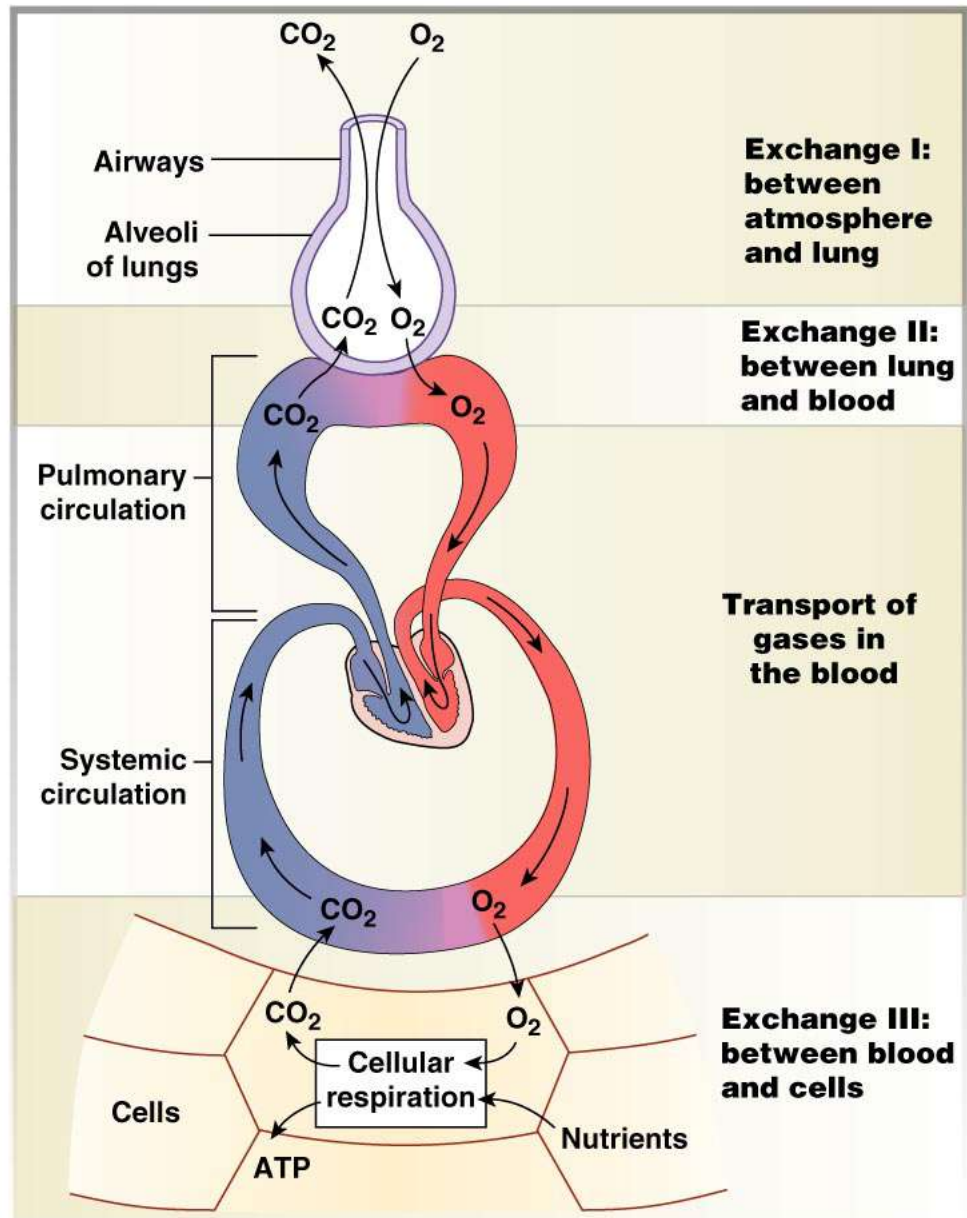
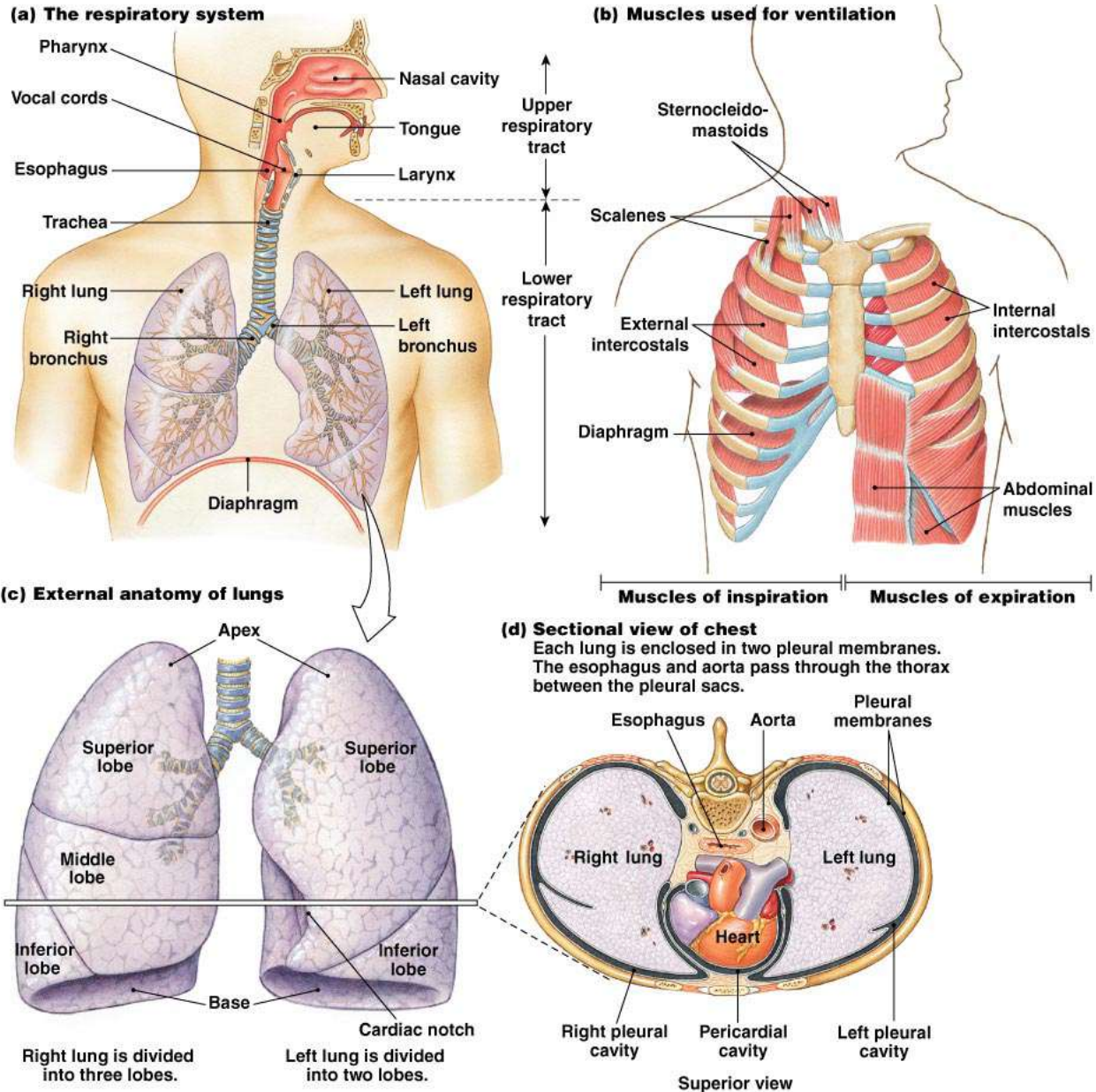


RESPIRATORY SYSTEM

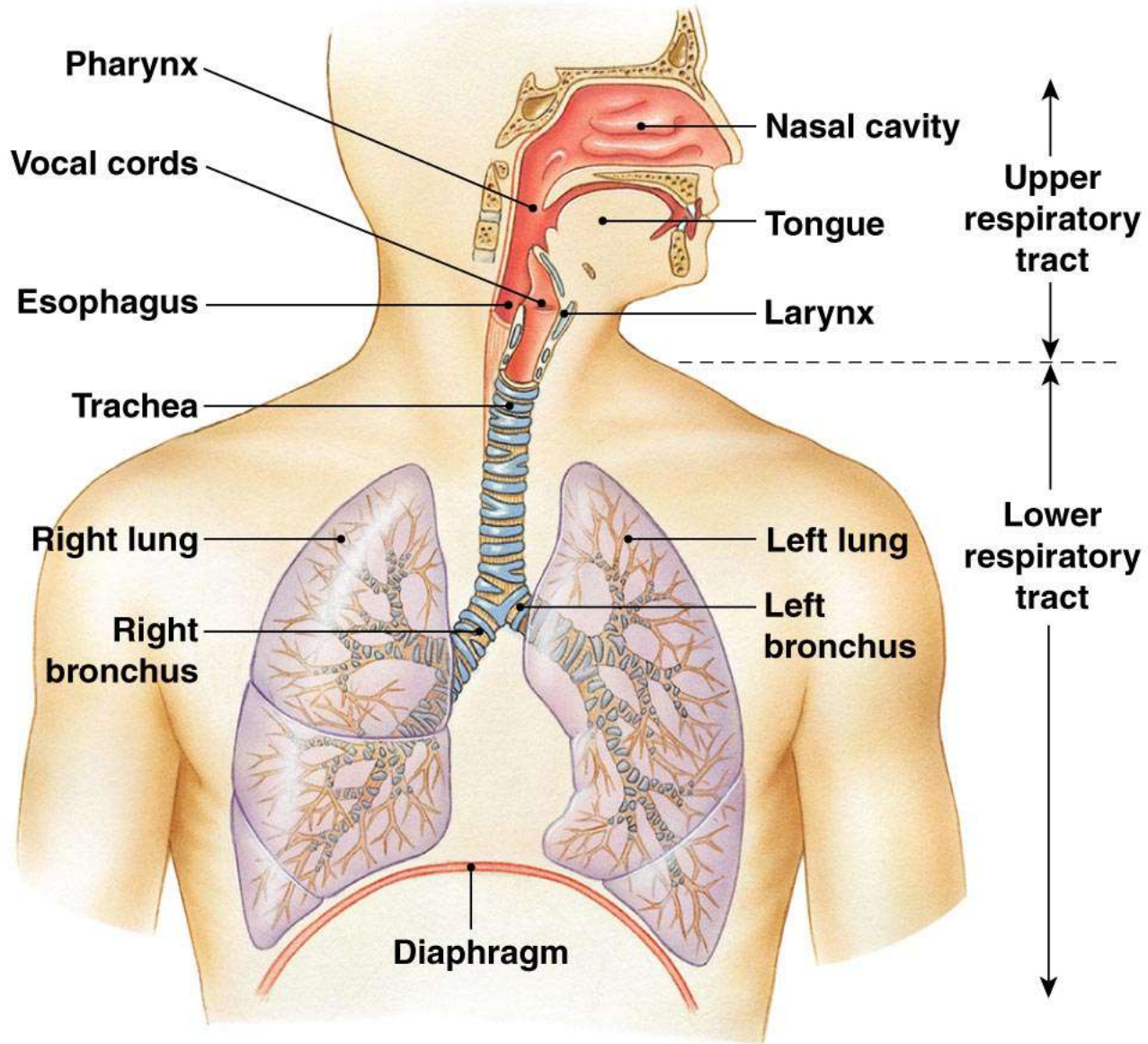


Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

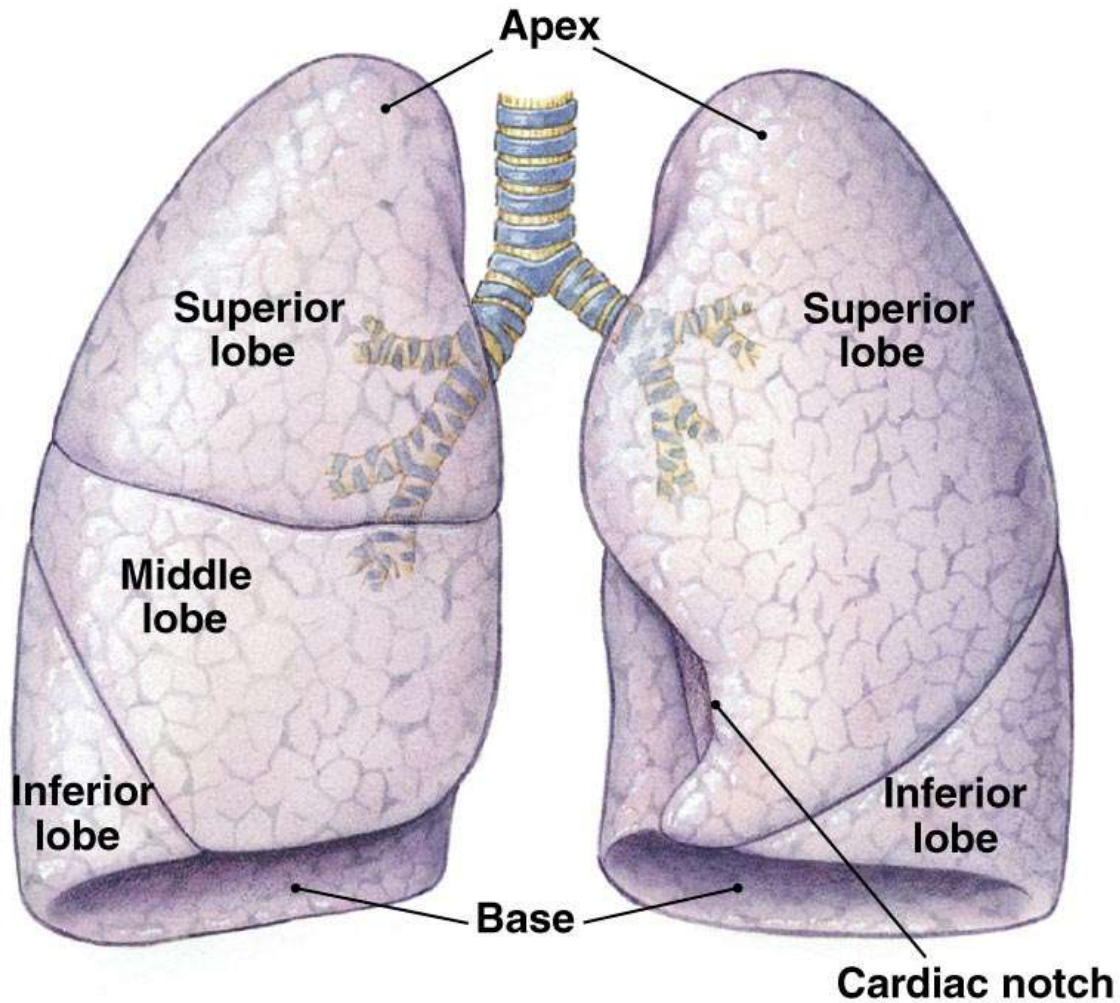
Figure 17-1



(a) The respiratory system



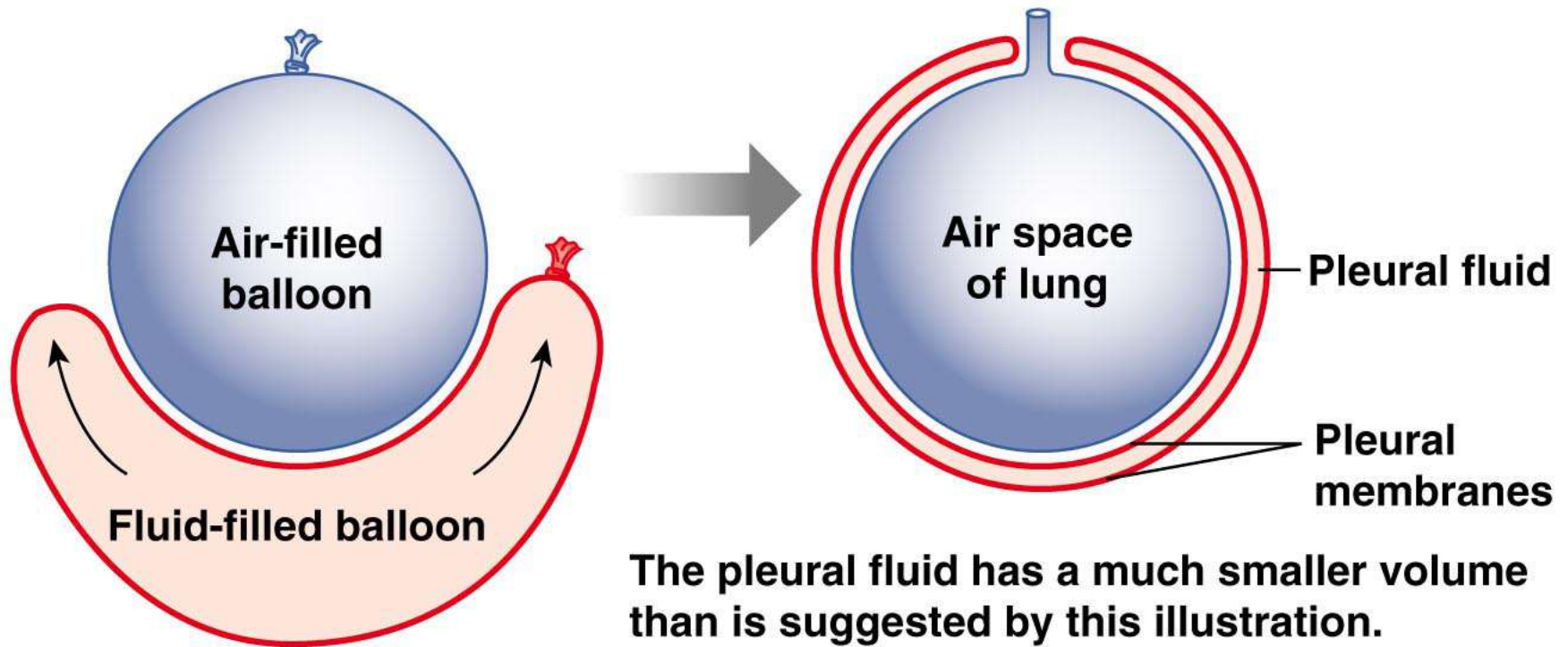
(c) External anatomy of lungs



**Right lung is divided
into three lobes.**

**Left lung is divided
into two lobes.**

The pleural sac forms a double membrane surrounding the lung, similar to a fluid-filled balloon surrounding an air-filled balloon.

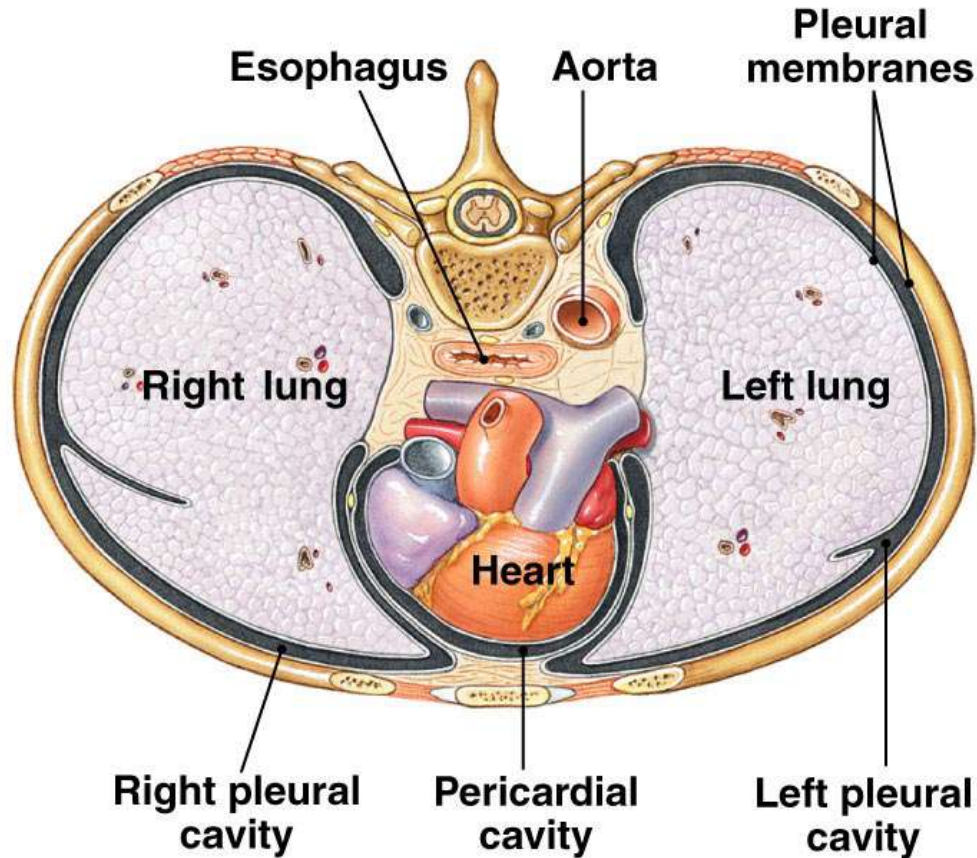


The pleural fluid has a much smaller volume than is suggested by this illustration.

Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

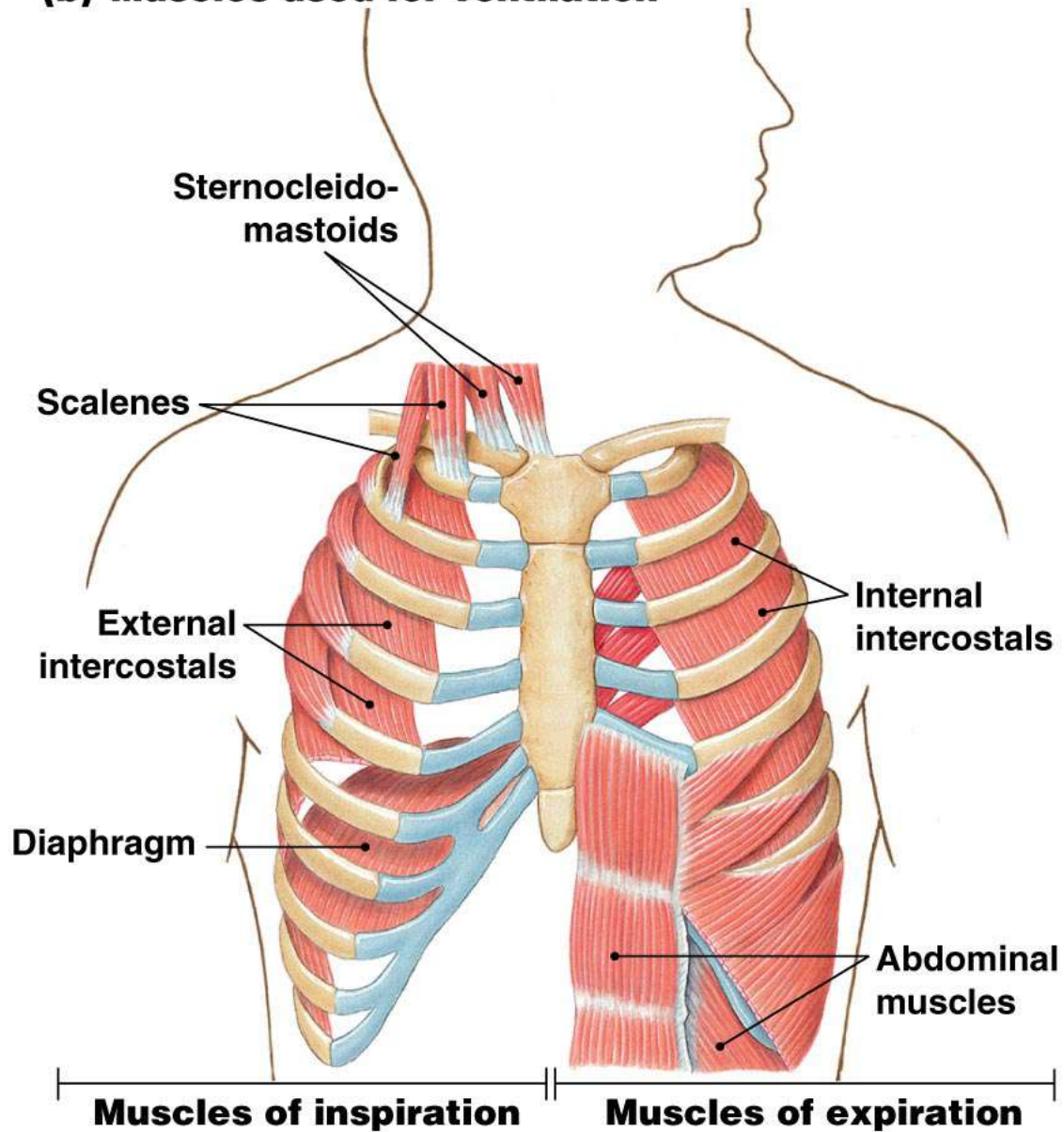
(d) Sectional view of chest

Each lung is enclosed in two pleural membranes. The esophagus and aorta pass through the thorax between the pleural sacs.



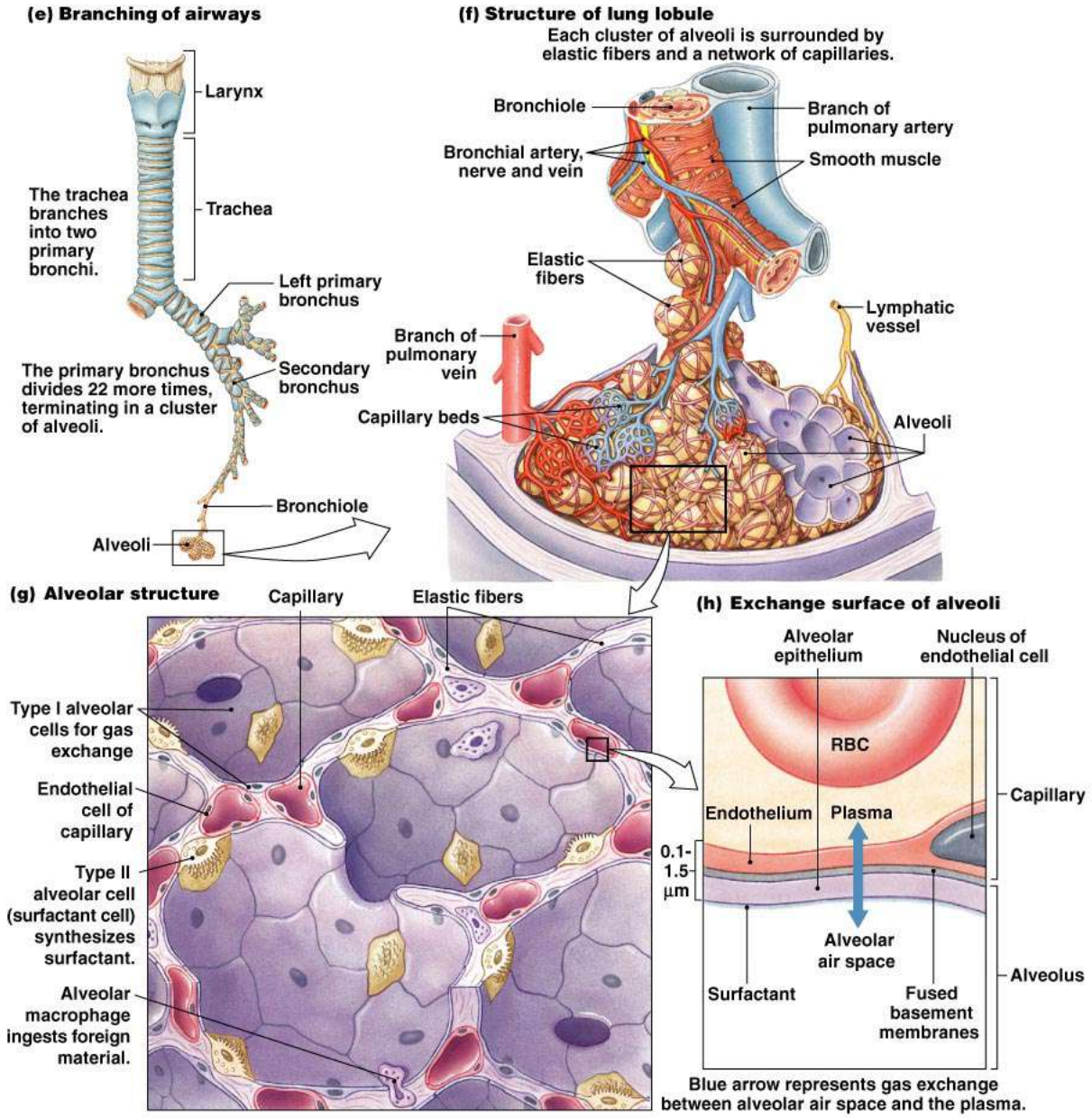
Superior view

(b) Muscles used for ventilation



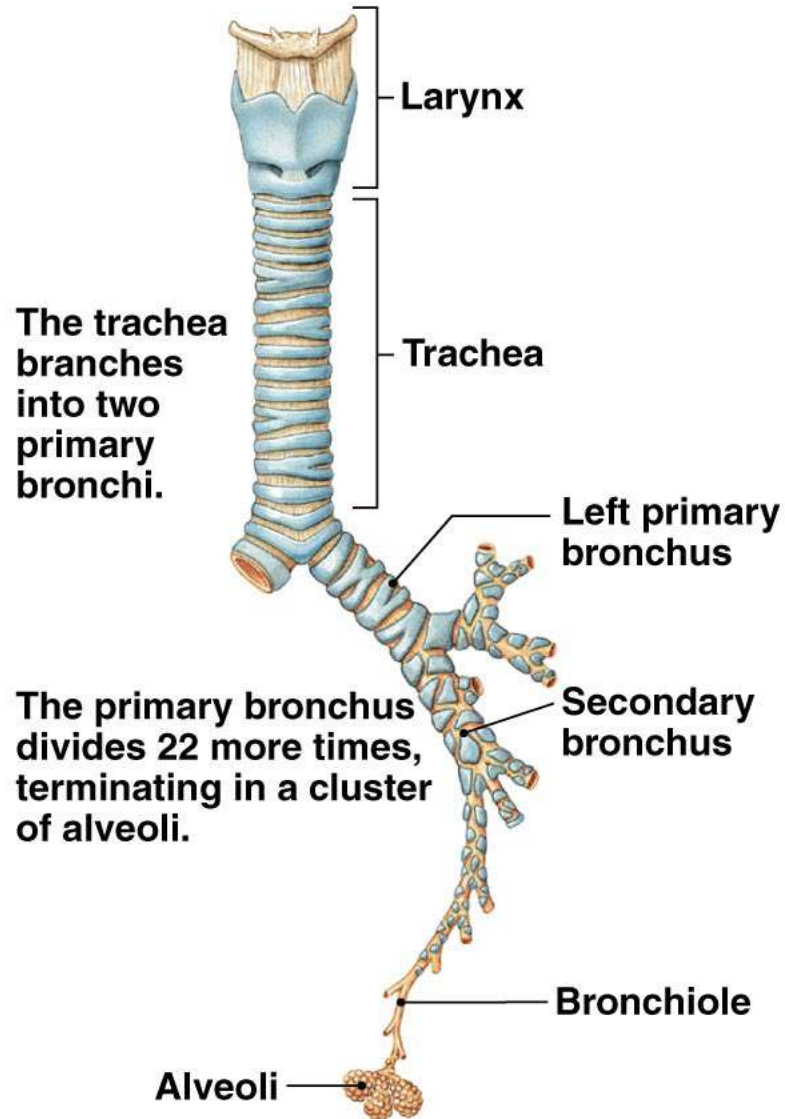
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-2b



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings. **Figure 17-2 – Overview (2 of 2)**

(e) Branching of airways



Trachea

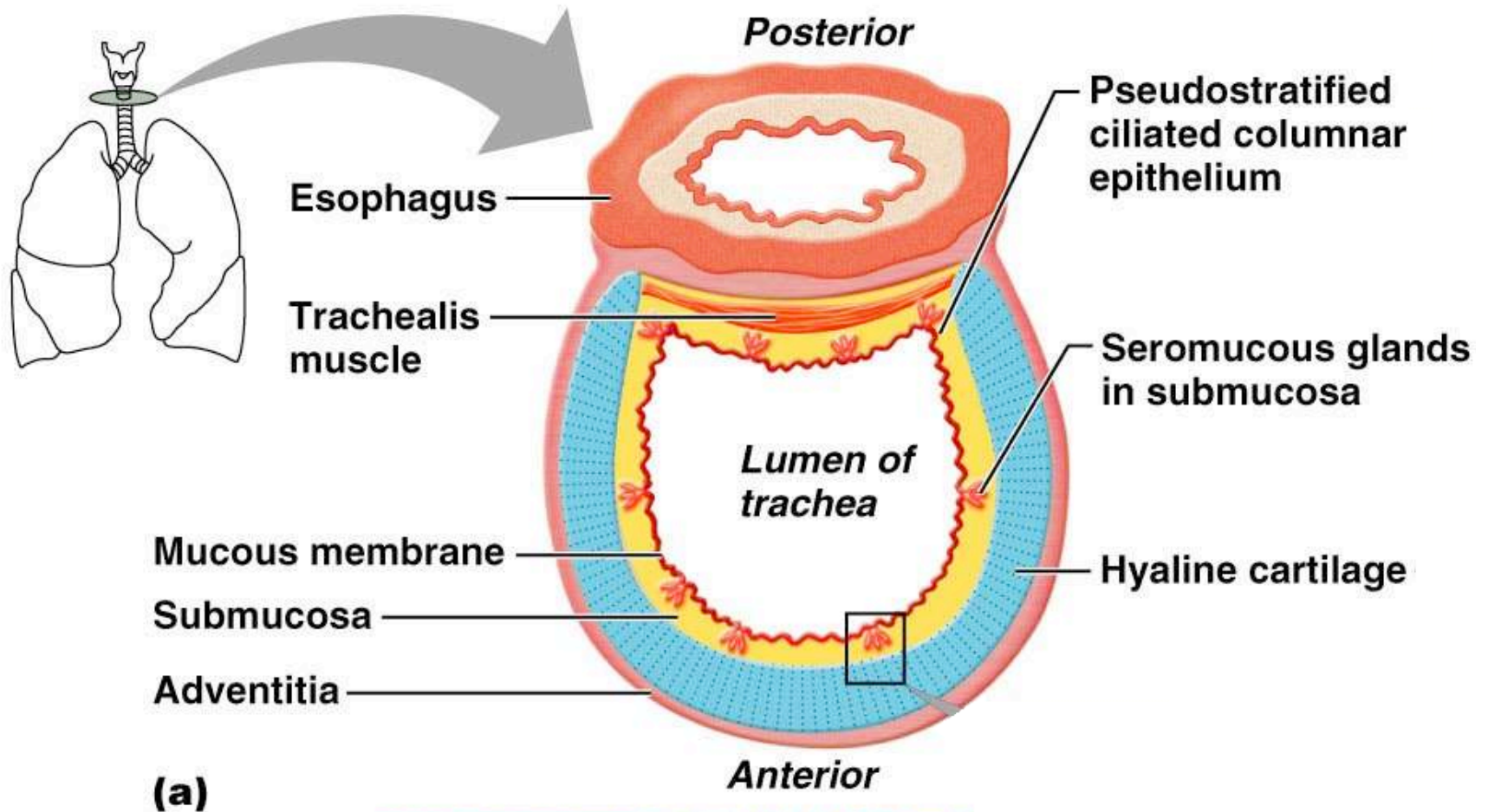
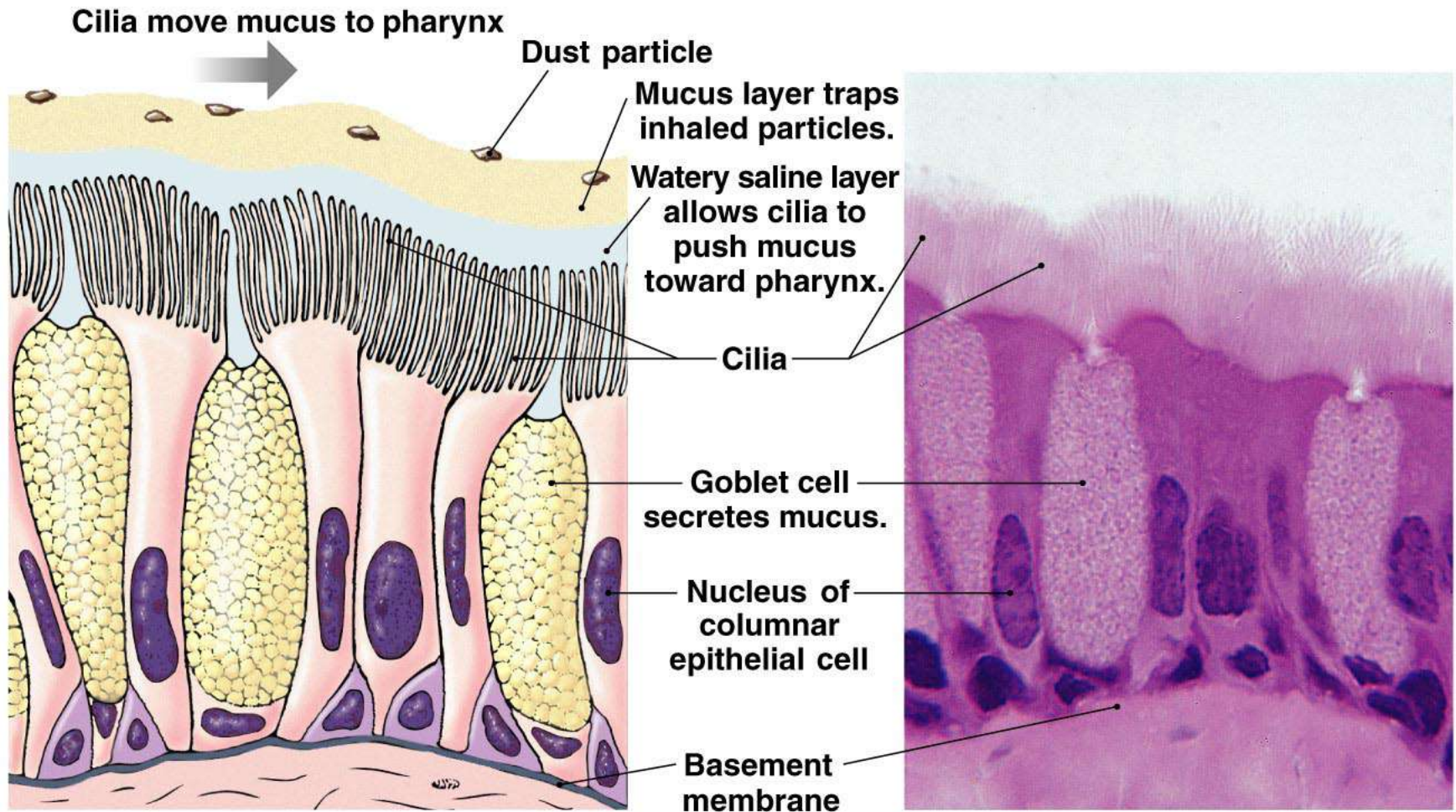


