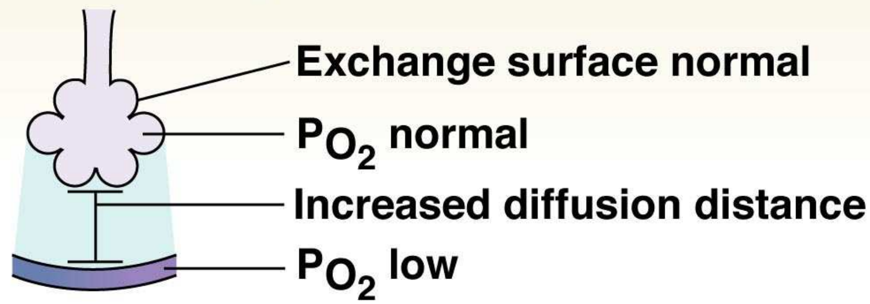
(d) Pulmonary edema: fluid in interstitial space increases diffusion distance. Arterial P_{CO_2} may be normal due to higher CO_2 solubility in water.



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Answer to Question #8. Solubility

- Solubilities or Bunsen's solubility coefficients for gasses in body-warm blood. *Ignore units at standard measurement conditions.*
- Carbon dioxide:0.52
- Carbon monoxide:0.018
- Nitrogen: 0.012 (Water: 0.013; Fat: 0.065)
- Oxygen:0.022

Note: Learn the principle. Don't memorize the table.

Question #9.

- What is the name for hemoglobin bound to oxygen?

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- Oxyhemoglobin
- $Hb{\cdot}O_2$

Buzz Words:

1. Loading Reaction

2. Unloading Reaction

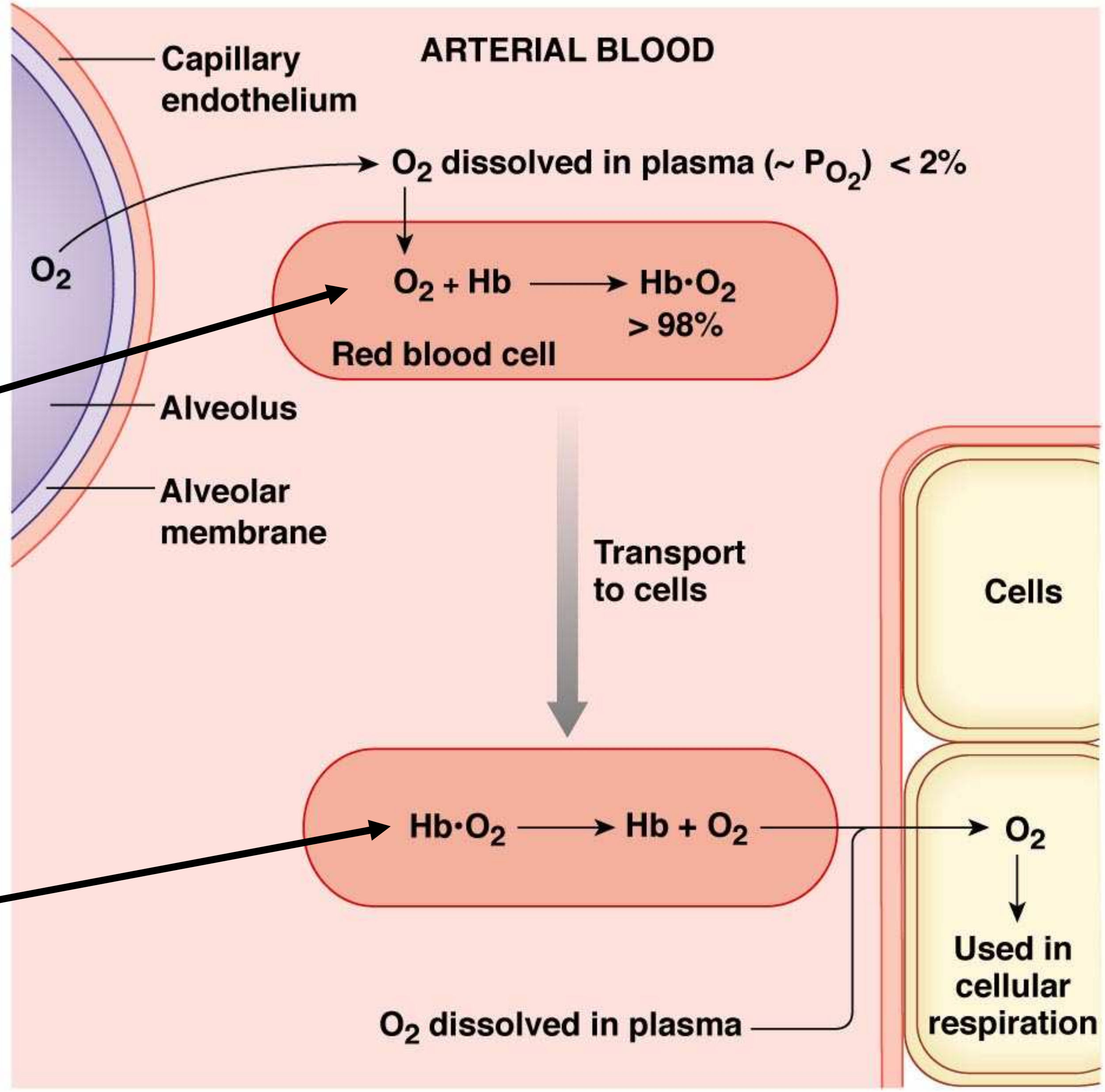

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Figure 18-6

Question #10.

- What determines the number of binding sites for oxygen?

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- Number of hemoglobin molecules

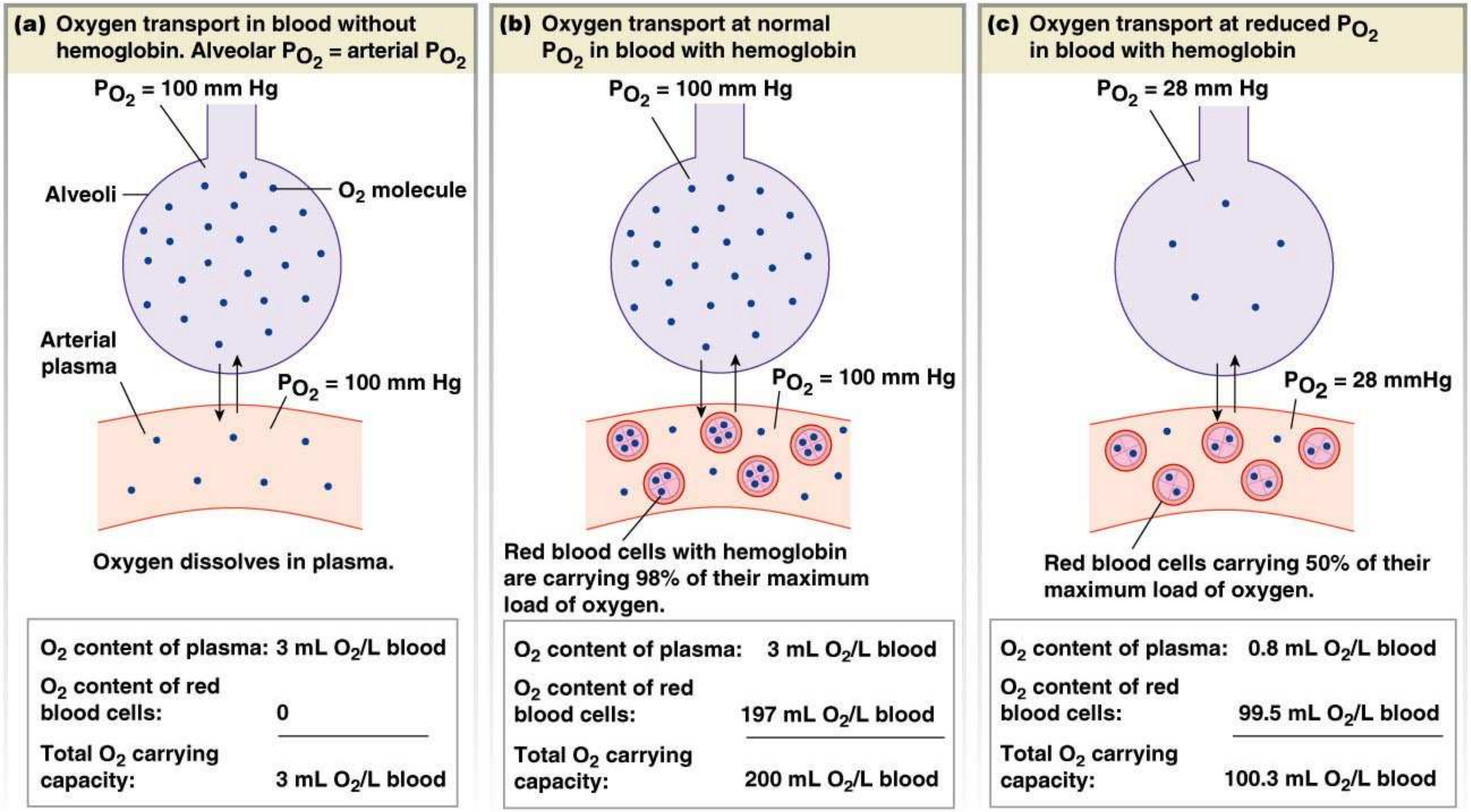

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Figure 18-7 - Overview

Question #11.

