Respiratory System

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Respiratory System

- Consists of the respiratory and conducting zones
- **Respiratory zone:**
  - Site of gas exchange
  - Consists of bronchioles, alveolar ducts, and alveoli
- **Conducting zone:**
  - Conduits for air to reach the sites of gas exchange
  - Includes all other respiratory structures (e.g., nose, nasal cavity, pharynx, trachea)
- **Respiratory muscles:**
- Diaphragm, Intercostals, Abdominal and other muscles that promote ventilation

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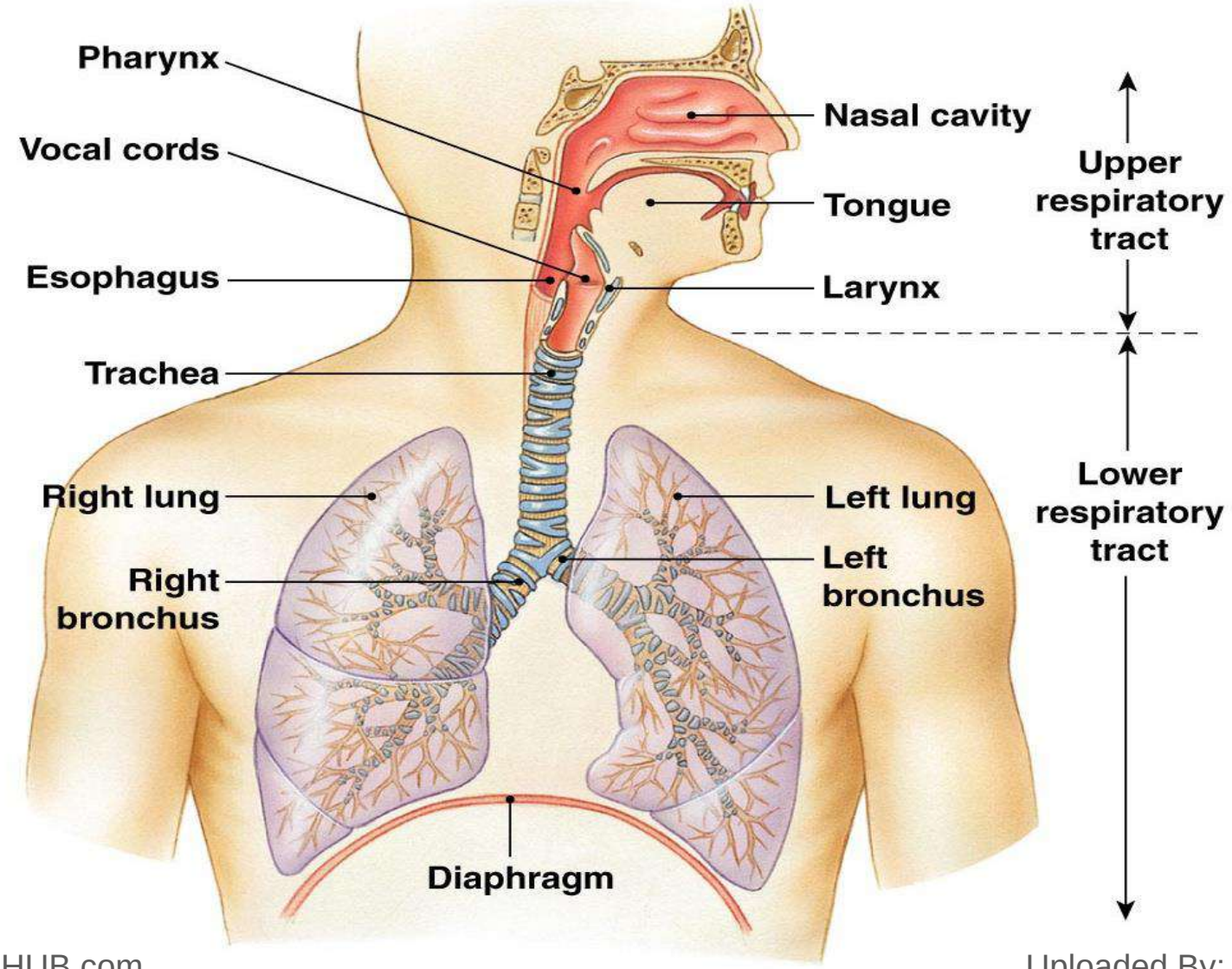
Respiratory System