Figure 22.6a

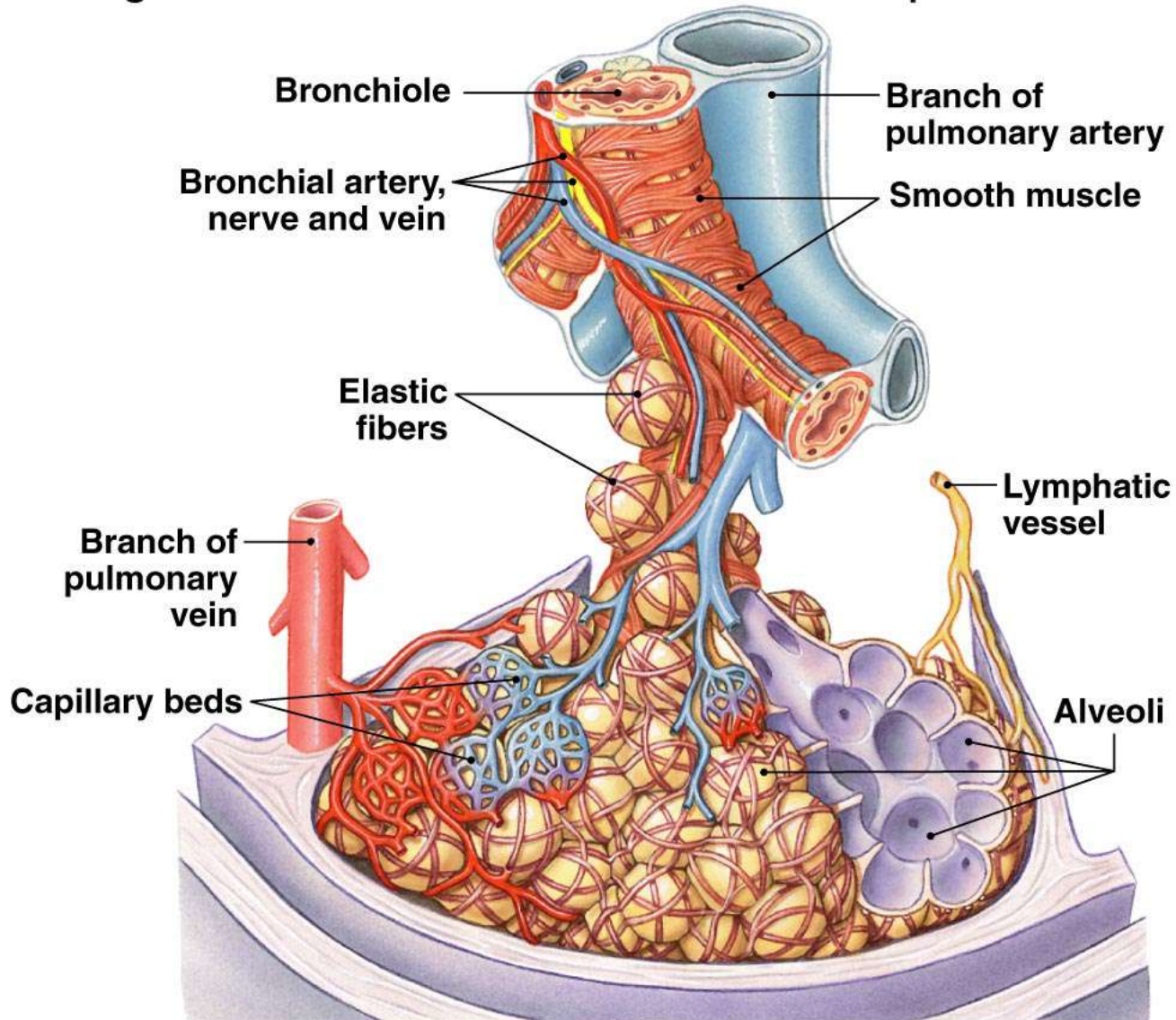


Ciliated epithelium of the trachea

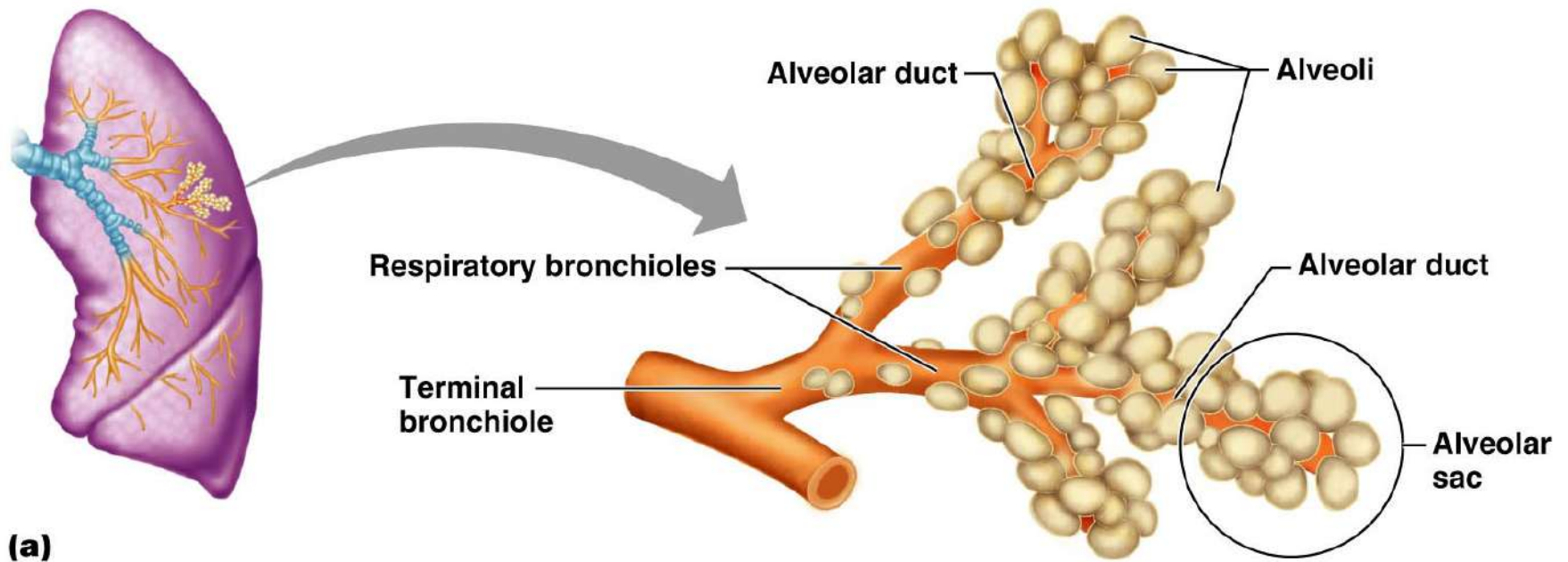
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

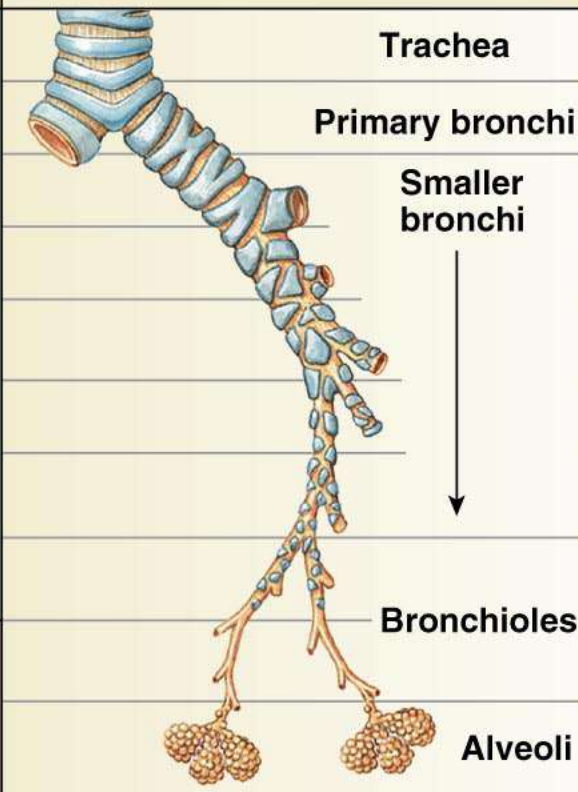
(f) Structure of lung lobule

Each cluster of alveoli is surrounded by elastic fibers and a network of capillaries.



Respiratory Zone



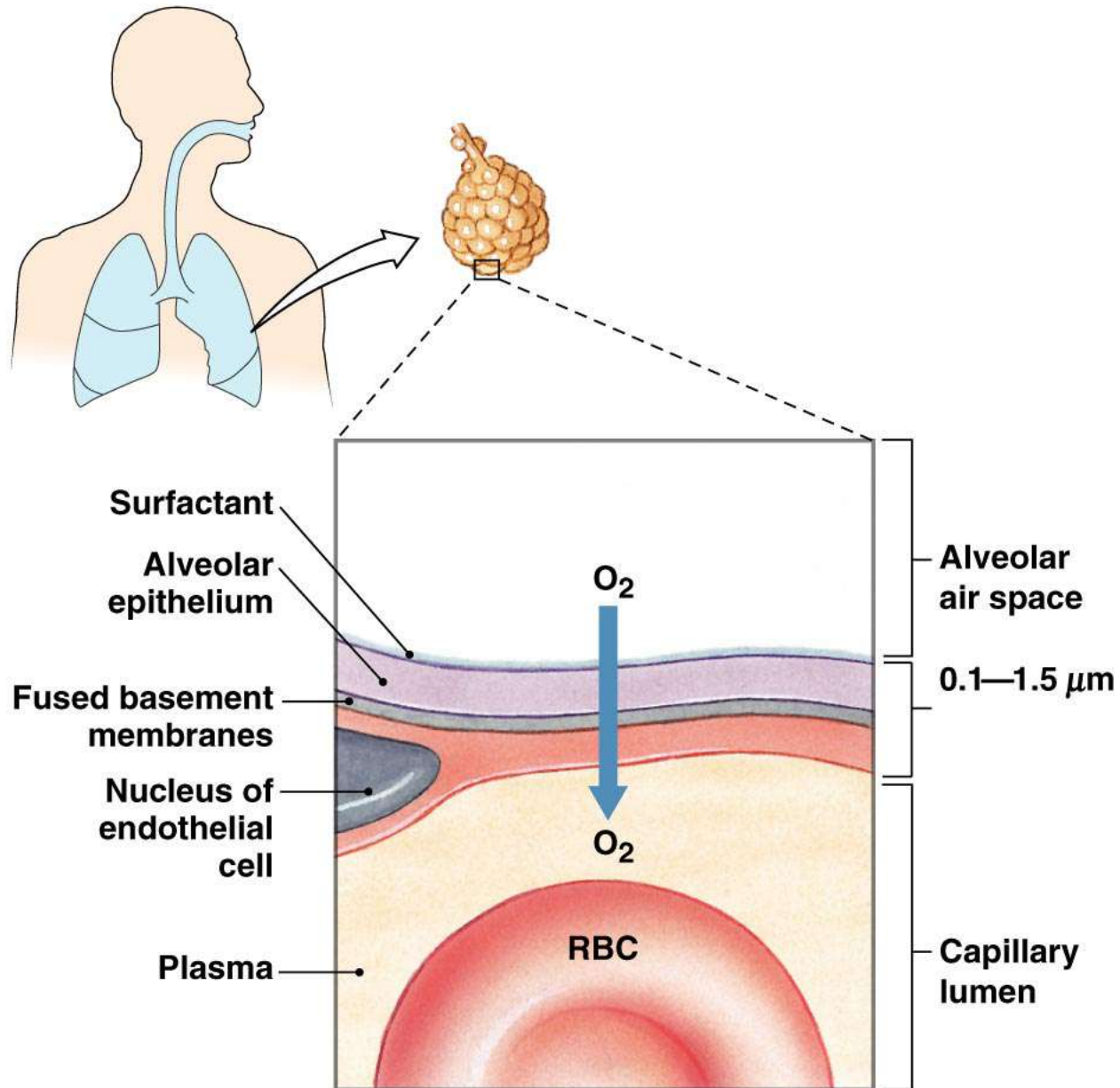
		Name	Division	Diameter (mm)	How many?	Cross-sectional area (cm²)
Conducting system		Trachea	0	15–22	1	2.5
		Primary bronchi	1	10–15	2	↓
		Smaller bronchi	2	1–10	4	
			3			
			4			
			5			
			6–11		1×10^4	
Bronchioles	1–23	0.5–1	2×10^4	↓	100	
Exchange surface				8×10^7	↓	5×10^3
		Alveoli	24	0.3	$3-6 \times 10^8$	$>1 \times 10^6$

Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-4

Respiratory Membrane

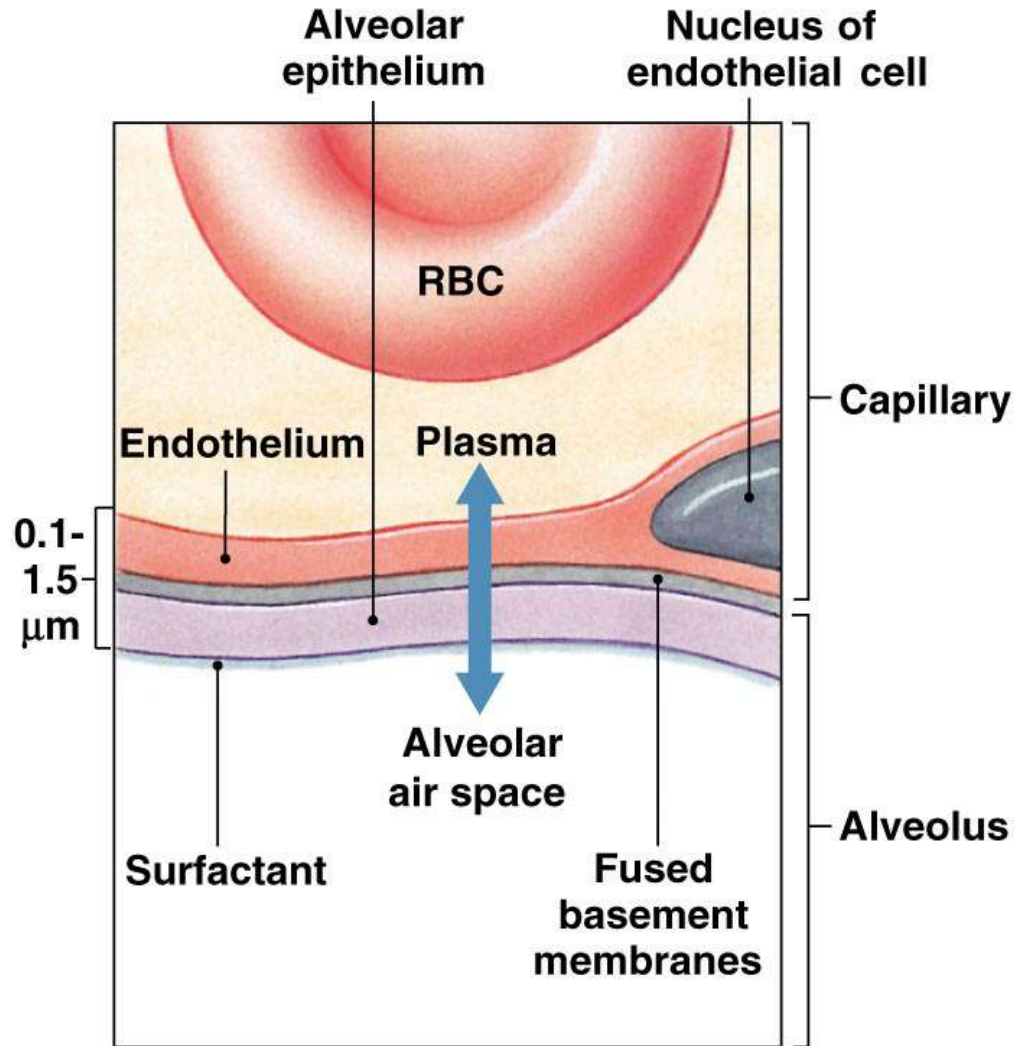
- This air-blood barrier is composed of:
 - Alveolar and capillary walls
 - Their fused basal laminas
- Alveolar walls:
 - Are a single layer of type I epithelial cells
 - Permit gas exchange by simple diffusion
 - Secrete angiotensin converting enzyme (ACE)
- Type II cells secrete surfactant



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-5

(h) Exchange surface of alveoli



Blue arrow represents gas exchange between alveolar air space and the plasma.

(g) Alveolar structure

Capillary

Elastic fibers

Type I alveolar cells for gas exchange

Endothelial cell of capillary

Type II alveolar cell (surfactant cell) synthesizes surfactant.

Alveolar macrophage ingests foreign material.

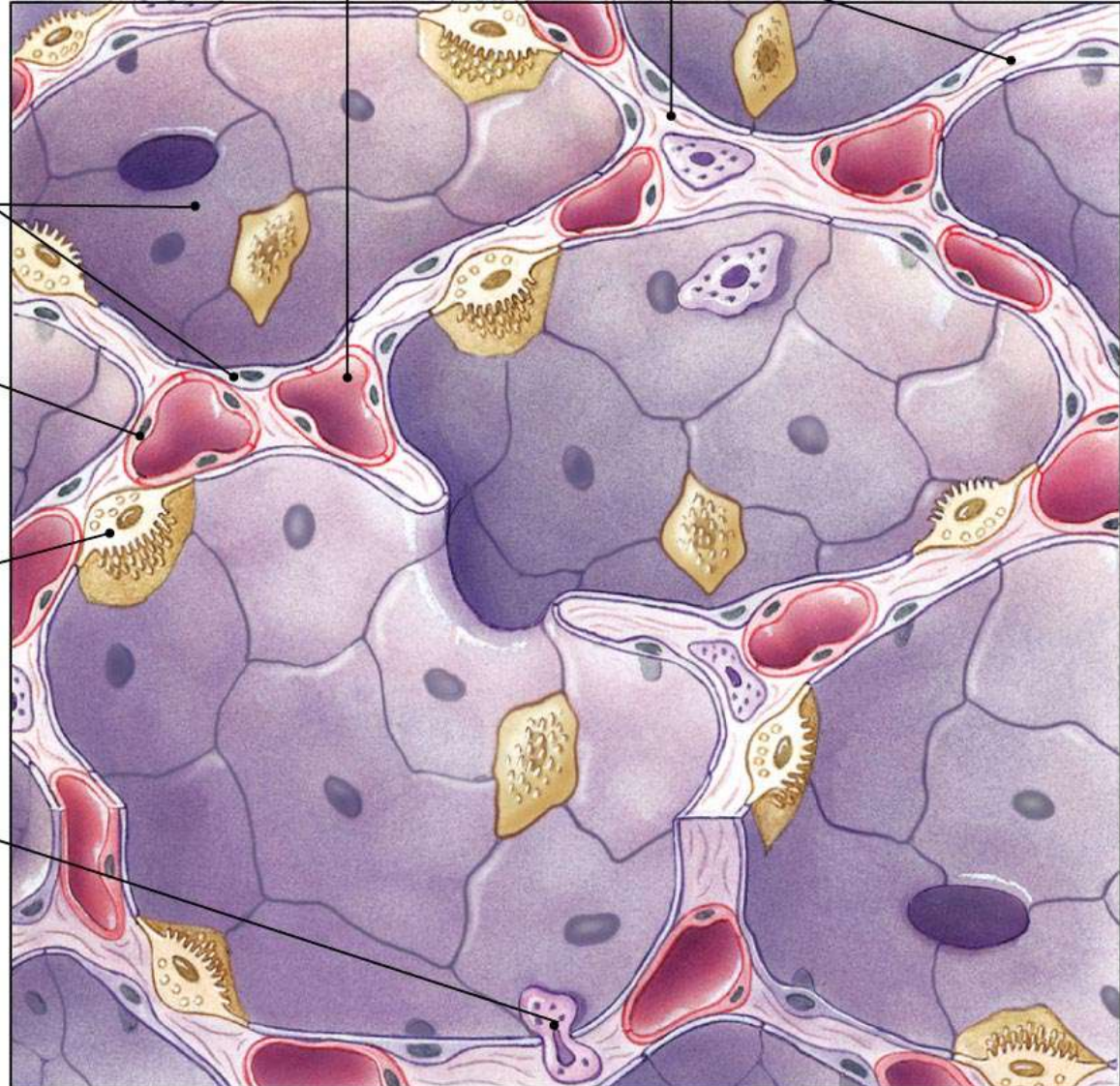


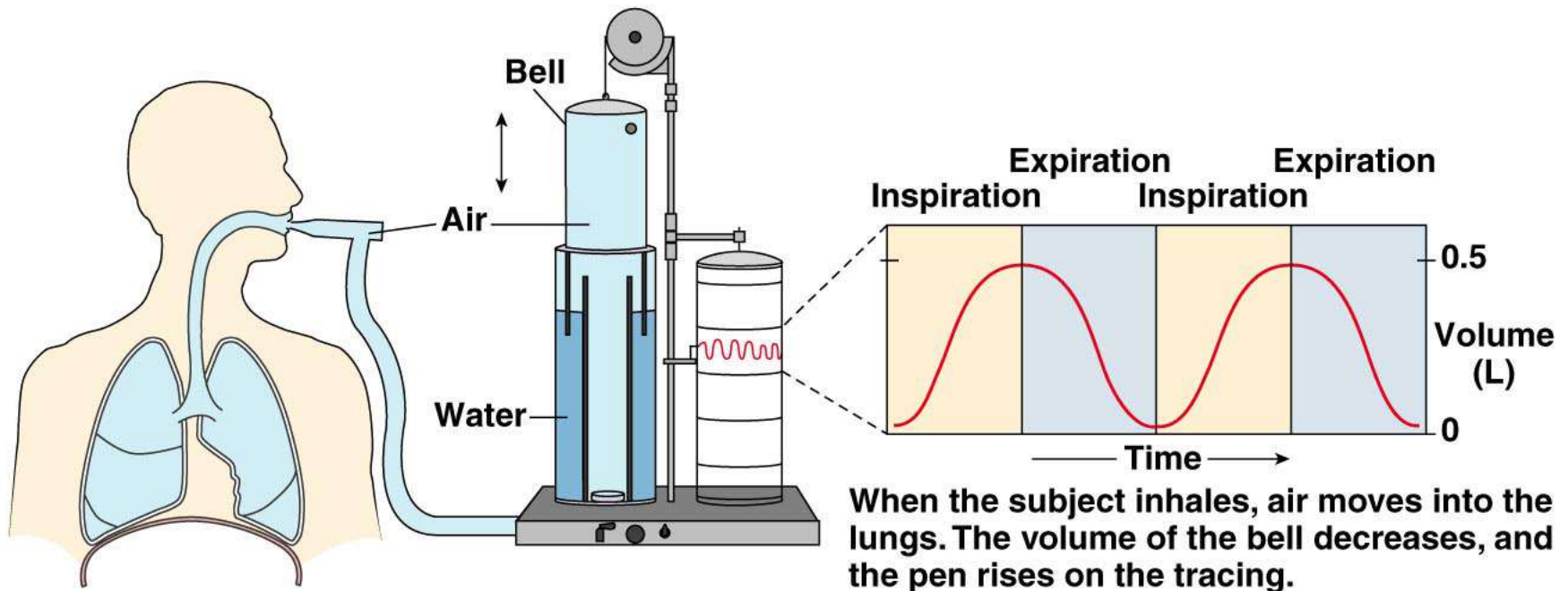
TABLE 17-1 **Gas Laws**

1. The total pressure of a mixture of gases is the sum of the pressures of the individual gases (Dalton's law).
2. Gases, singly or in a mixture, move from areas of higher pressure to areas of lower pressure.
3. If the volume of a container of gas changes, the pressure of the gas will change in an inverse manner (Boyle's law).