- About 70% of what element is found in the center of the heme group of hemoglobin?

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- Iron

(a) A hemoglobin molecule is composed of four protein globin chains, each surrounding a central heme group.

(b) Each heme group consists of a porphyrin ring with an iron atom in the center.

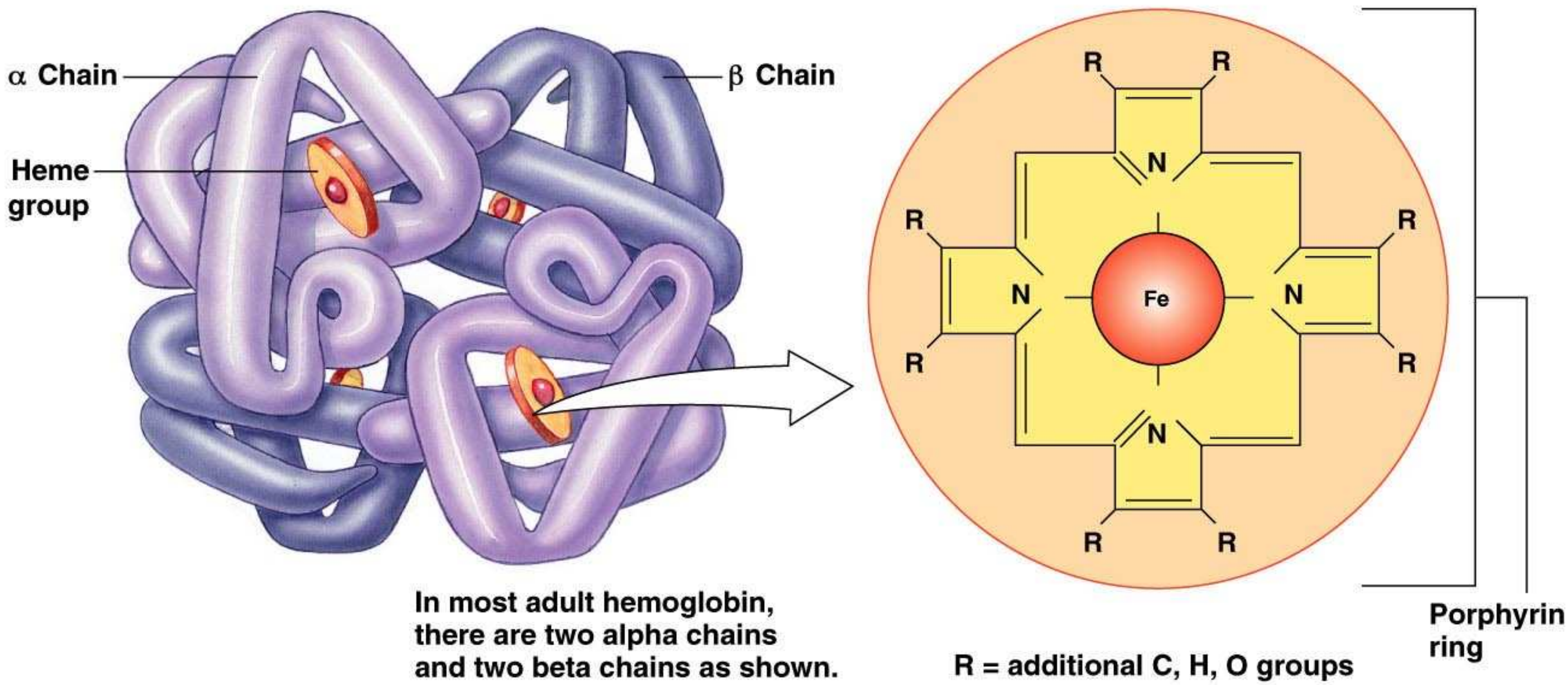

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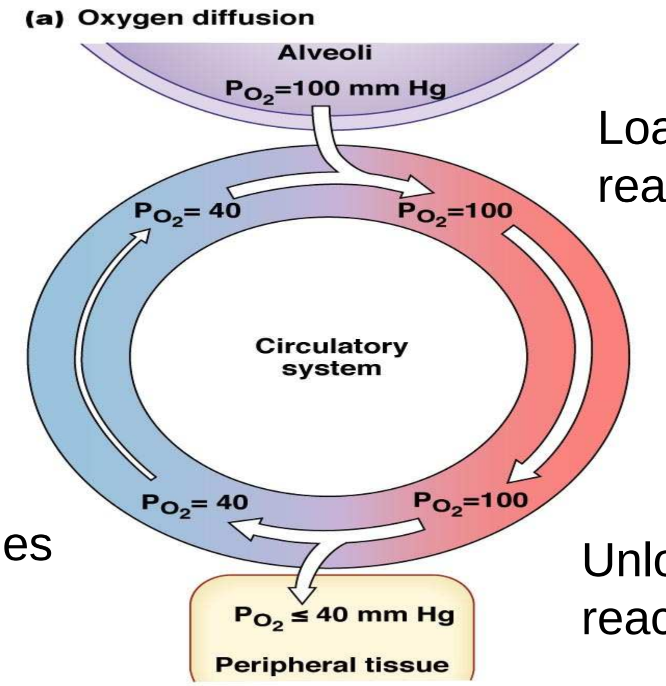
Figure 18-8 - Overview

Question #12.

- What is the name of the graph that indicates the relationship between PO2 levels and how much oxygen binds to hemoglobin?
- Oxyhemoglobin dissociation curve