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Respiration – four distinct processes

- **Pulmonary ventilation** – moving air into and out of the lungs
- **Chemical Respiration**– gas exchange between the lungs and the blood
- **Transport** – transport of oxygen and carbon dioxide between the lungs and tissues
- **Internal respiration** – gas exchange between systemic blood vessels and tissues

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Major Functions of the Respiratory System

- To supply the body with oxygen and dispose of carbon dioxide

- **WHAT ELSE?????**

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Function of the Nose

- The only externally visible part of the respiratory system that functions by:
  - Providing an airway for respiration
  - Moistening and warming the entering air
  - Filtering inspired air and cleaning it of foreign matter
  - Serving as a resonating chamber for speech
  - Housing the olfactory receptors

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Nasal Cavity

- **Vestibule** – nasal cavity superior to the nares
  - Vibrissae – hairs that filter coarse particles from inspired air
- **Olfactory mucosa**
  - Lines the superior nasal cavity
  - Contains smell receptors
- **Respiratory mucosa**
  - Lines the balance of the nasal cavity
  - Glands secrete mucus containing lysozyme and defensins to help destroy bacteria

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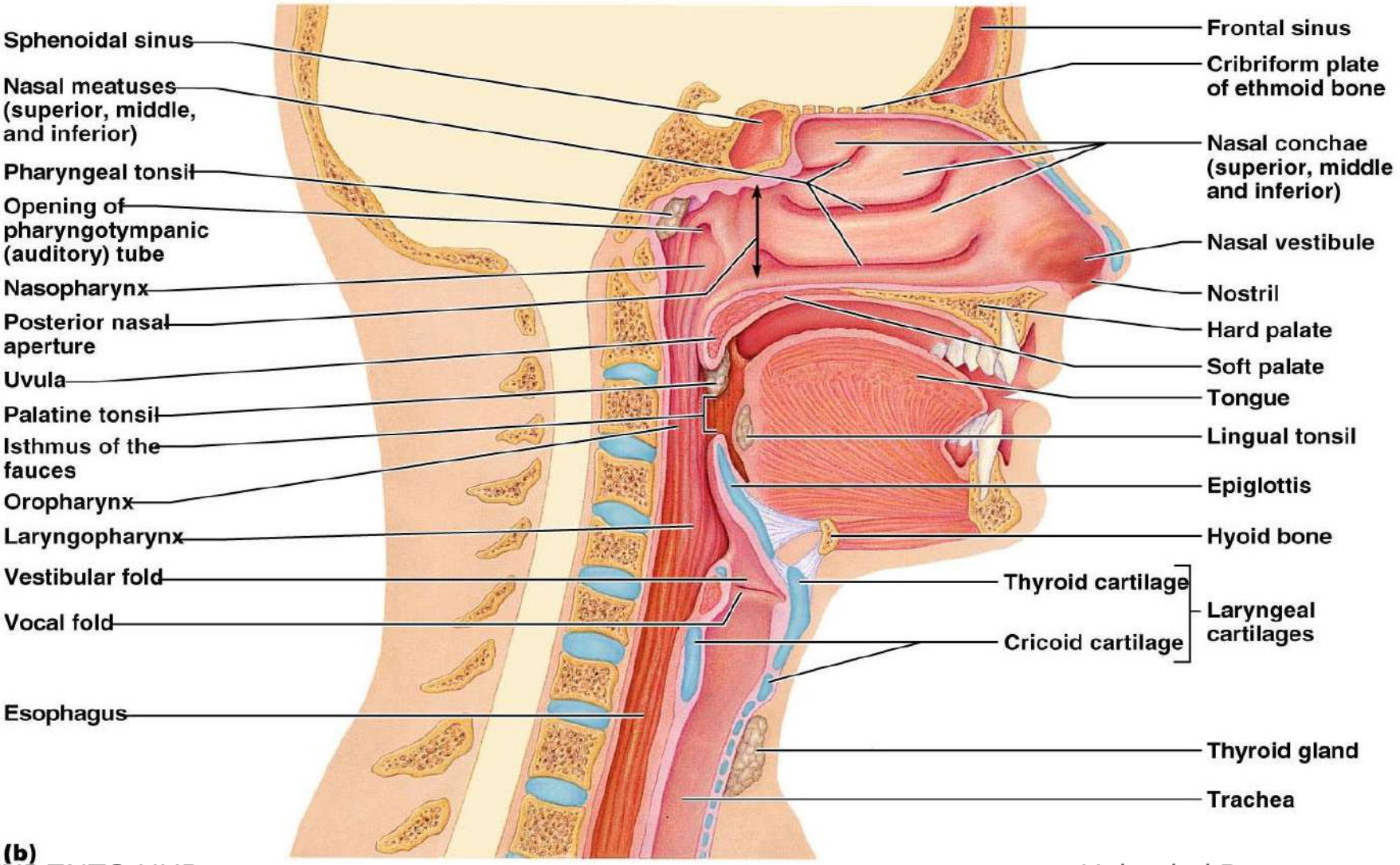
Nasal Cavity