TABLE 17-2 Partial Pressures (P_{gas}) of Atmospheric Gases at 760 mm Hg

GAS AND ITS PERCENTAGE IN AIR	P_{gas} IN DRY, 25° C AIR	P_{gas} IN 25° C AIR, 100% HUMIDITY	P_{gas} IN 37° C AIR, 100% HUMIDITY
Nitrogen (N_2) 78%	593 mm Hg	574 mm Hg	556 mm Hg
Oxygen (O_2) 21%	160 mm Hg	155 mm Hg	150 mm Hg
Carbon dioxide (CO_2) 0.033%	0.25 mm Hg	0.24 mm Hg	0.235 mm Hg
Water vapor	0 mm Hg	24 mm Hg	47 mm Hg

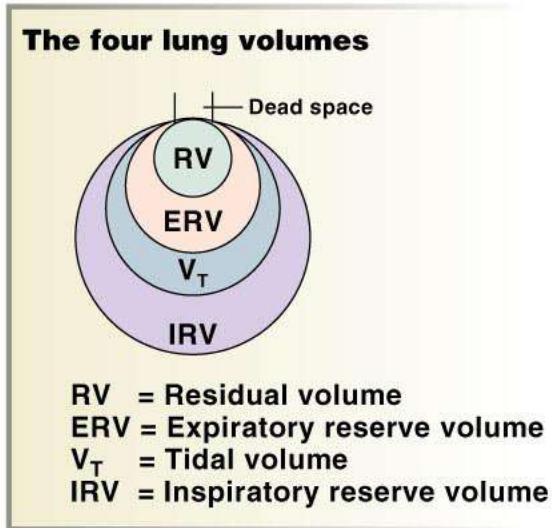
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

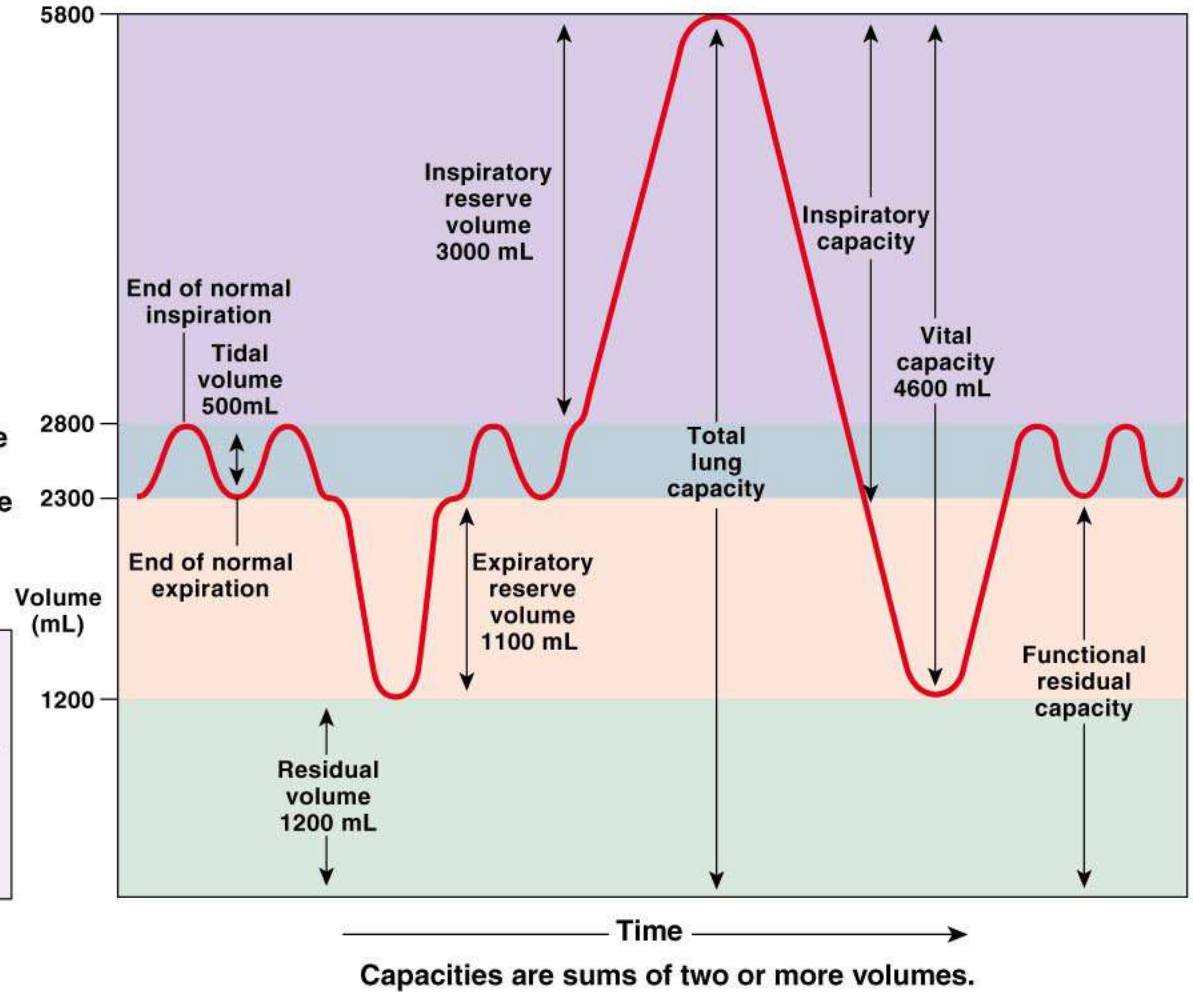
Figure 17-6

A spirometer tracing showing lung volumes and capacities



Pulmonary volumes

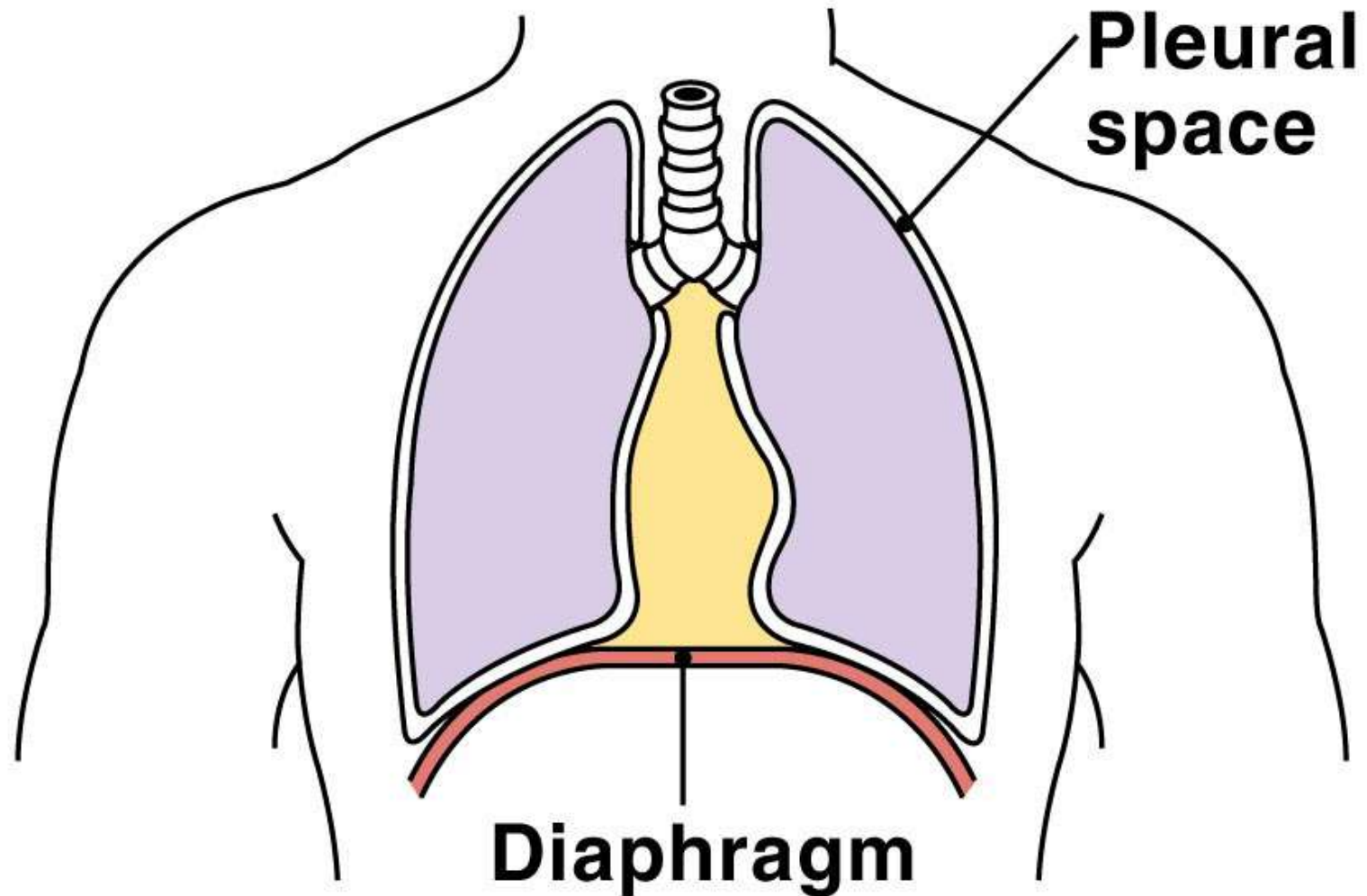
	Males	Females	
Vital capacity	IRV 3000	1900	Inspiratory capacity
	V_T 500	500	
Residual volume	ERV 1100	700	Functional residual capacity
	1200	1100	
	5800 mL	4200 mL	



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-7

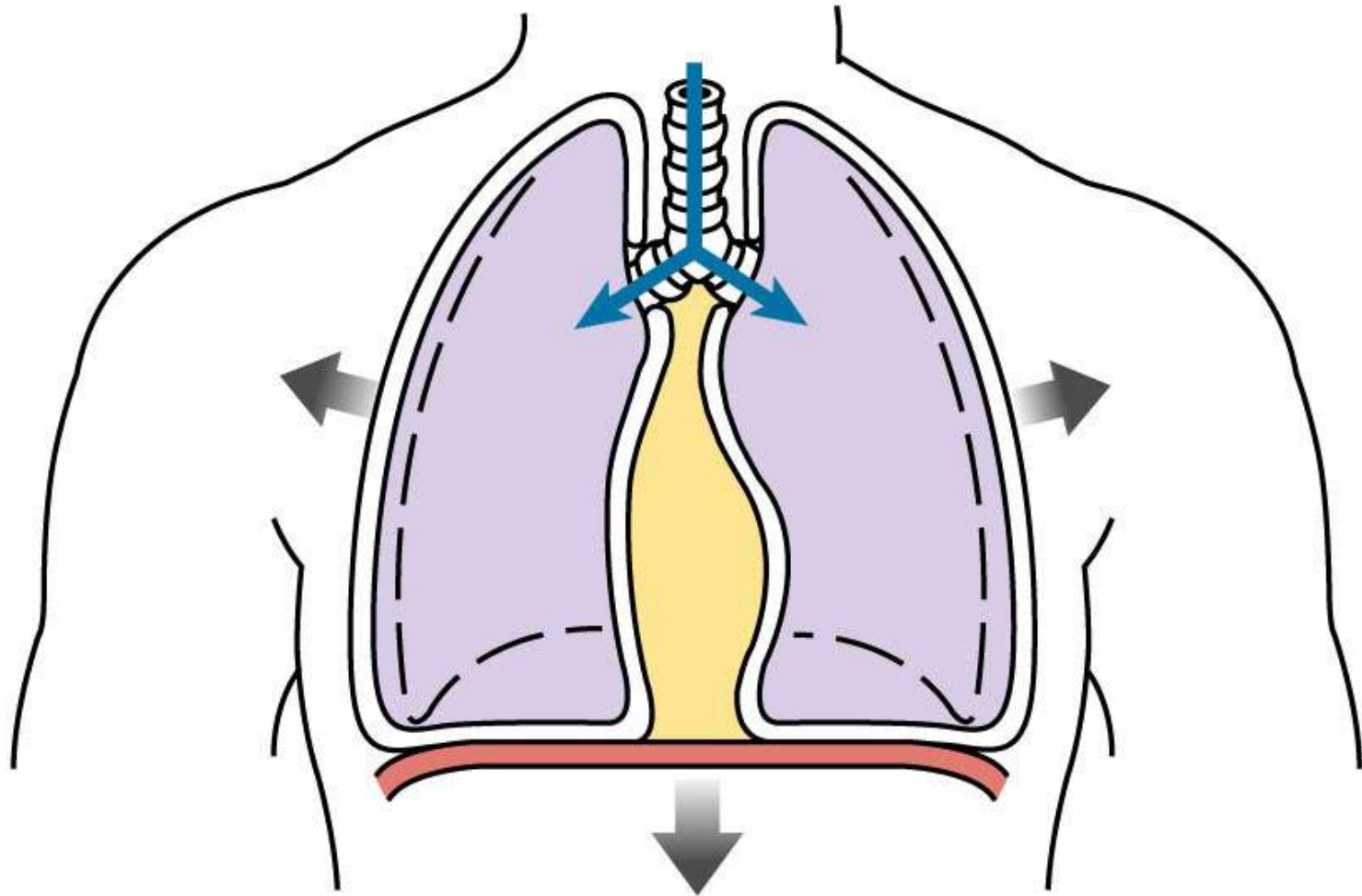
(a) At rest, diaphragm is relaxed.



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-9a

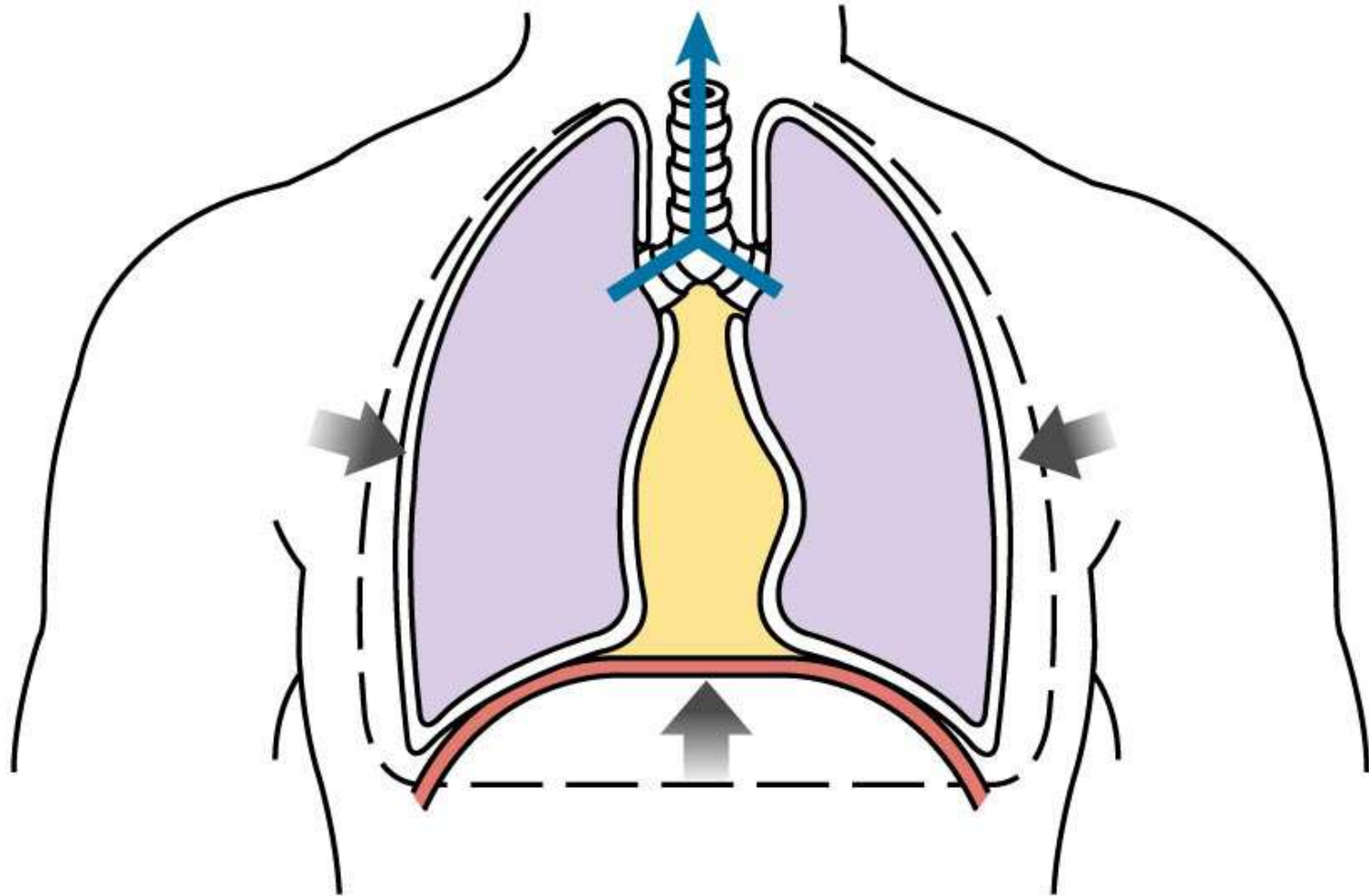
(b) Diaphragm contracts, thoracic volume increases.