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Loading reaction

Unloading reaction

Normal PO2 values *in situ*

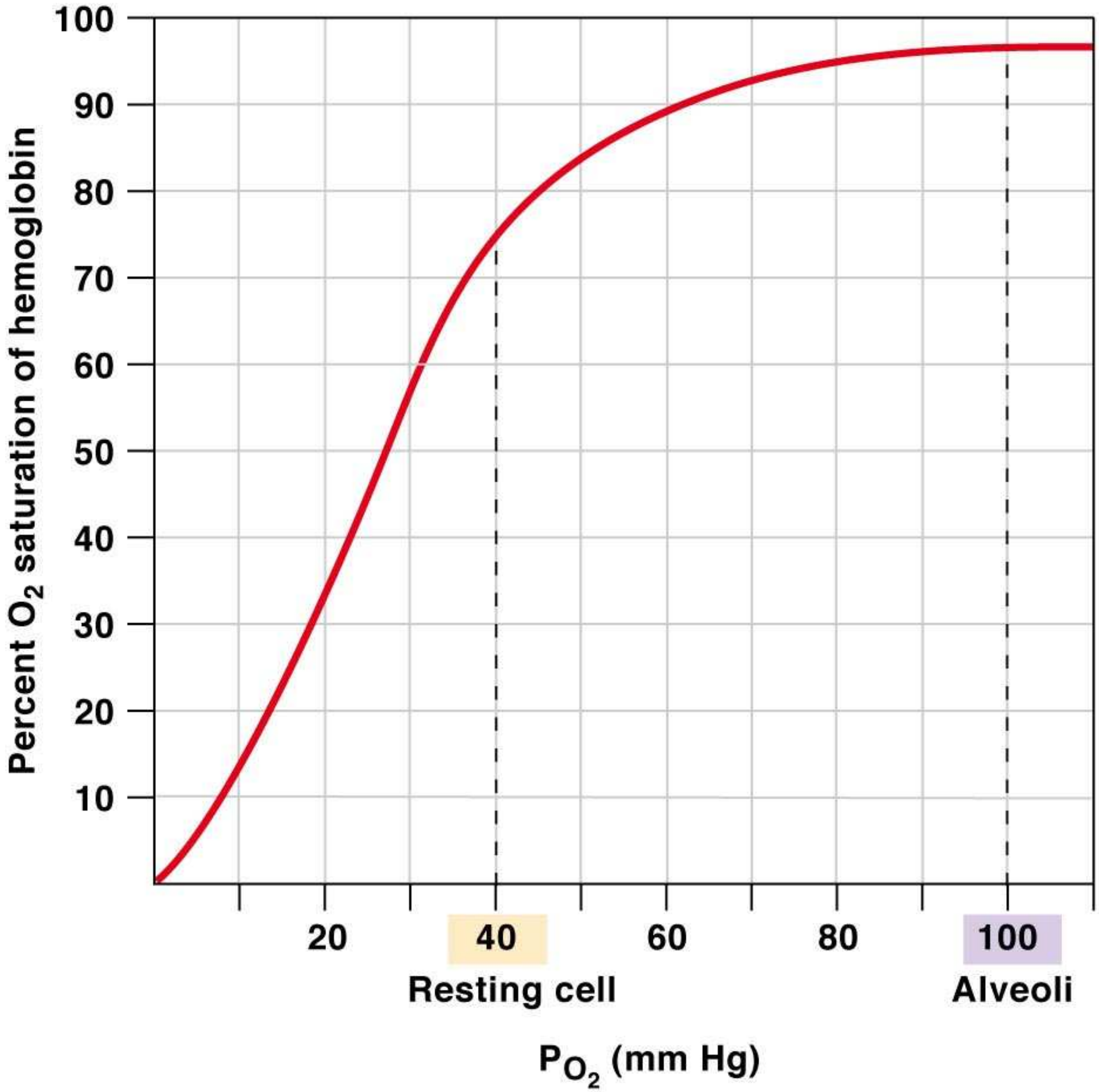

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Figure 18-9

Question #13-15.

- Which three factors affect the ability of hemoglobin to bind to oxygen? (any order)

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- Temperature
- pH
- Metabolite specifically

  2,3-DPG

(b) Effect of temperature

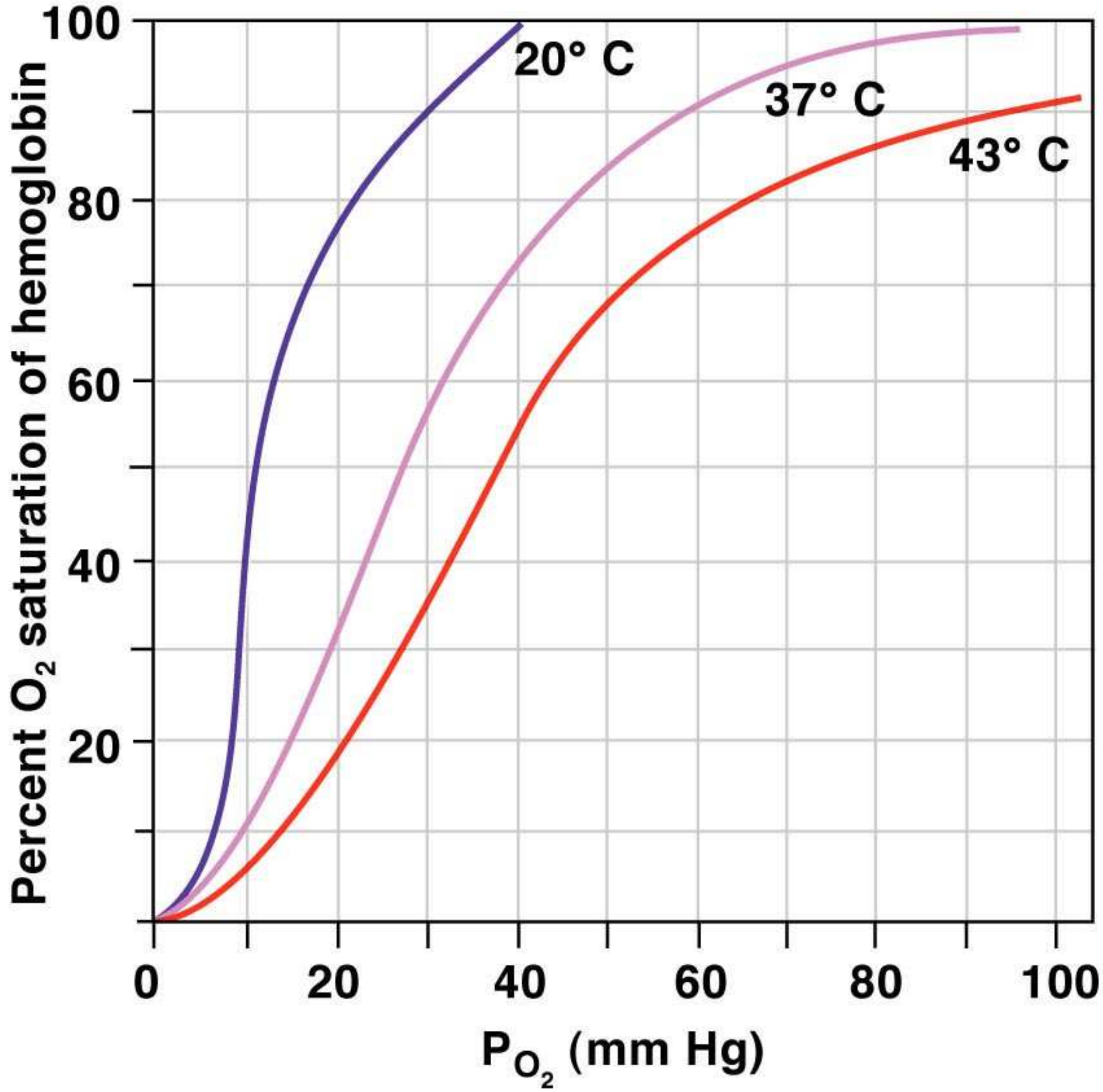

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Figure 18-10b

•**Effects of 2,3-DPG**. 2,3-diphosphoglycerate, or 2,3-DPG, is an organophosphate created in erythrocytes during glycolysis.

2,3-DPG binds to deoxyhemoglobin but not the oxygenated form, therefore diminishing the oxygen affinity for hemoglobin. This reaction enables hemoglobin to unload oxygen at the tissues.