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Functions of the Nasal Mucosa

- During inhalation the conchae and nasal mucosa:
  - **Filter, heat, and moisten air**
- During exhalation these structures:
  - Reclaim heat and moisture
  - Minimize heat and moisture loss

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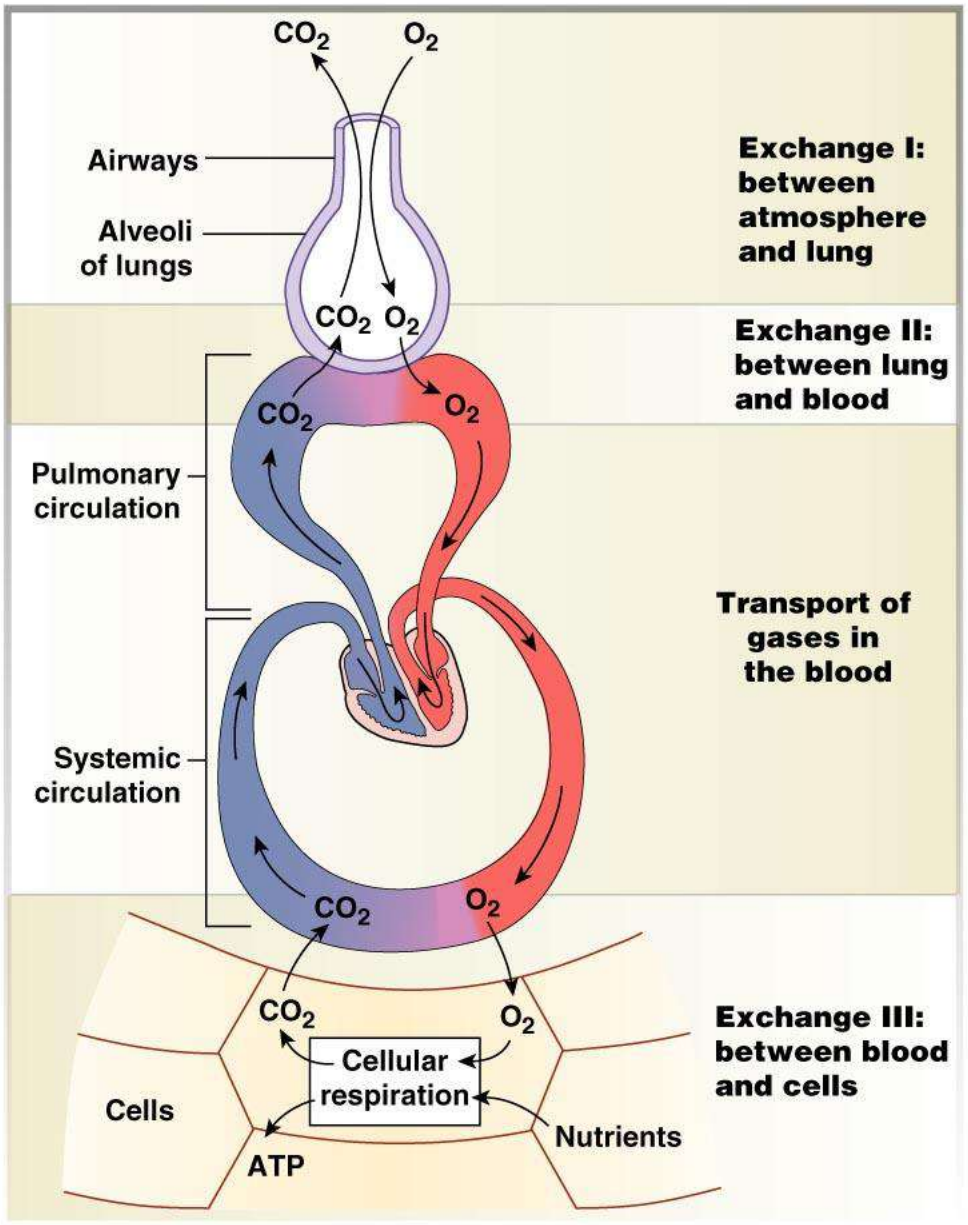