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-9b

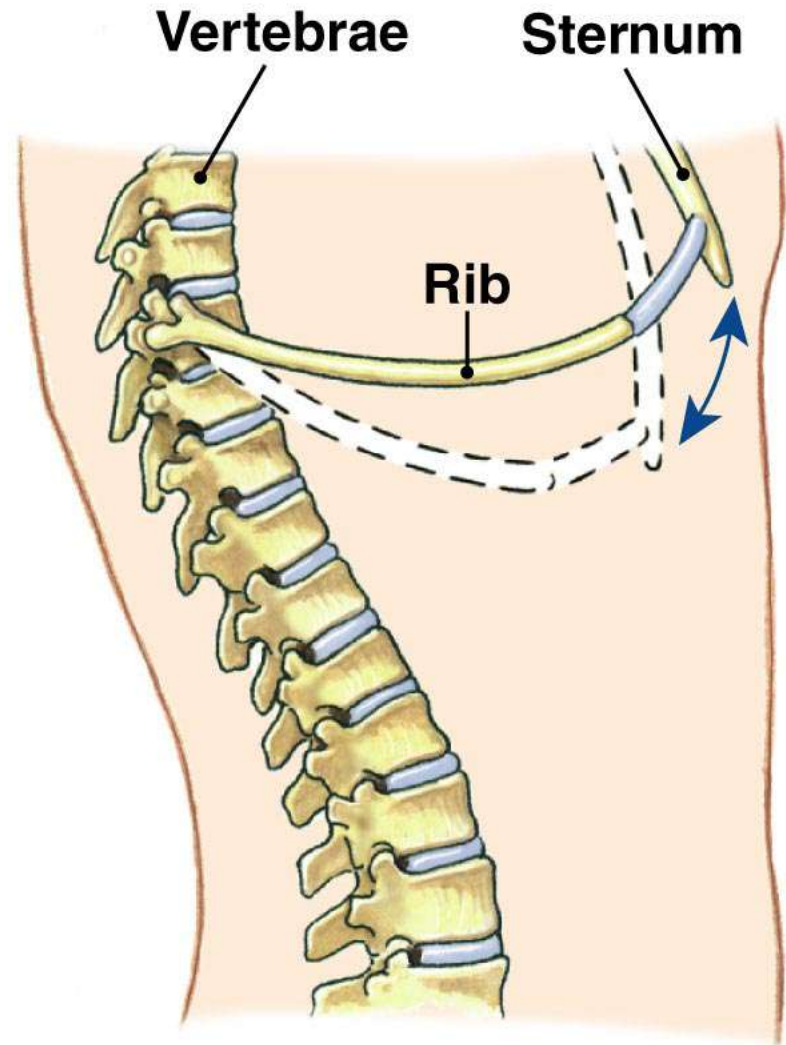
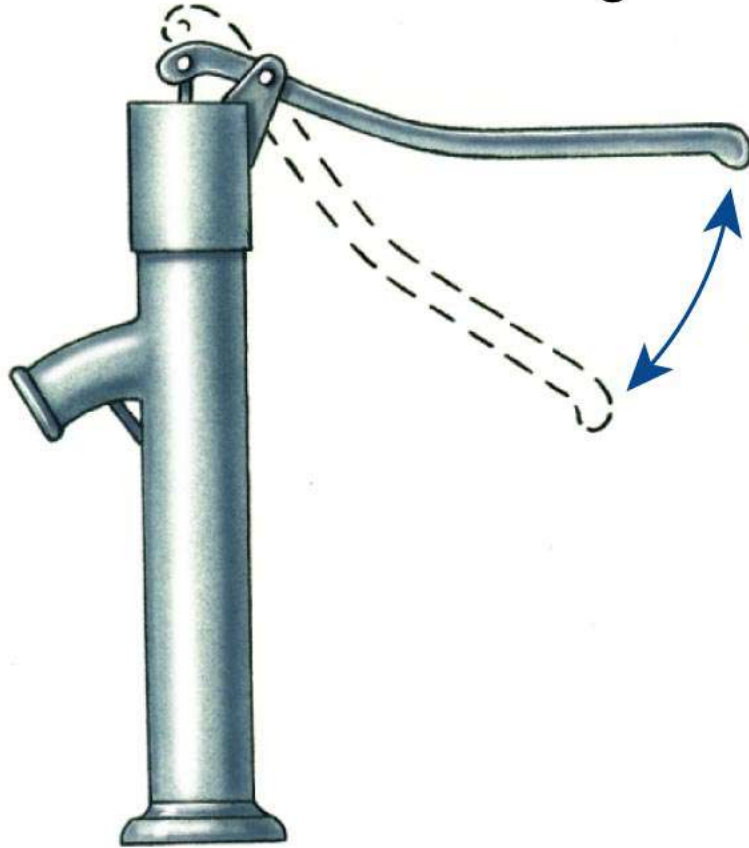
(c) Diaphragm relaxes, thoracic volume decreases.



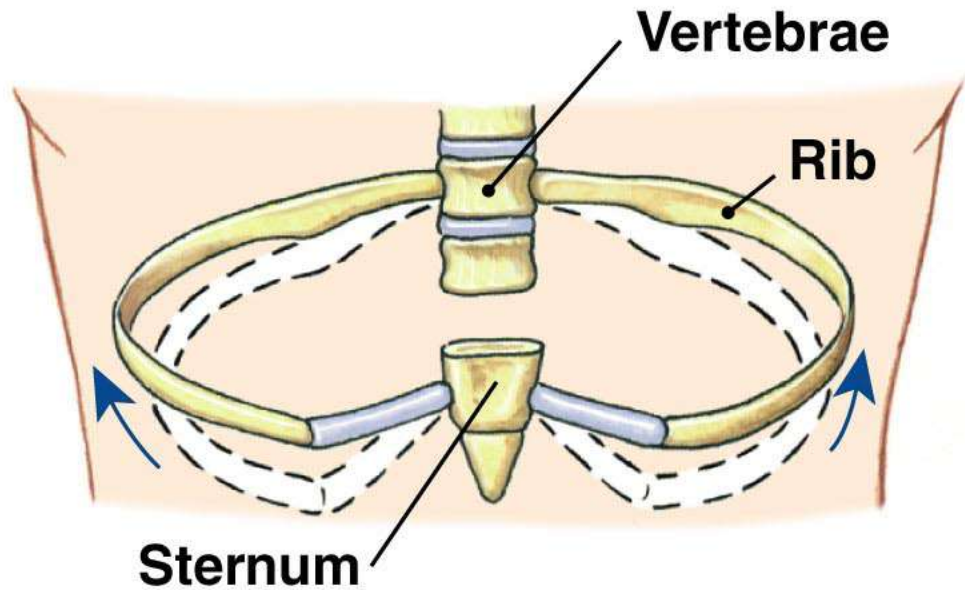
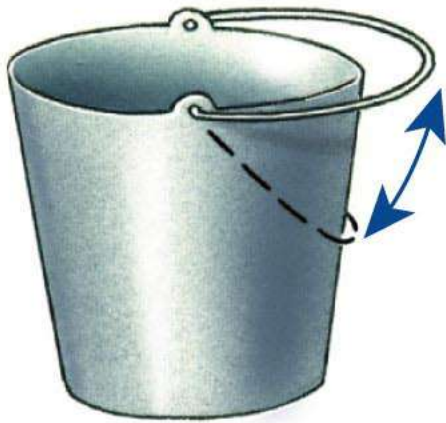
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 17-9c

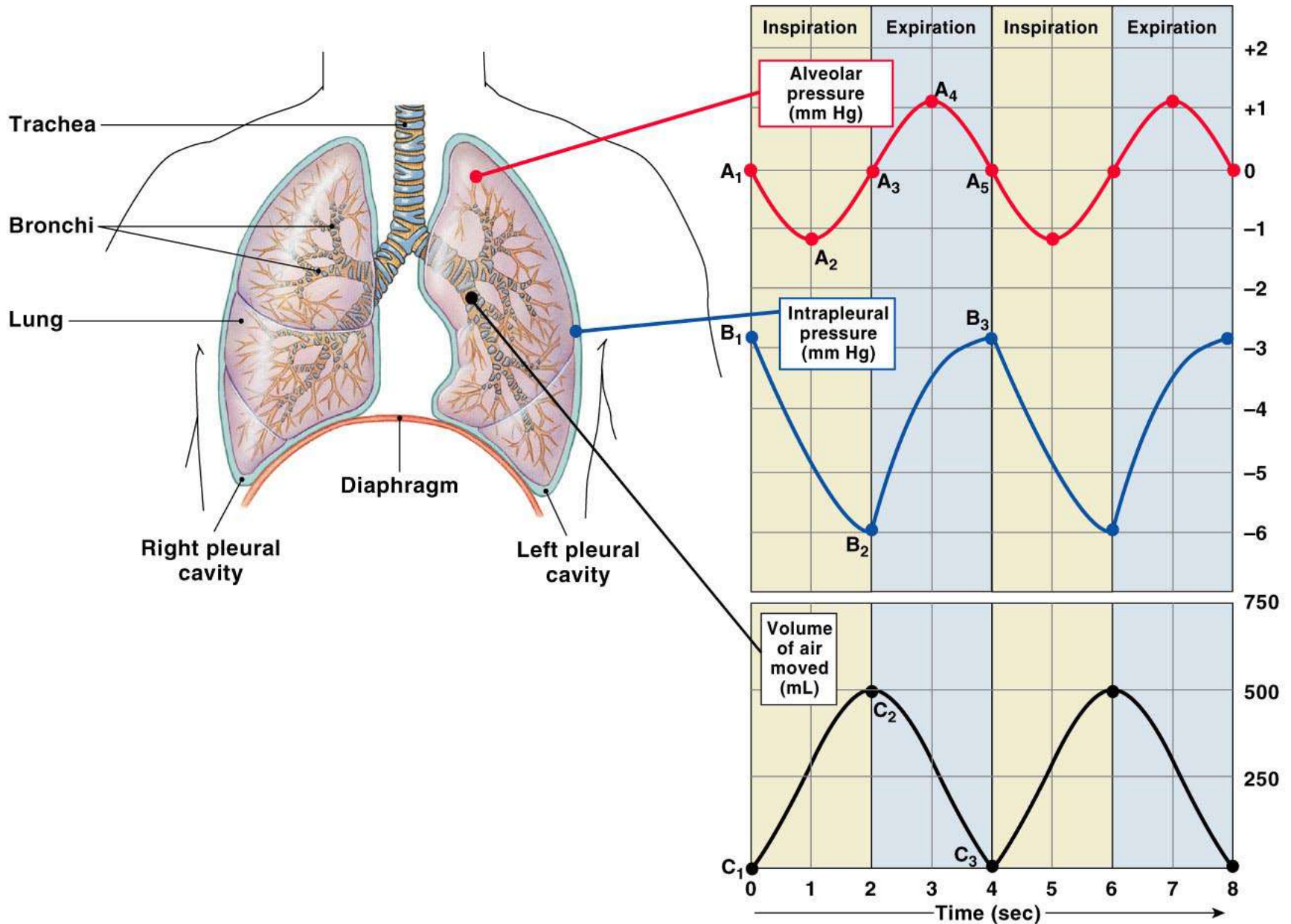
(a) “Pump handle” motion increases anterior-posterior dimension of rib cage.



(b) “Bucket handle” motion increases lateral dimension of rib cage.



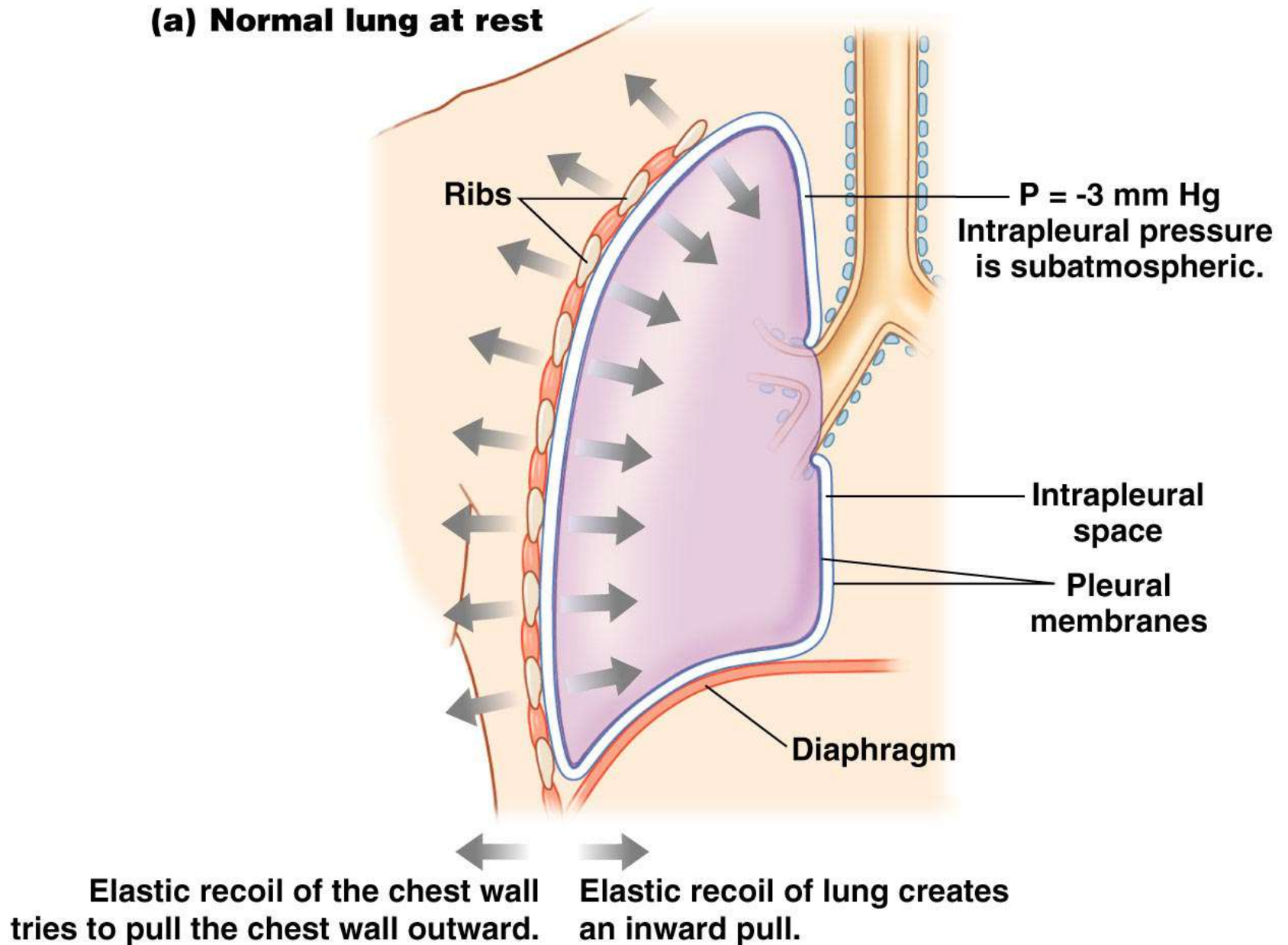
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.



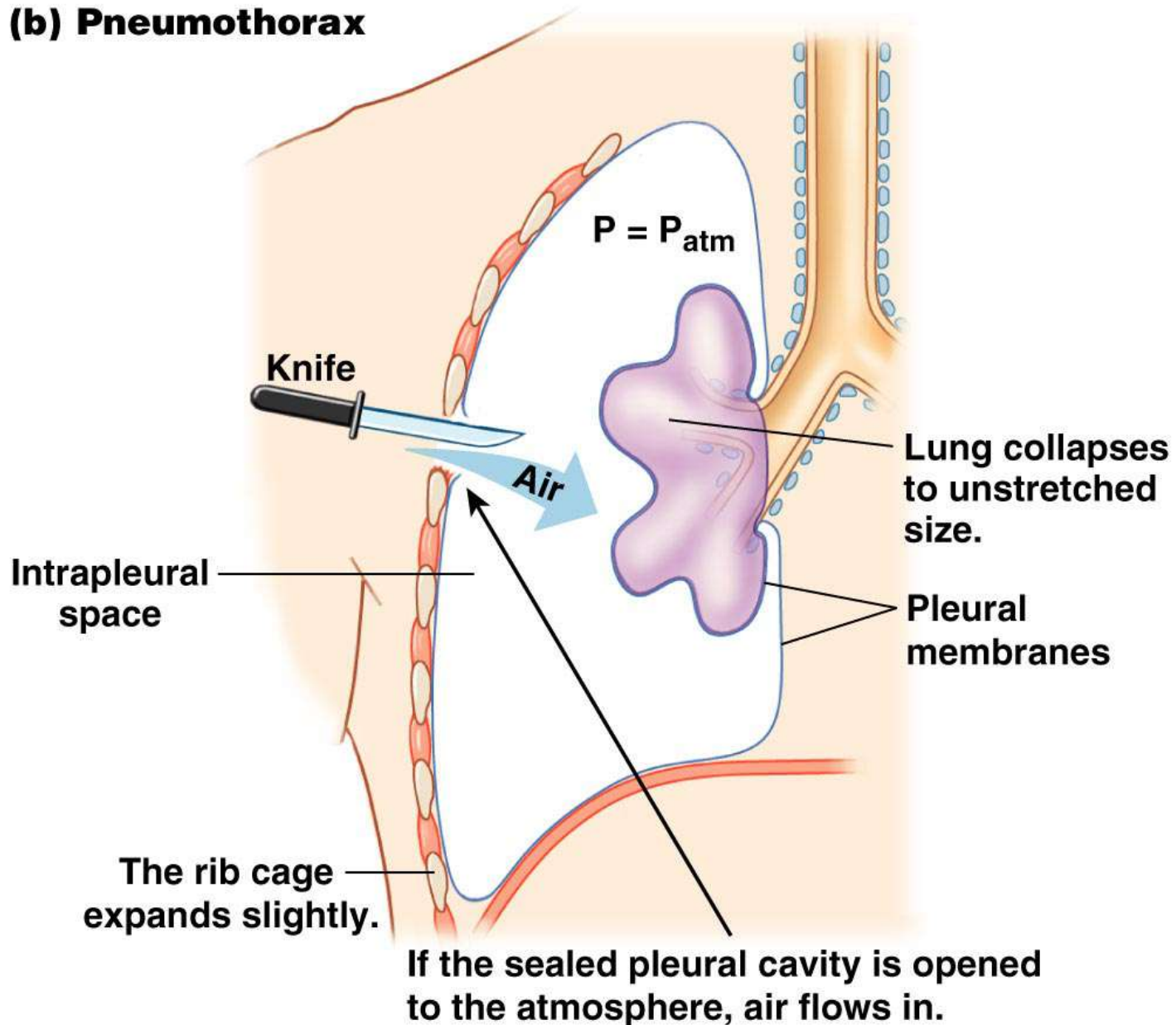
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