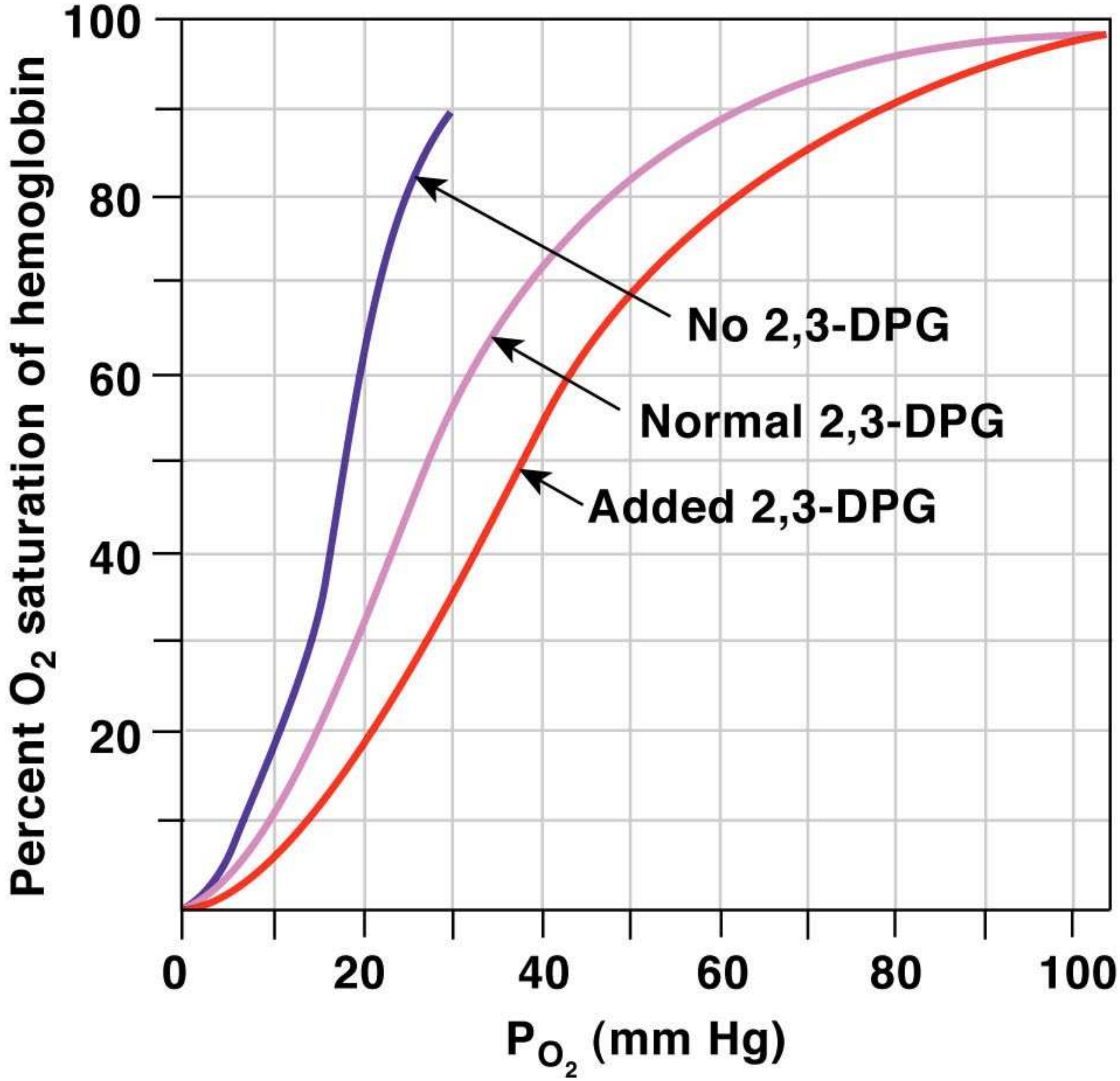

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Figure 18-11

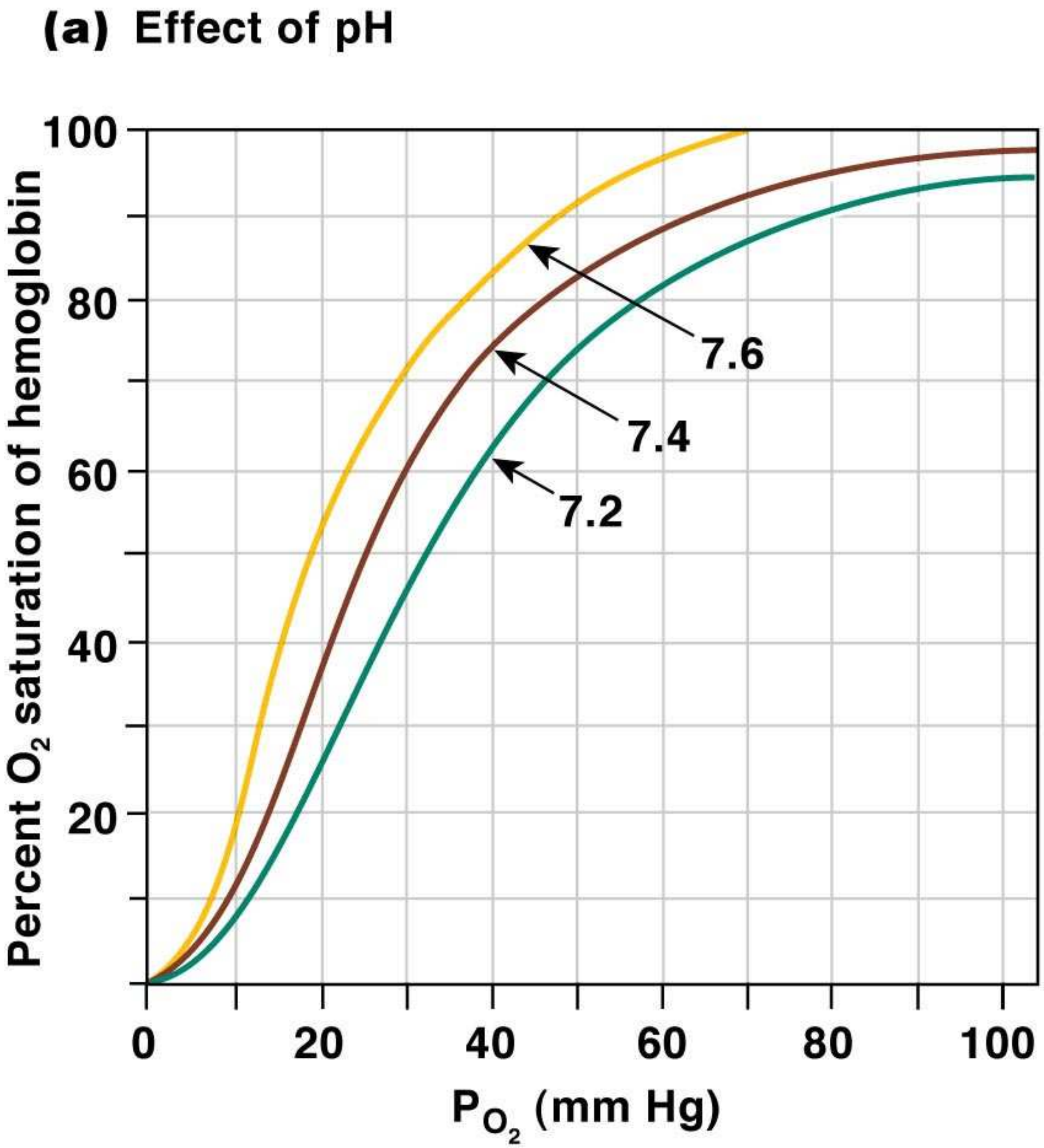

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Figure 18-10a

Normal P_{co2} values *in situ*

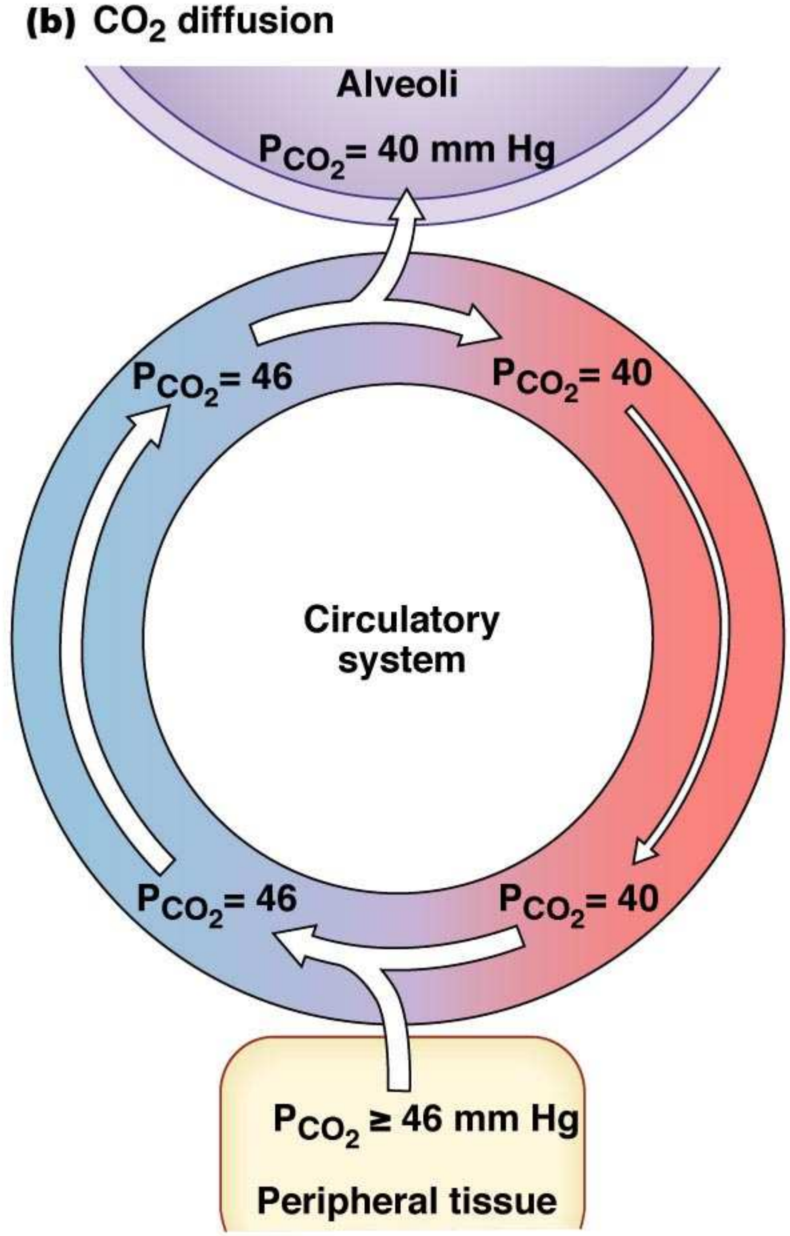

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Figure 18-3b

- Interactive Dissociation Tool at

  http://www.ventworld.com/resources/oxydisso/oxydisso.html

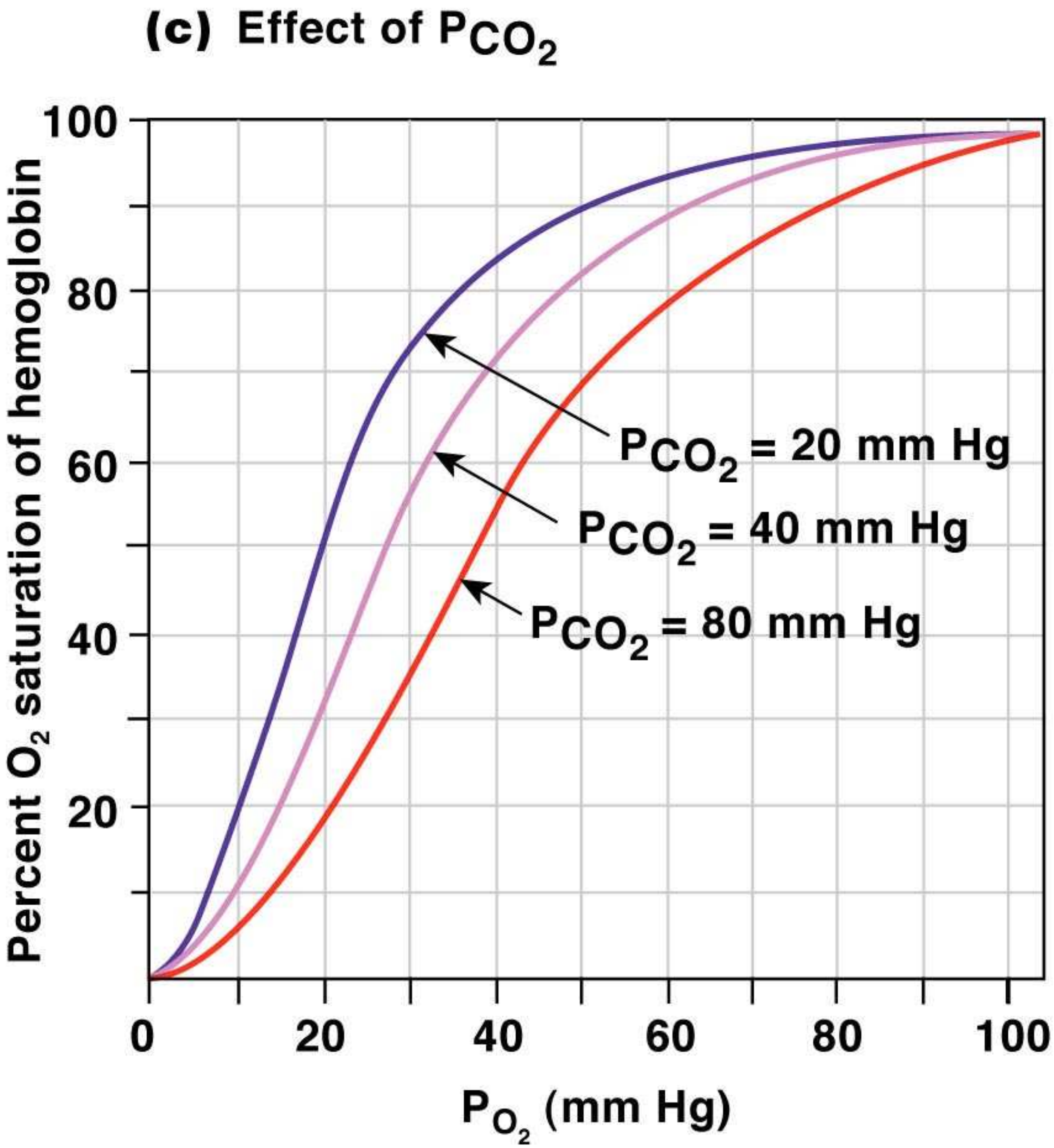