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Figure 17.1

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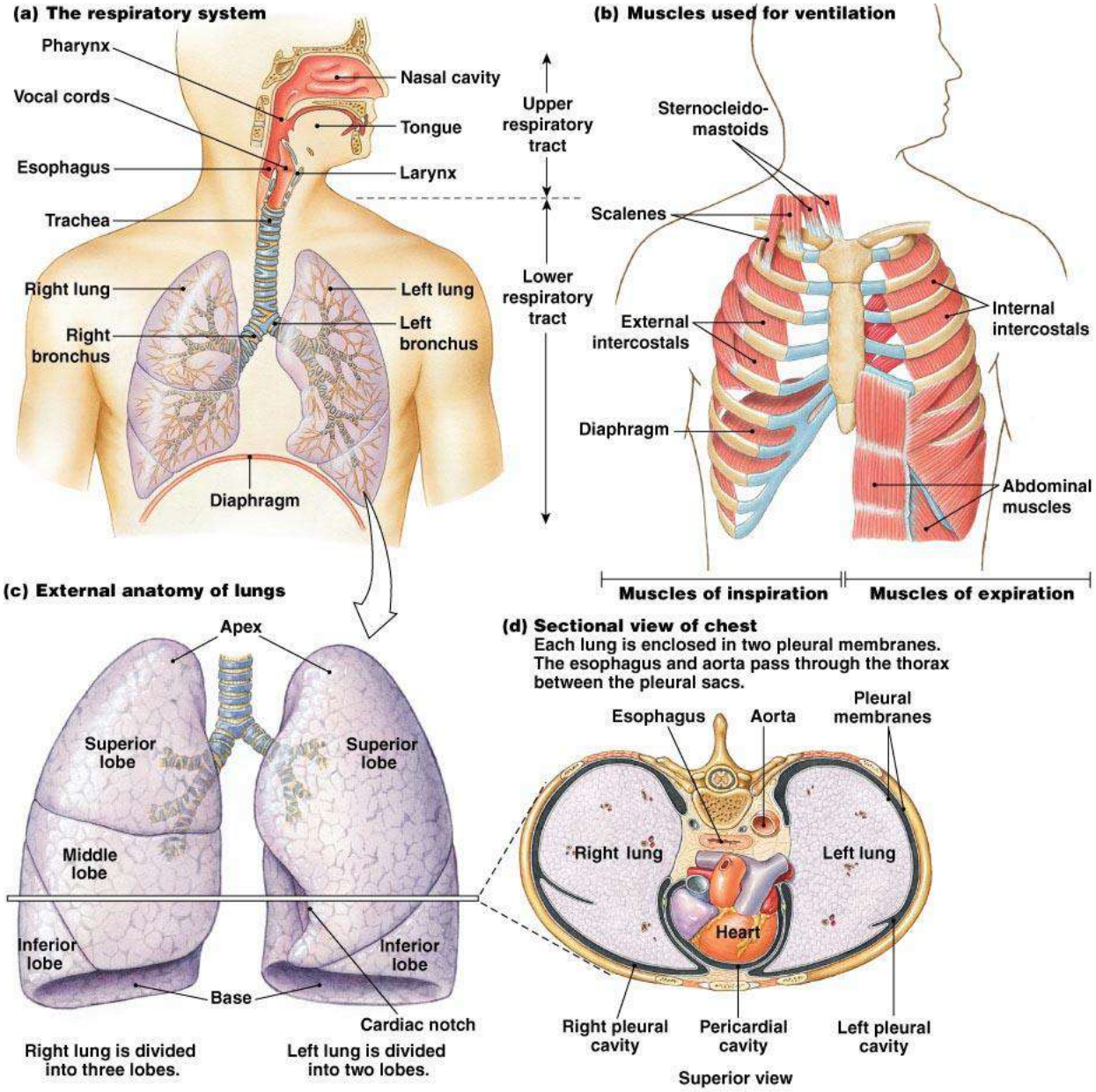