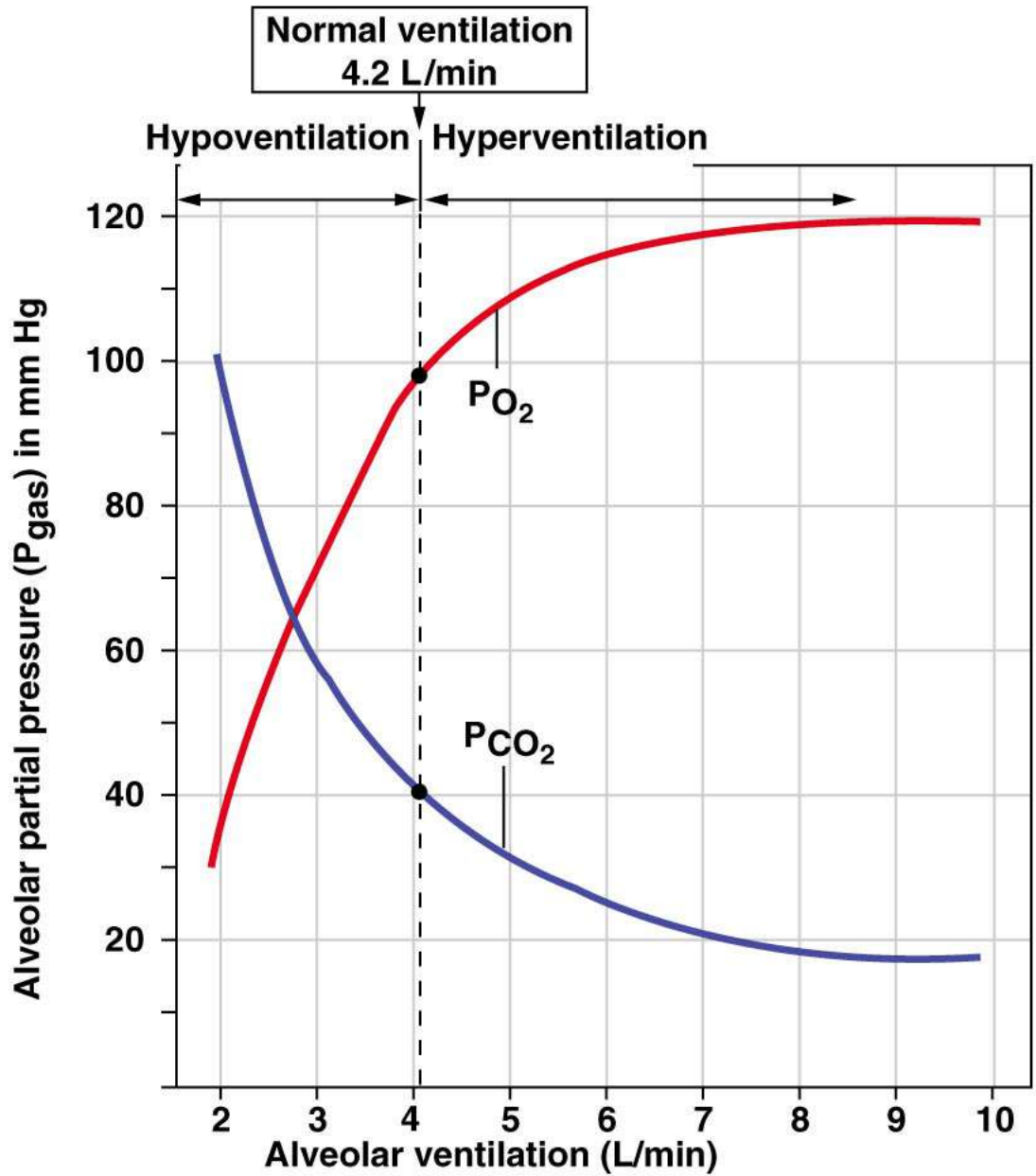
Figure 17-11

(a) Normal lung at rest



(b) Pneumothorax

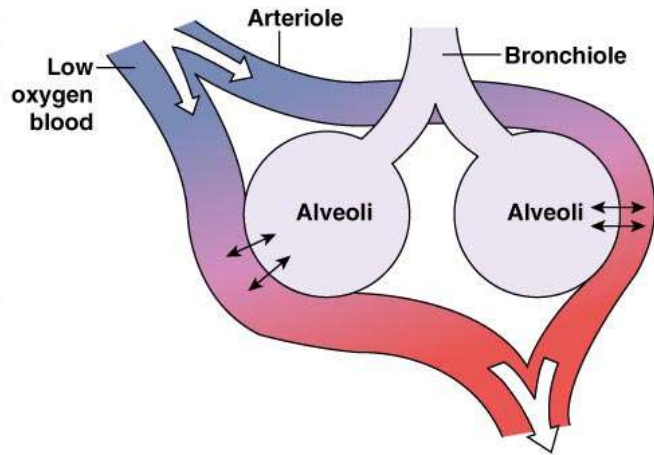




Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

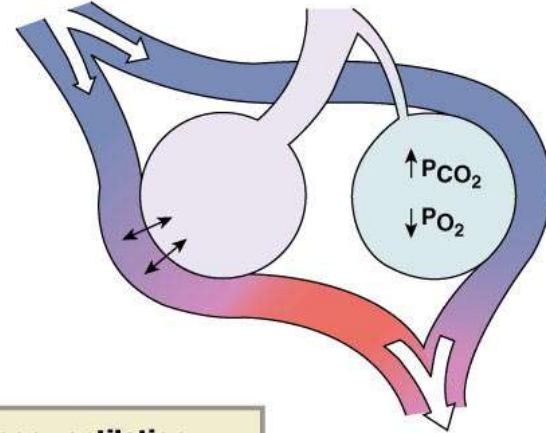
Figure 17-15

(a) Ventilation in alveoli is matched to perfusion through pulmonary capillaries.



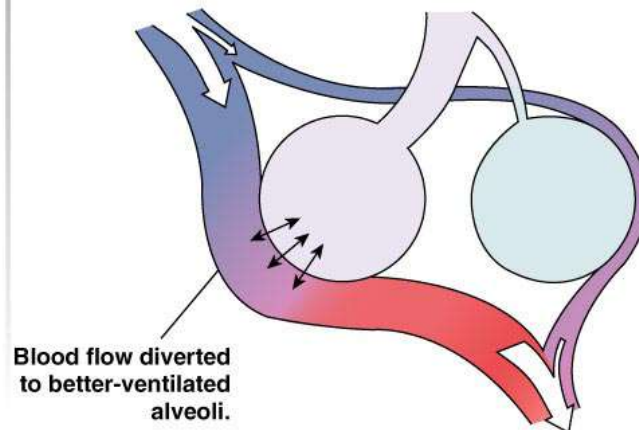
(b) Ventilation-perfusion mismatch.

If ventilation decreases in a group of alveoli (blue), PCO_2 increases and PO_2 decreases. Blood flowing past those alveoli does not get oxygenated.

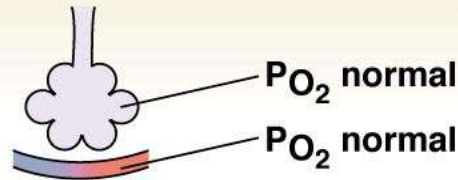


(c) Local control mechanisms try to keep ventilation and perfusion matched.

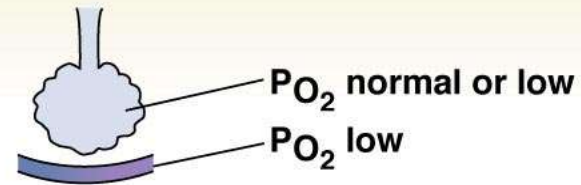
Decreased tissue PO_2 around underventilated alveoli constricts their arterioles, diverting blood to better-ventilated alveoli.



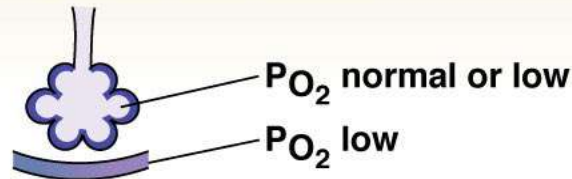
(a) Normal lung



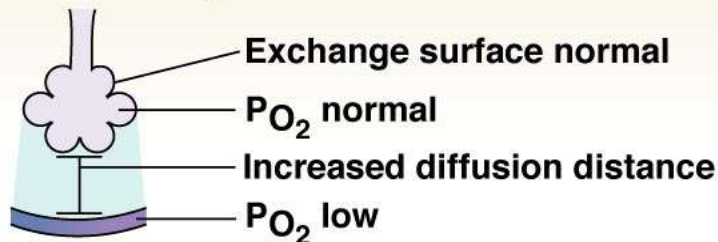
(b) Emphysema: destruction of alveoli reduces surface area for gas exchange.



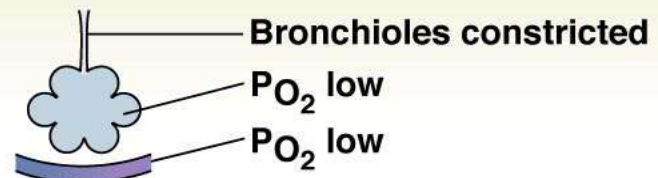
(c) Fibrotic lung disease: thickened alveolar membrane slows gas exchange. Loss of lung compliance may decrease alveolar ventilation.

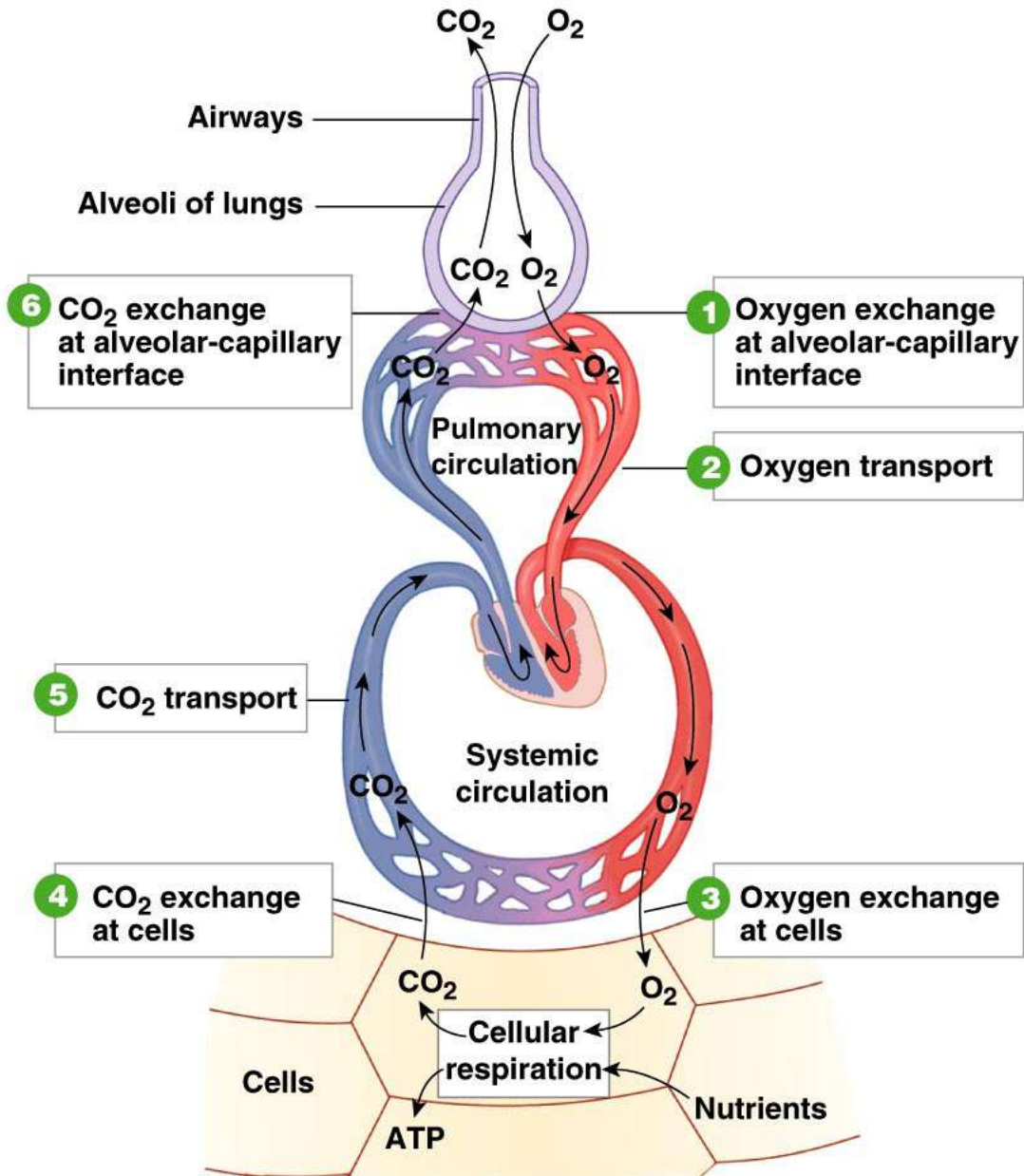


(d) Pulmonary edema: fluid in interstitial space increases diffusion distance. Arterial PCO₂ may be normal due to higher CO₂ solubility in water.



(e) Asthma: increased airway resistance decreases airway ventilation.

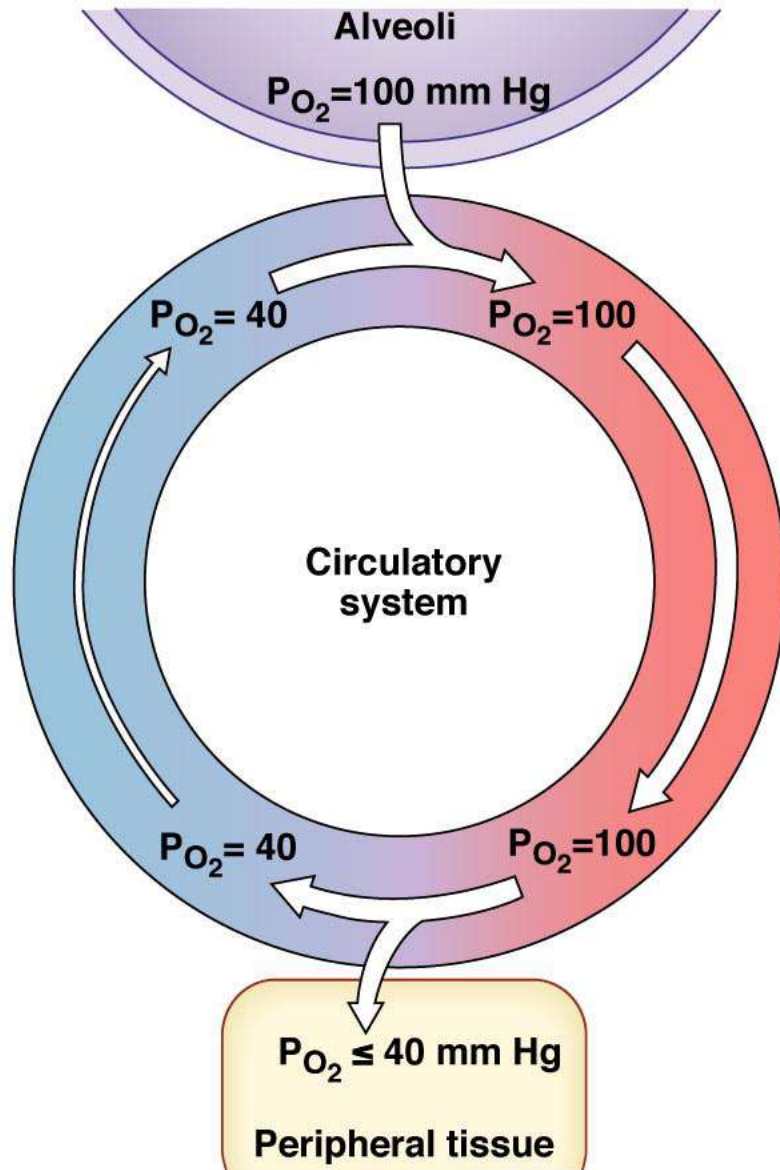




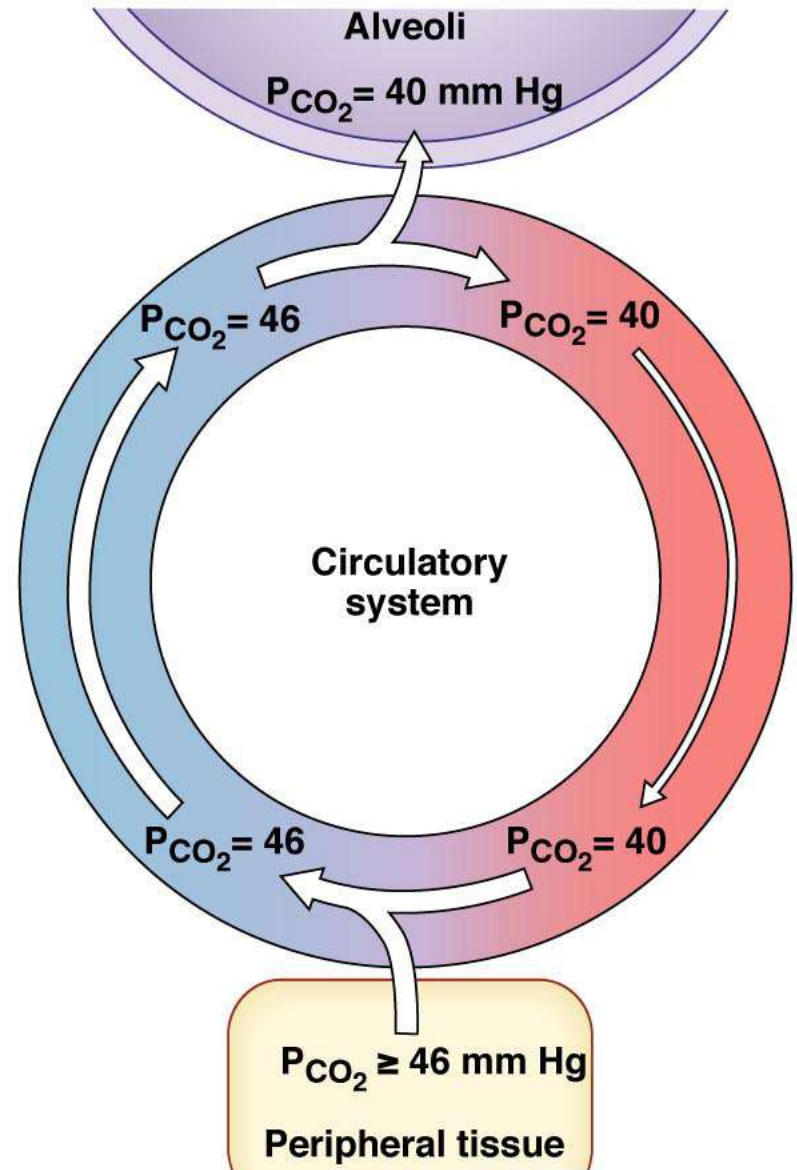
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-1 - Overview