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Figure 18-10c

TABLE 18-1	Normal Blood Values in Pulmonary Medicine	
	ARTERIAL	**VENOUS**
P_{O_2}	95 mm Hg (85–100)	40 mm Hg
P_{CO_2}	40 mm Hg (35–45)	46 mm Hg
pH	7.4 (7.38–7.42)	7.37

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HALDANE EFFECT AT THE LUNGS

BOHR EFFECT AT THE TISSUES

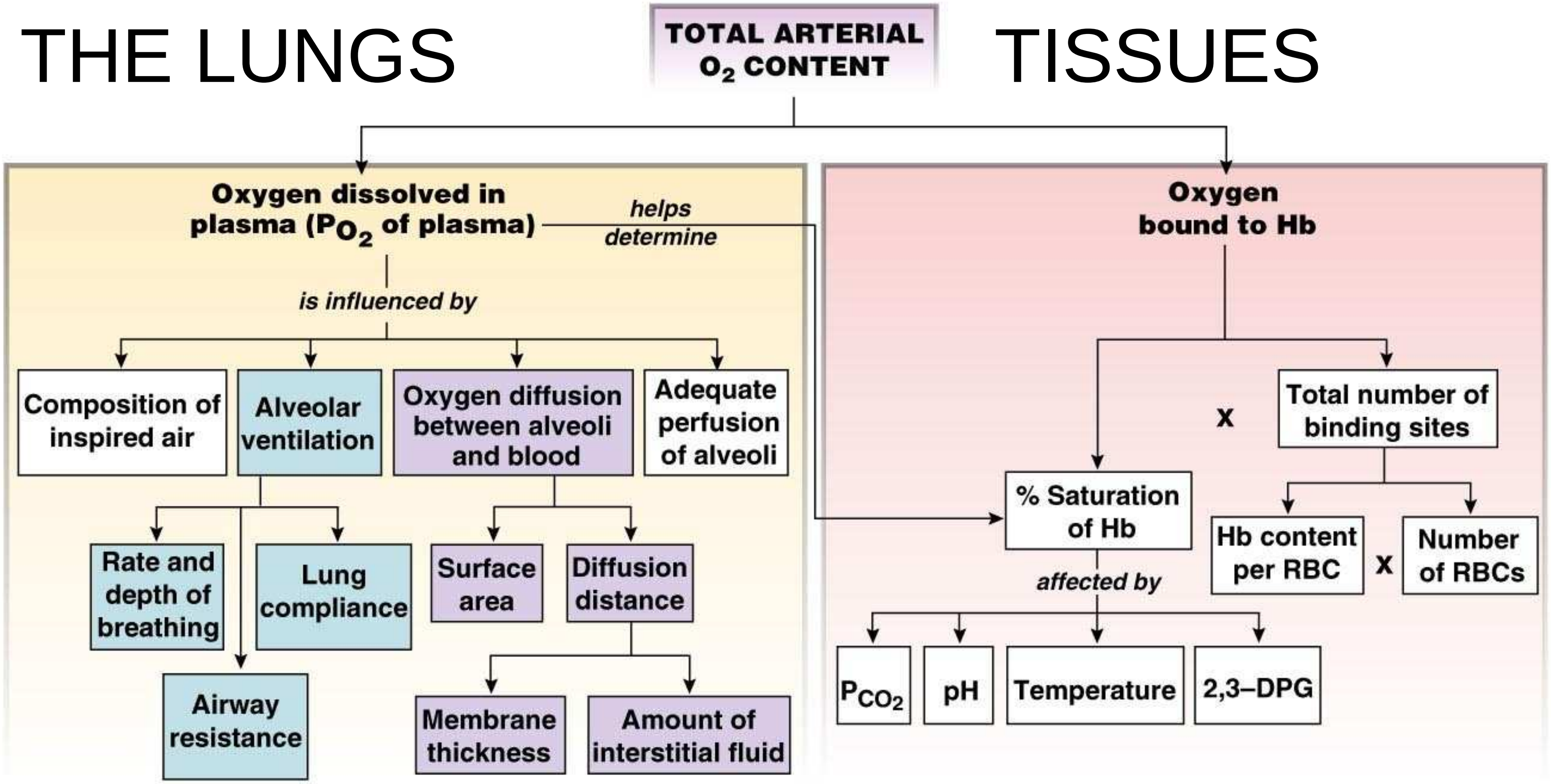

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Figure 18-13

Transport of Oxygen vs.

Transport of Carbon Dioxide

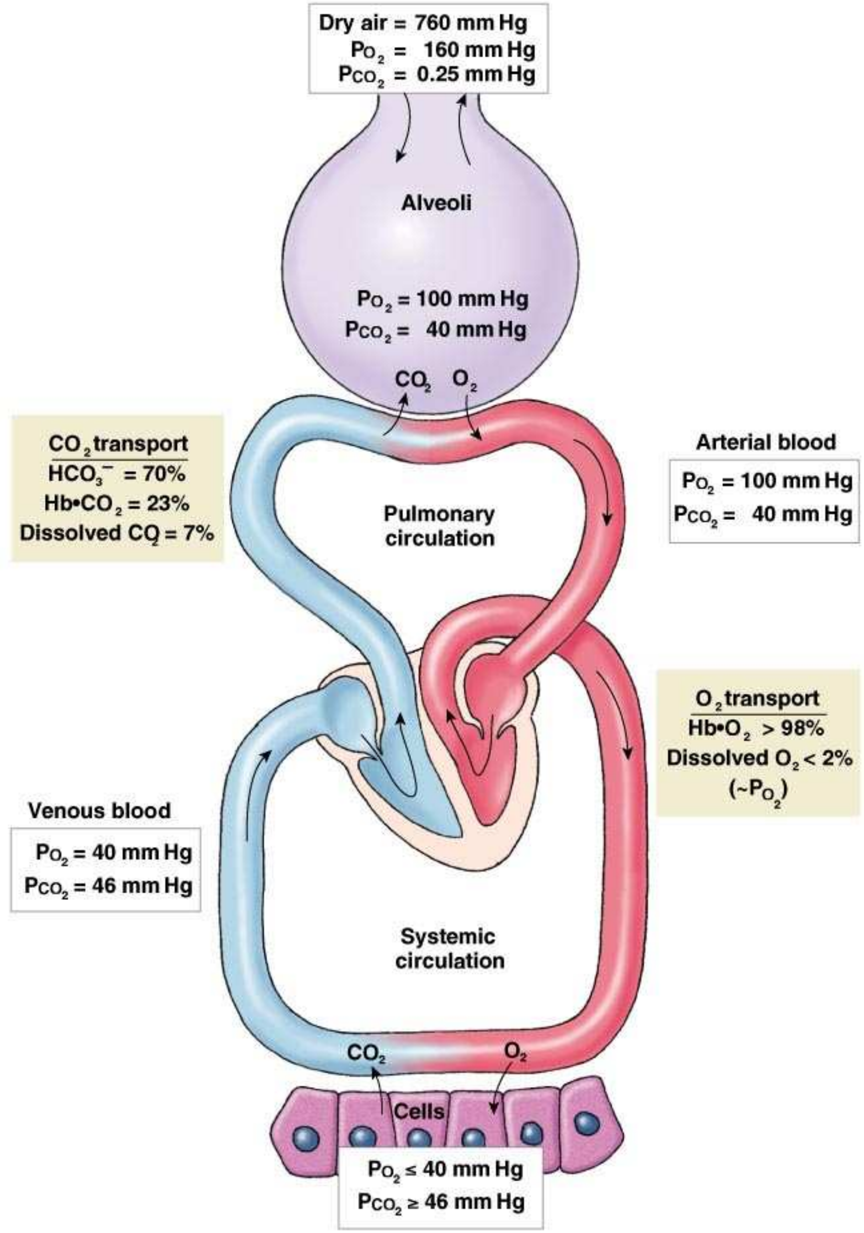

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Figure 18-15

Chloride Shift at the Tissues

Reverse Chloride Shift at the Lungs

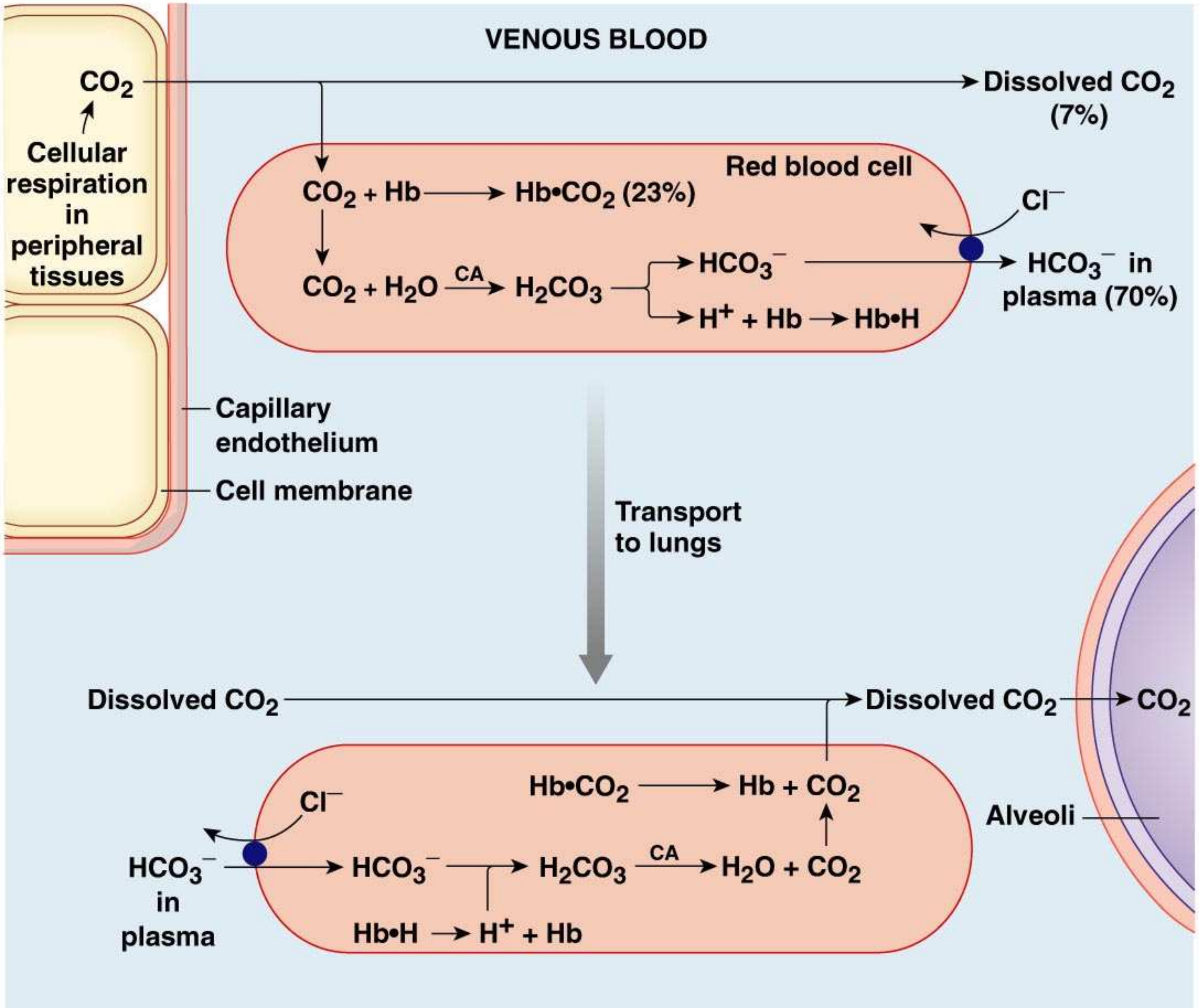

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Figure 18-14

REGULATION OF RESPIRATION

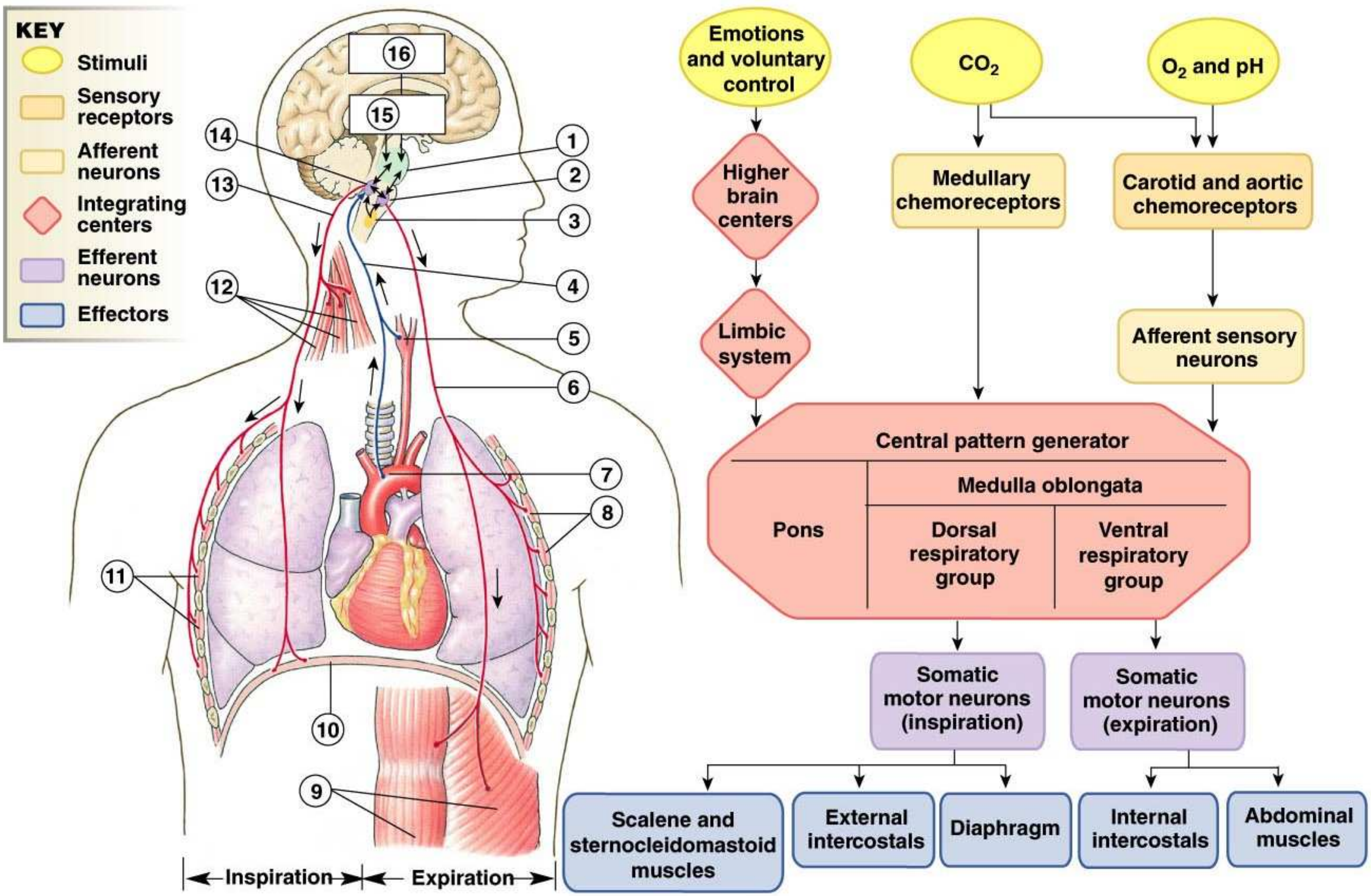