(a) Oxygen diffusion



(b) CO₂ diffusion



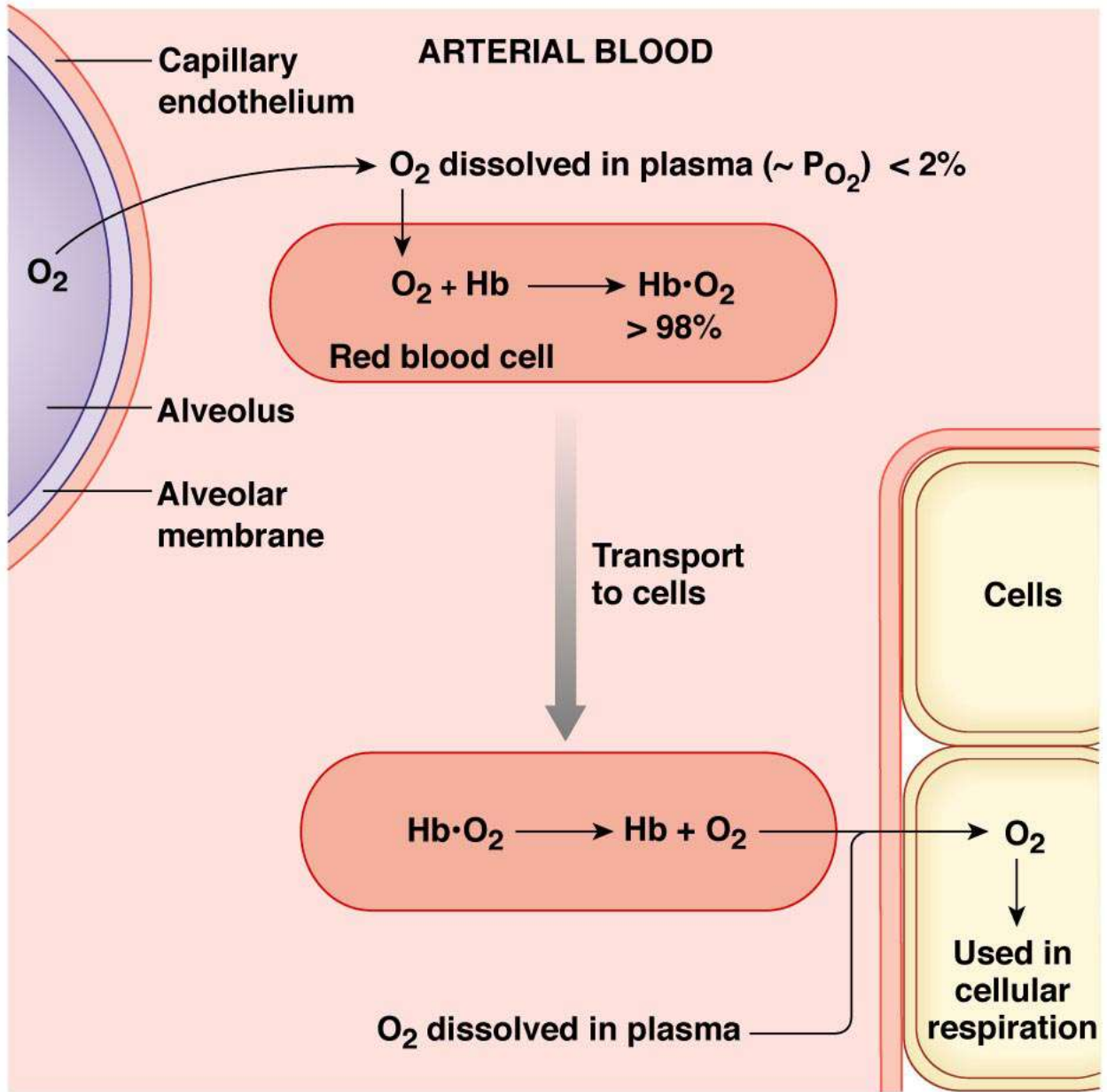
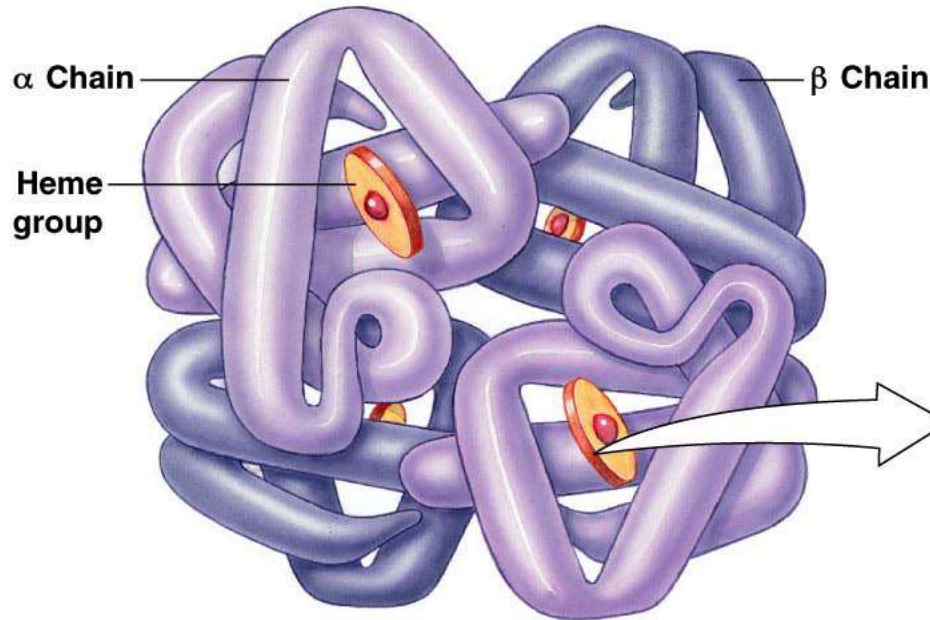


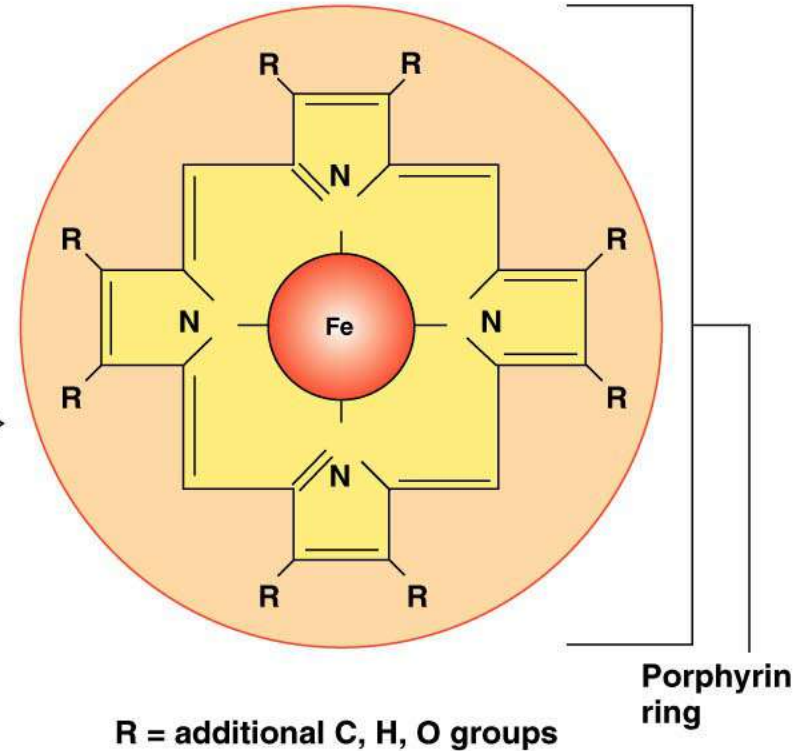
Figure 18-6

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

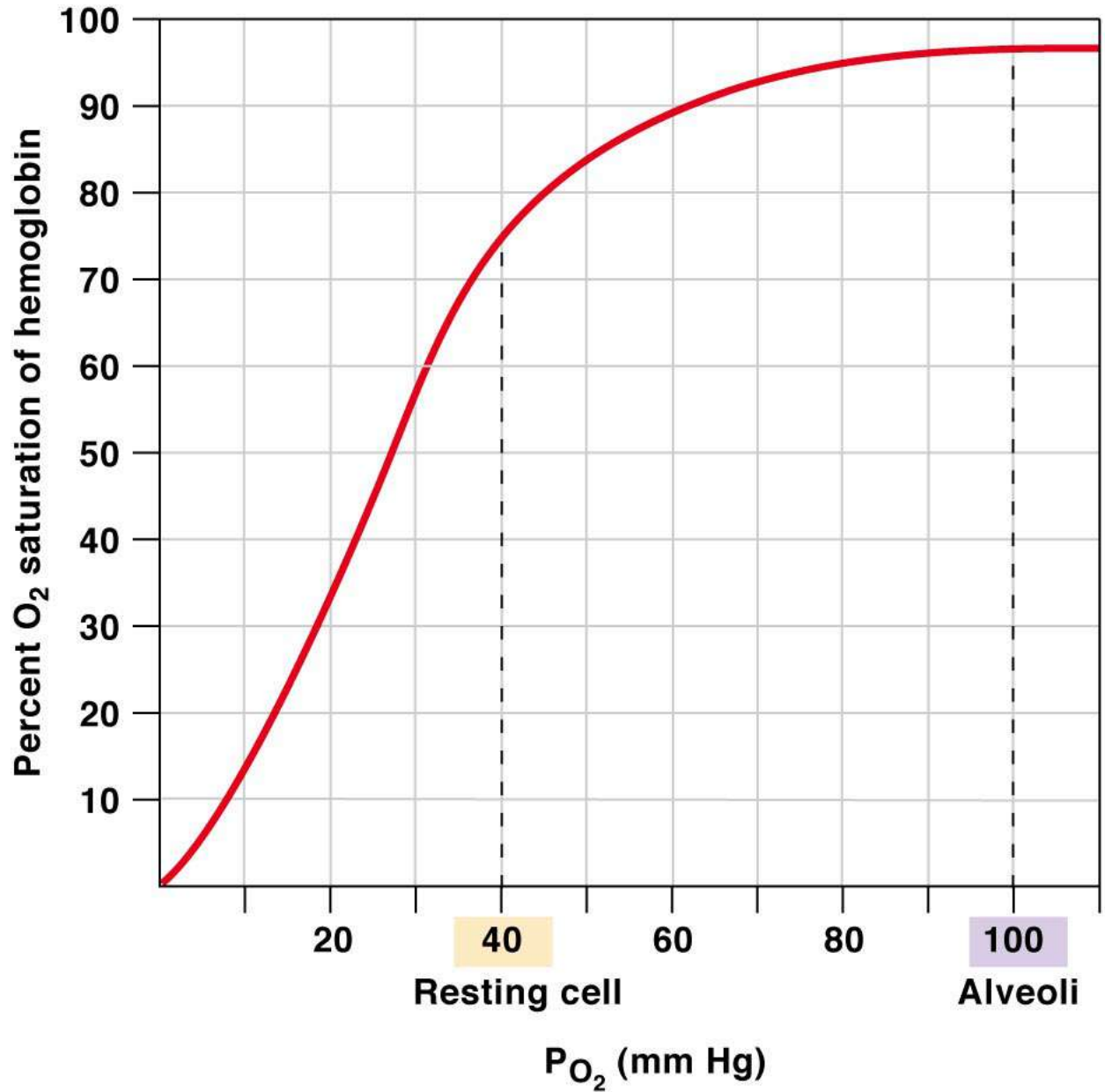


In most adult hemoglobin, there are two alpha chains and two beta chains as shown.

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



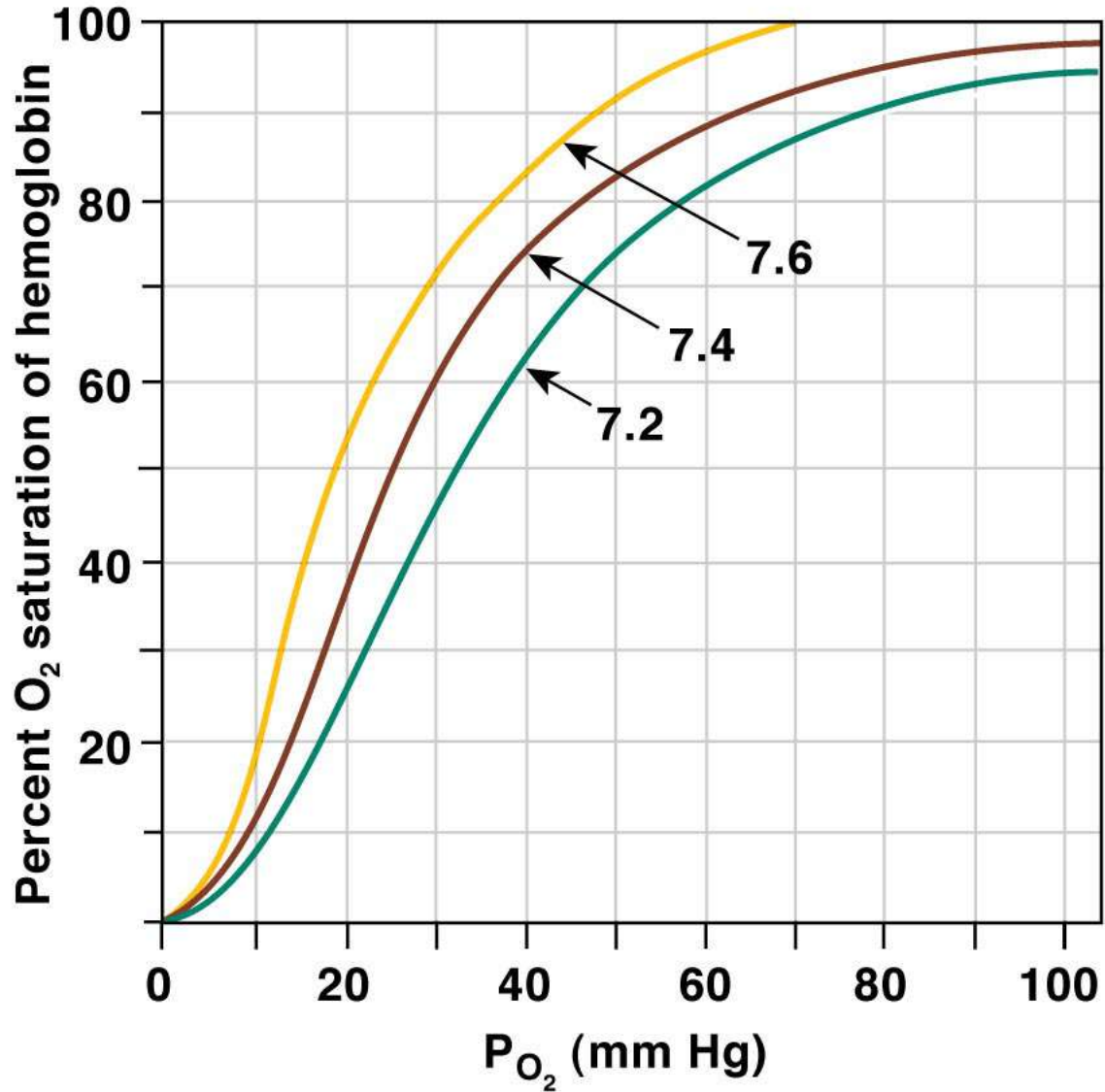
Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-9