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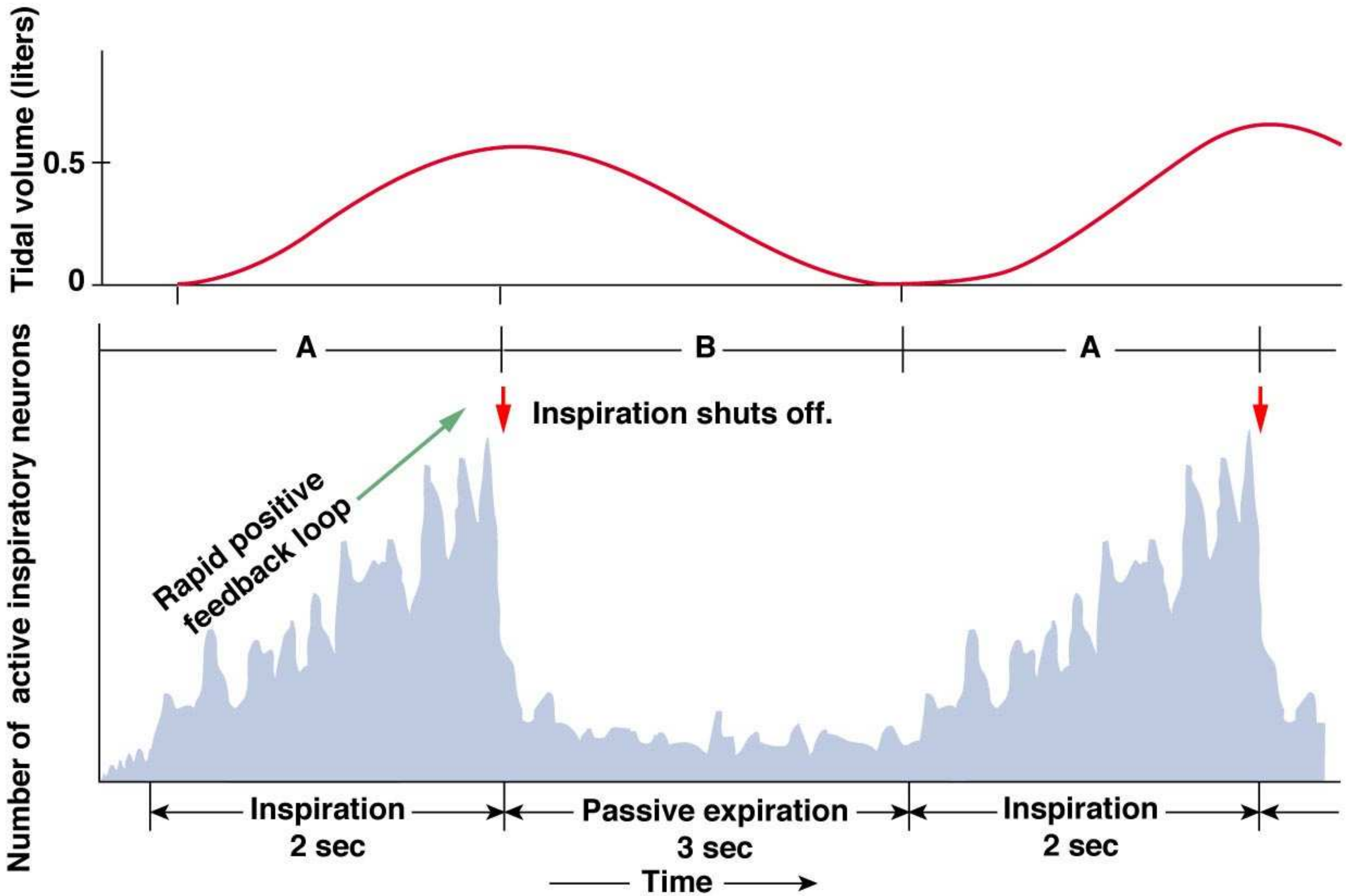
Figure 18-16



During inspiration, the activity of inspiratory neurons increases steadily, apparently through a positive feedback mechanism. At the end of inspiration, the activity shuts off abruptly and expiration takes place through recoil of elastic lung tissue.

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Figure 18-17

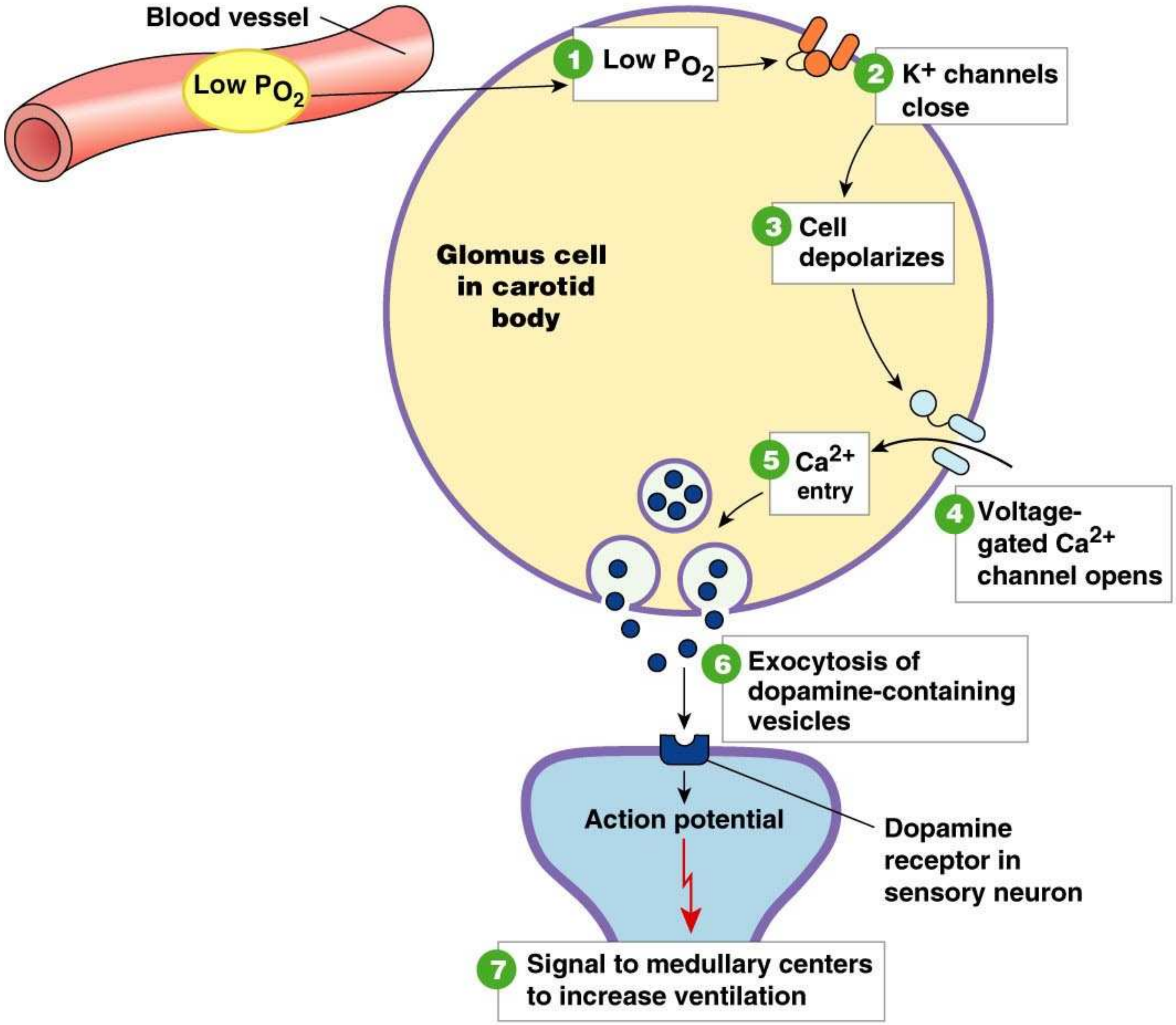

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Figure 18-18

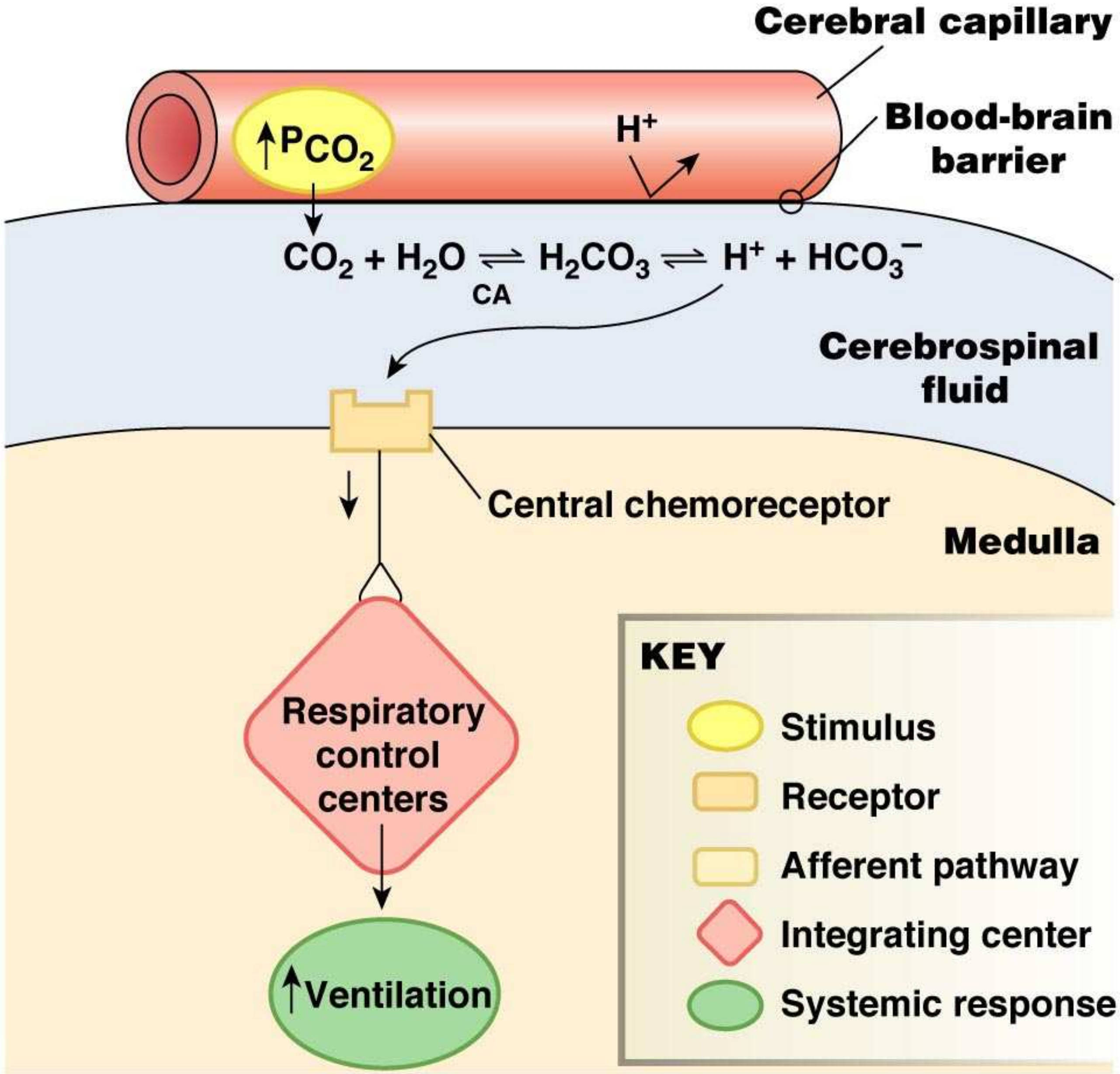

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Figure 18-19

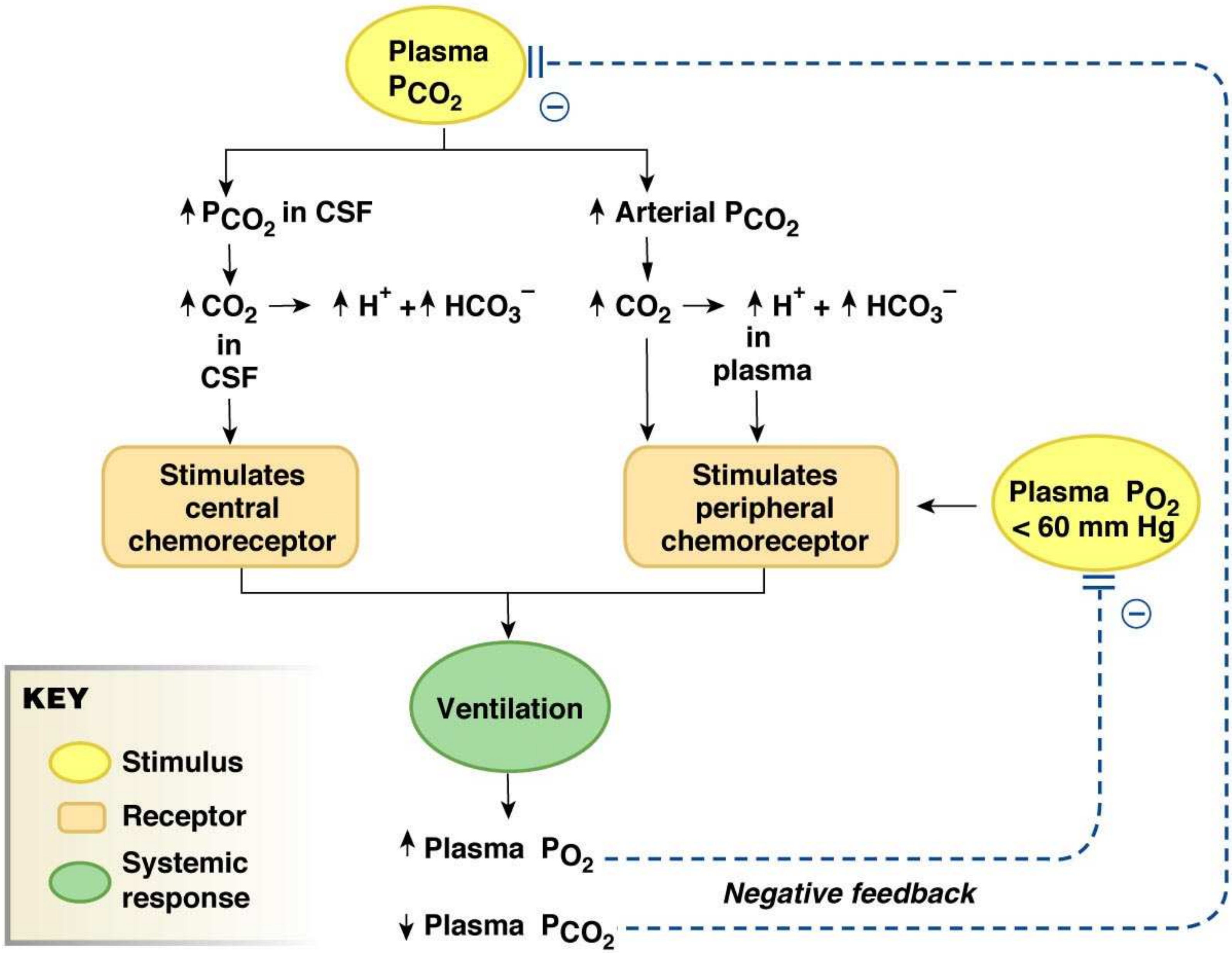

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Figure 18-20