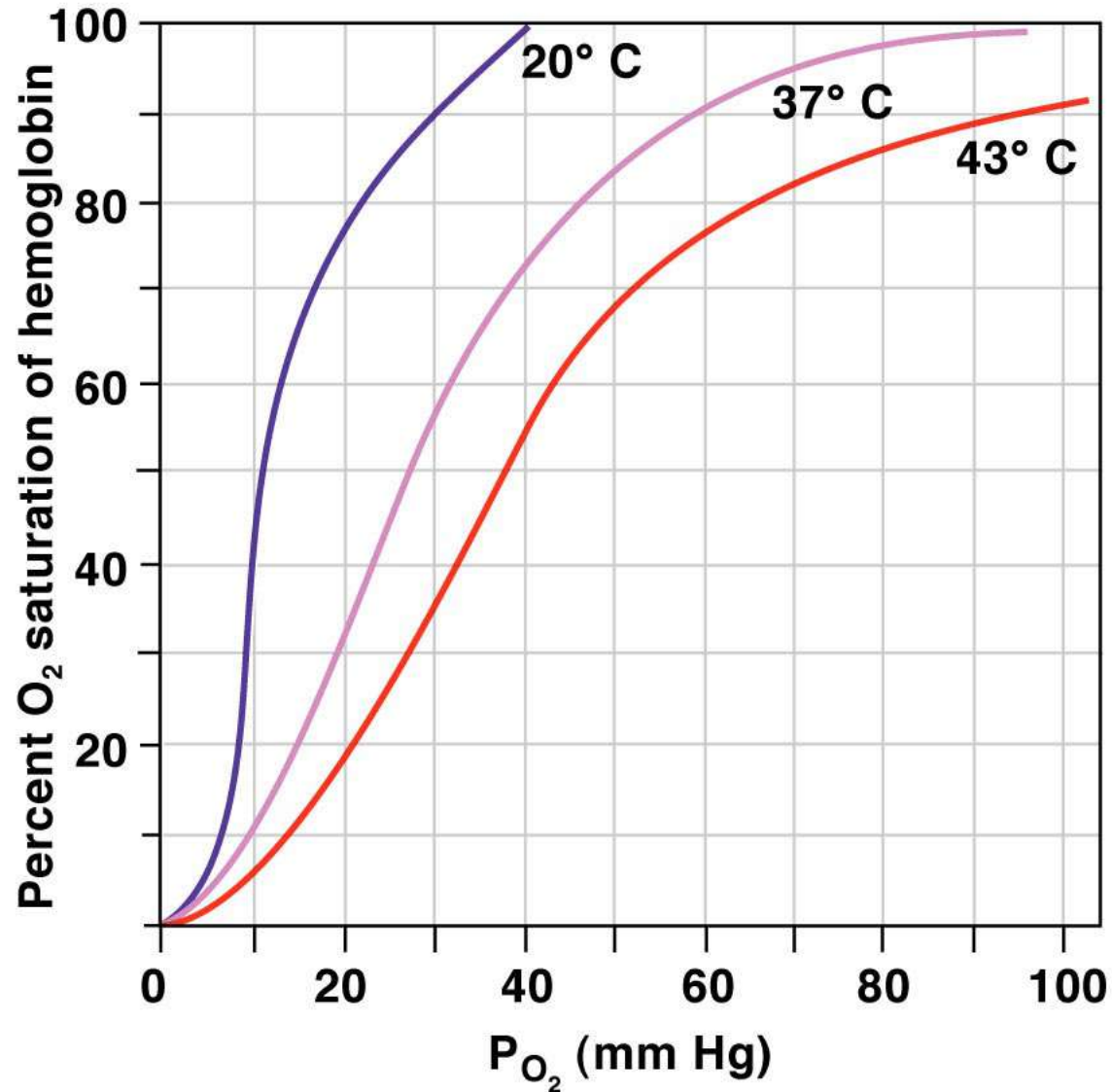
(a) Effect of pH



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-10a

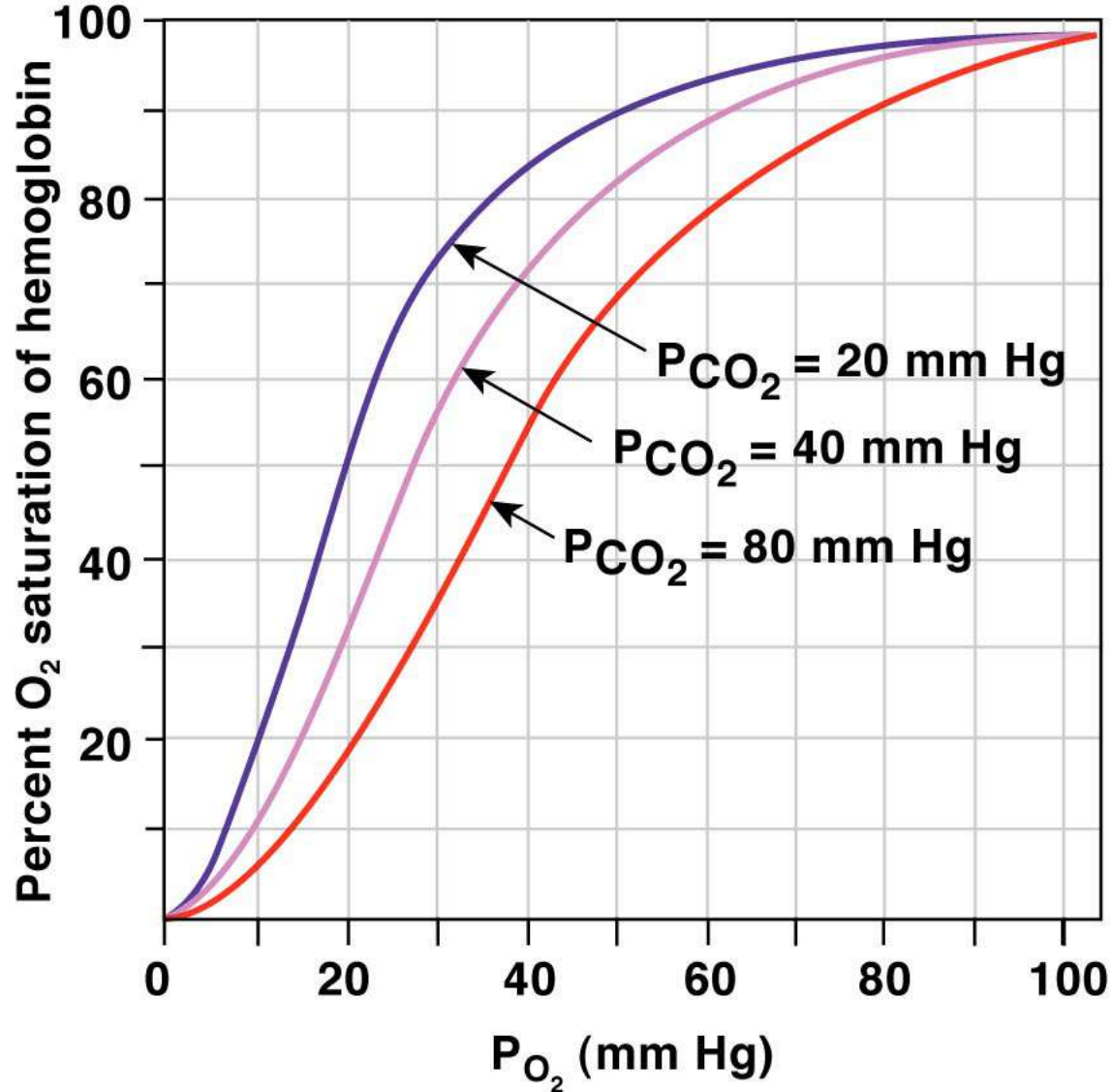
(b) Effect of temperature



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

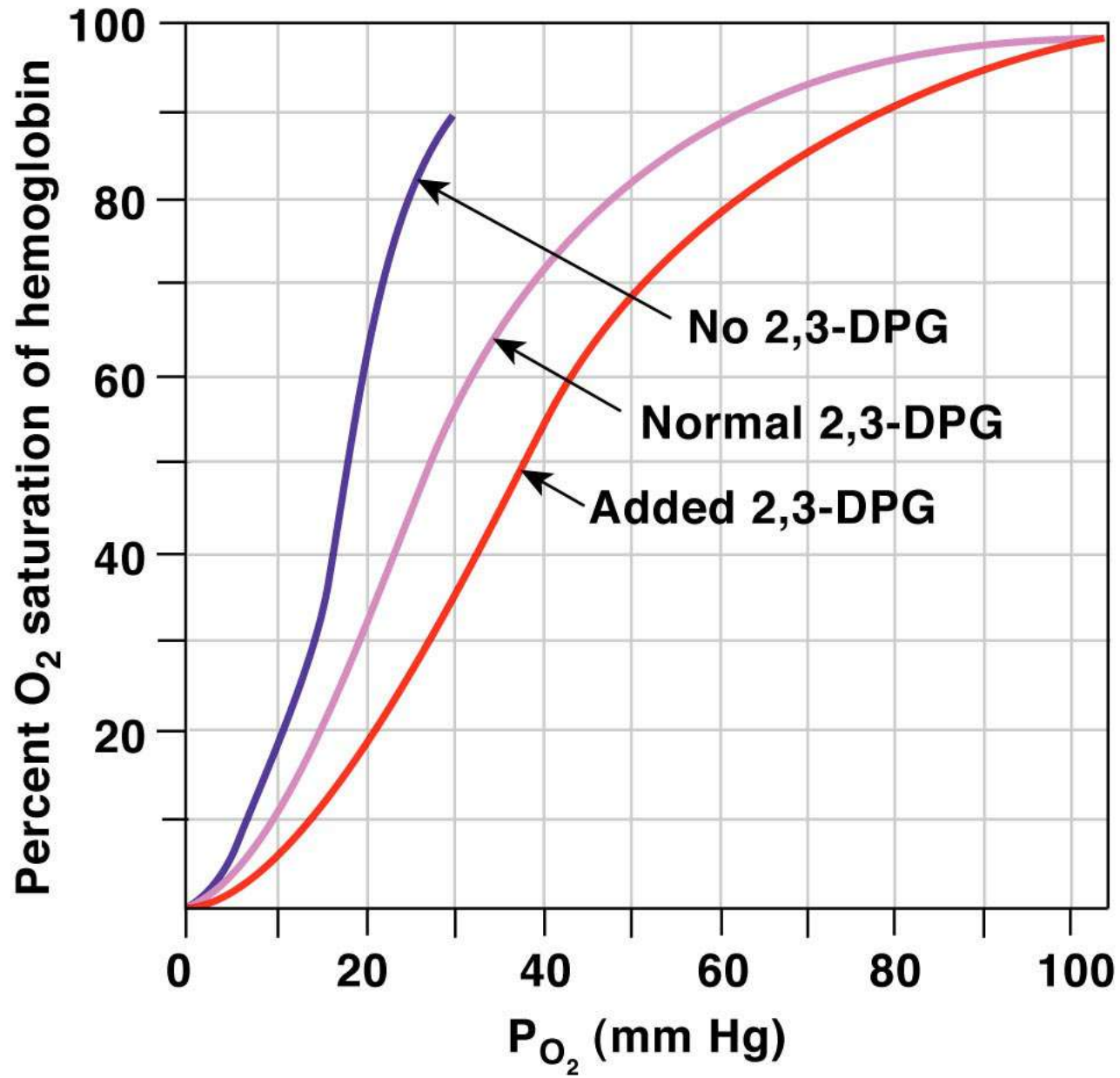
Figure 18-10b

(c) Effect of P_{CO_2}



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

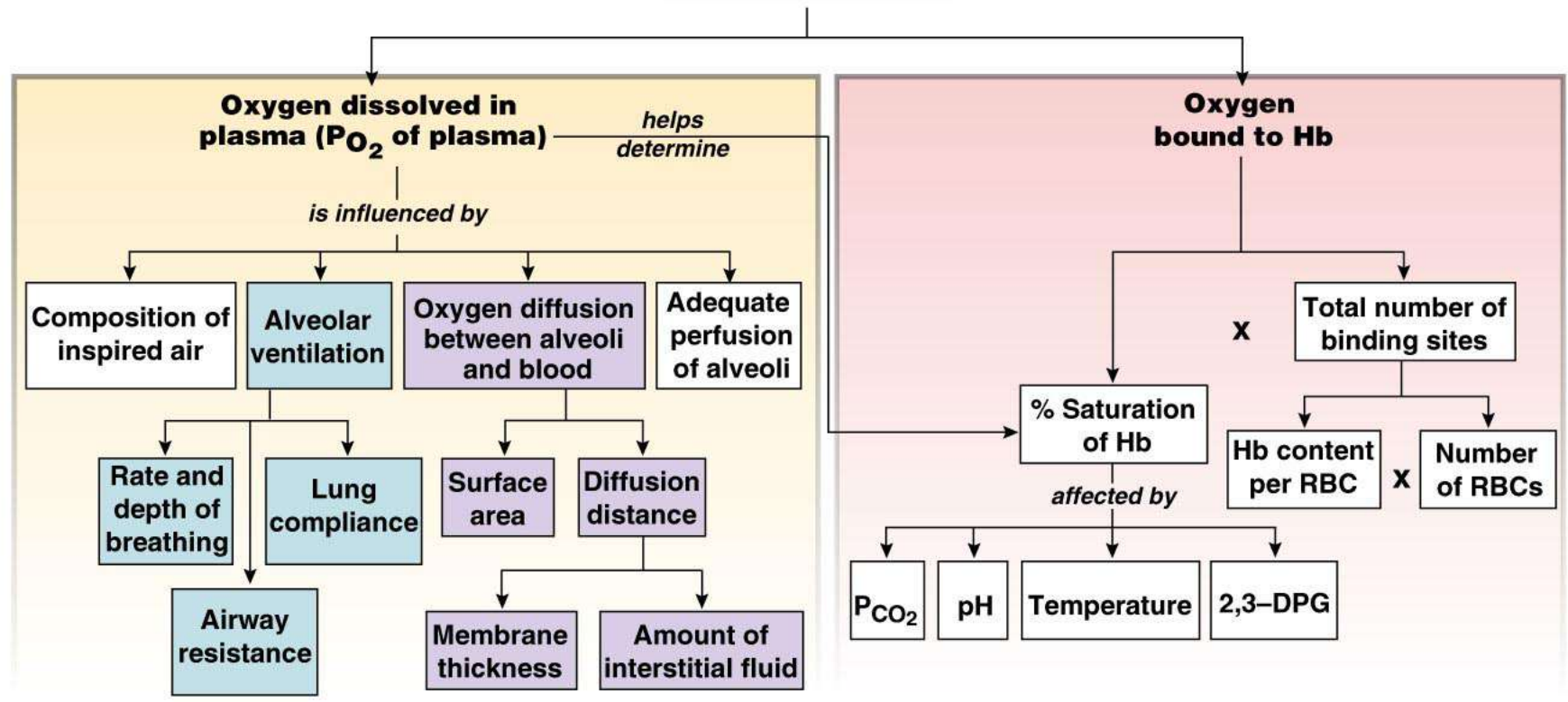
Figure 18-10c



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

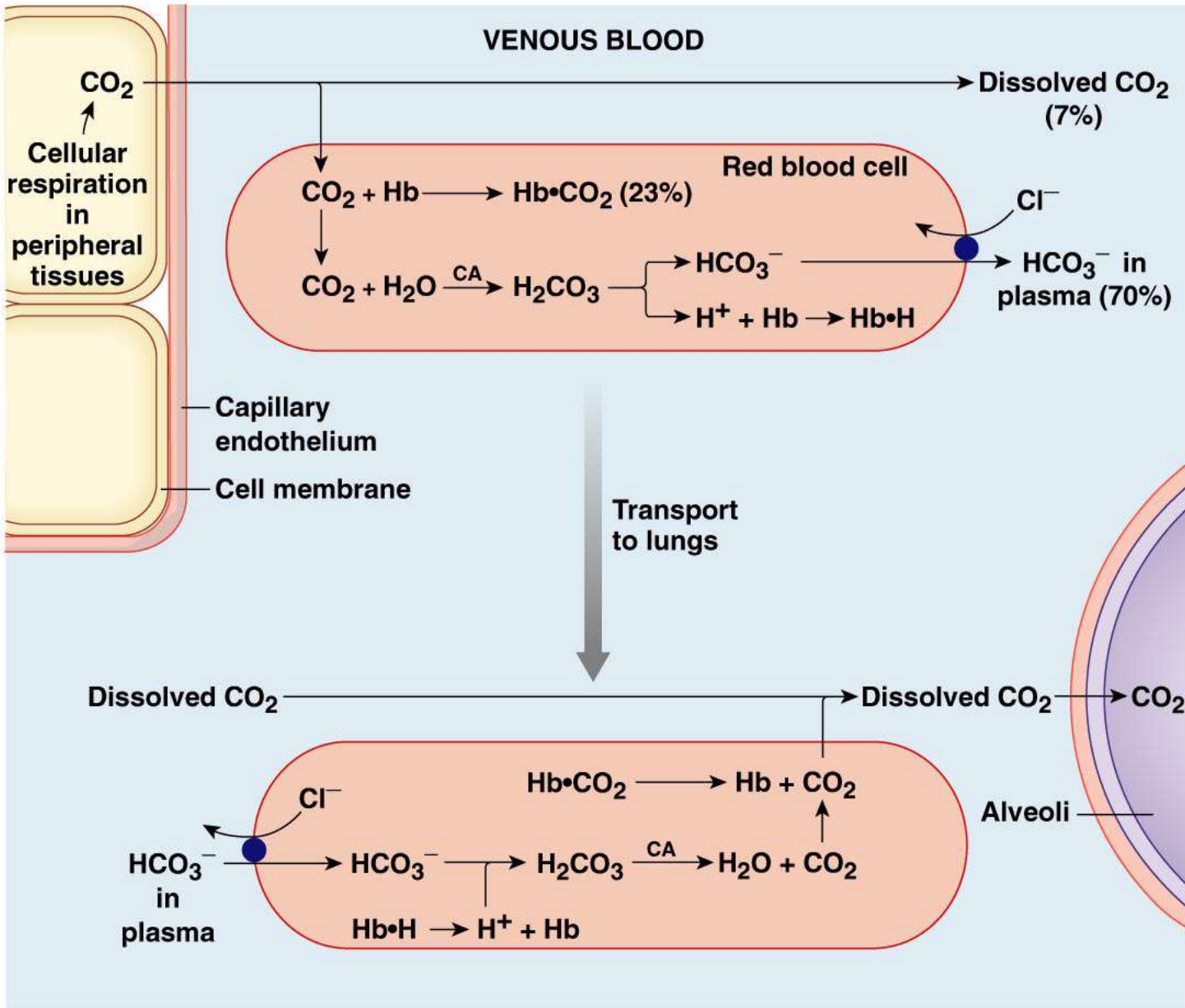
Figure 18-11

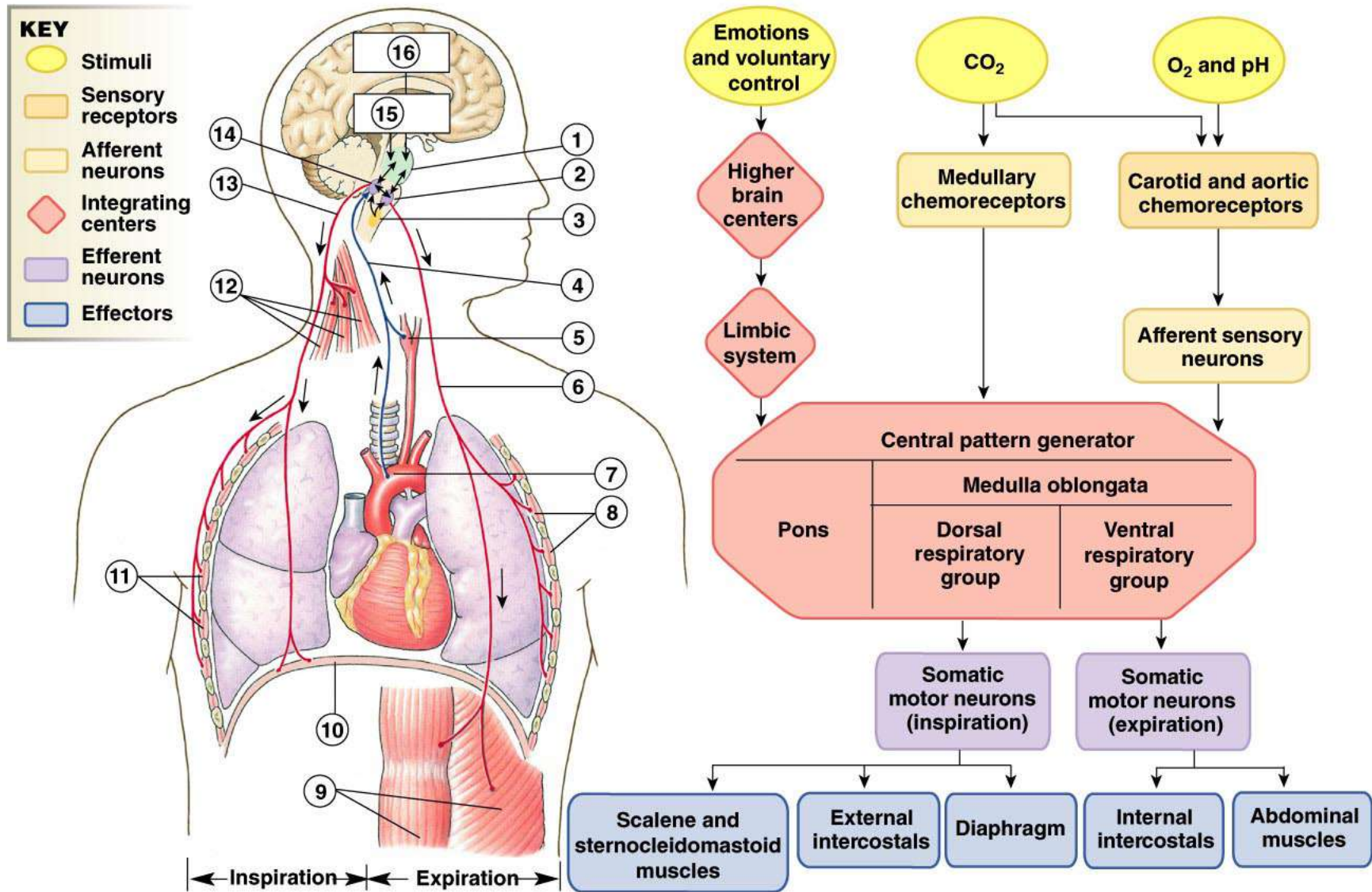
TOTAL ARTERIAL O₂ CONTENT



Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-13





Copyright © 2007 Pearson Education, Inc., publishing as Benjamin Cummings.

Figure 18-16

Medullary Respiratory Centers

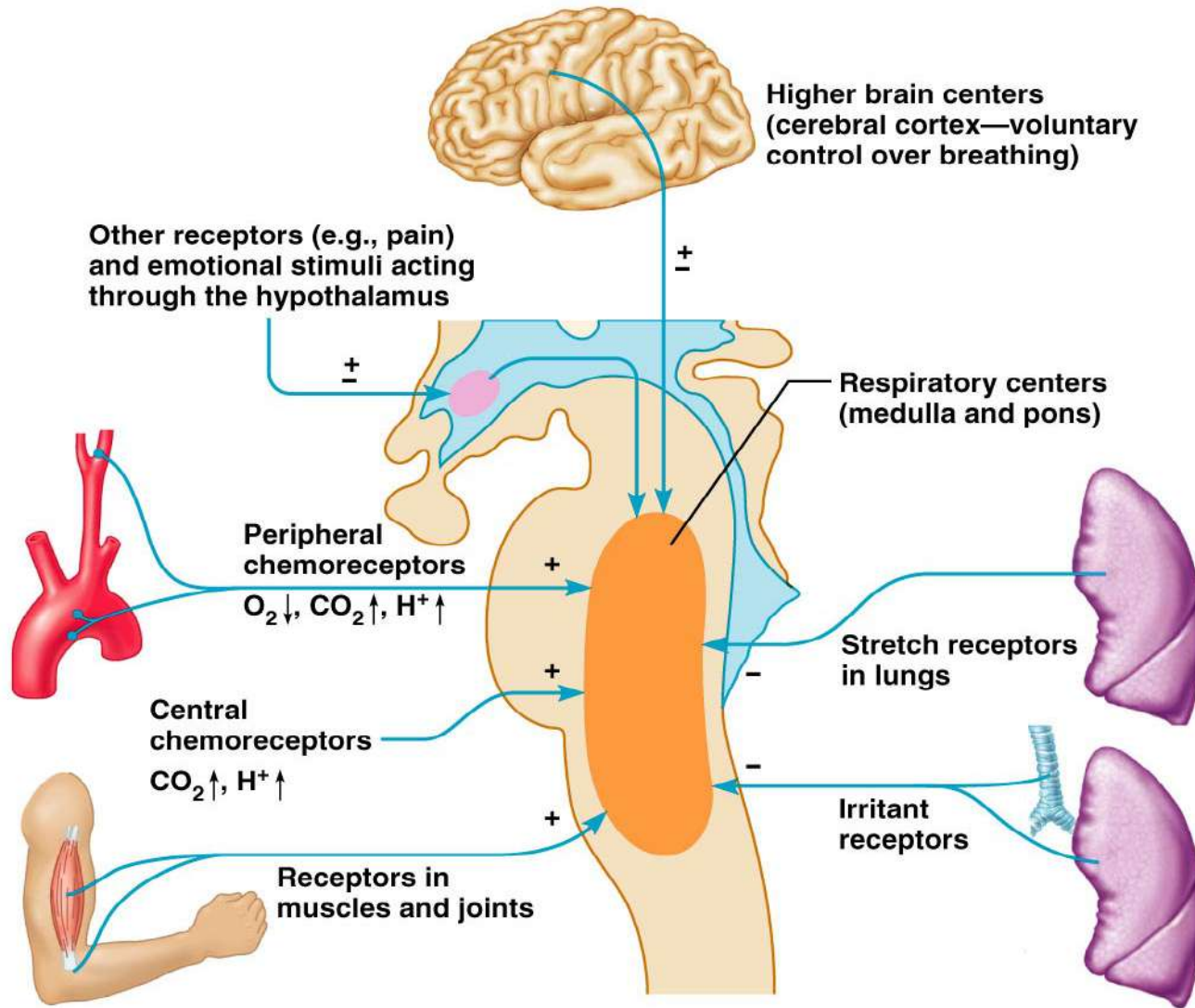


Figure 22.25