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Figure 17.2 Overview (1 of 2)

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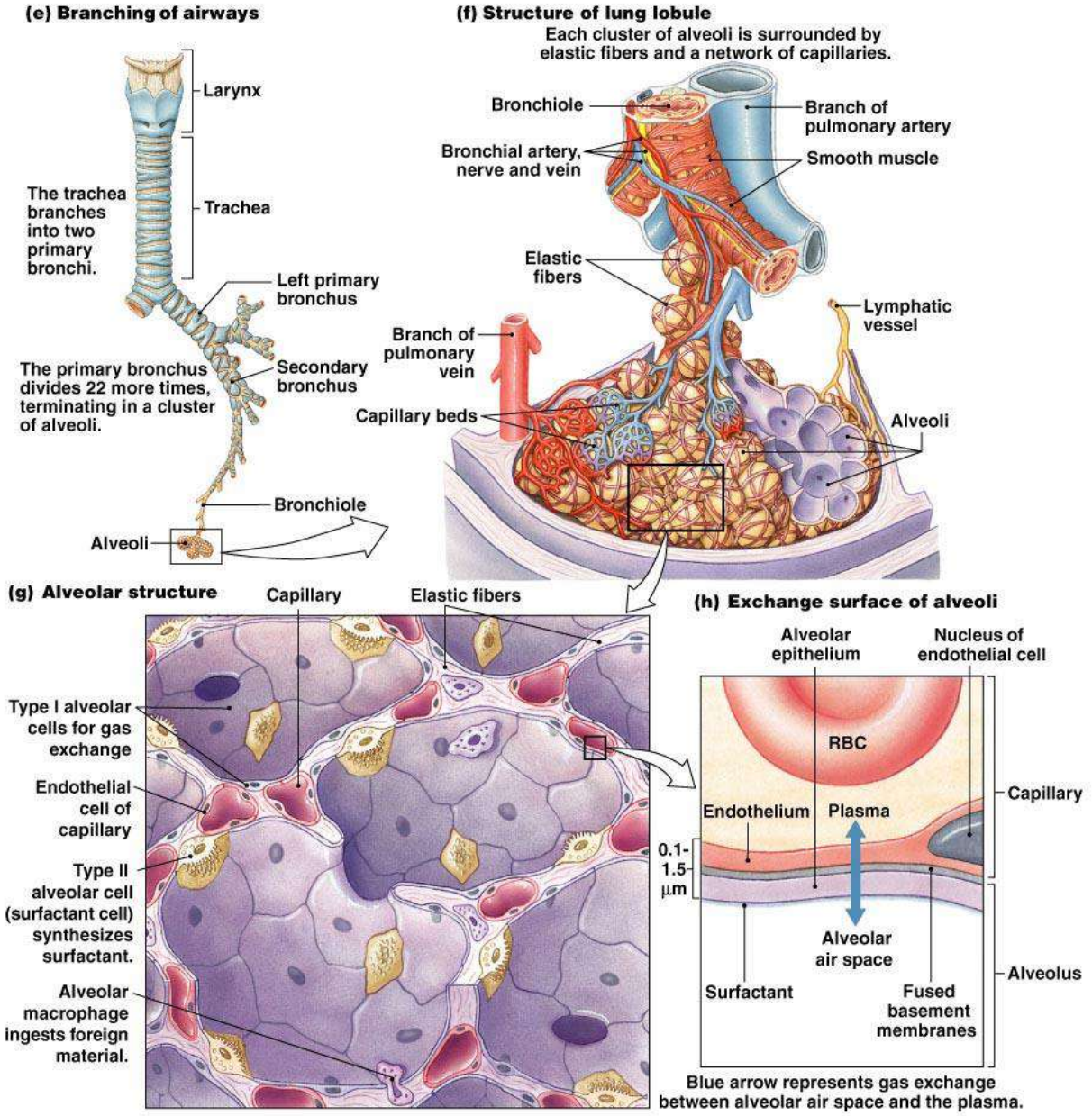

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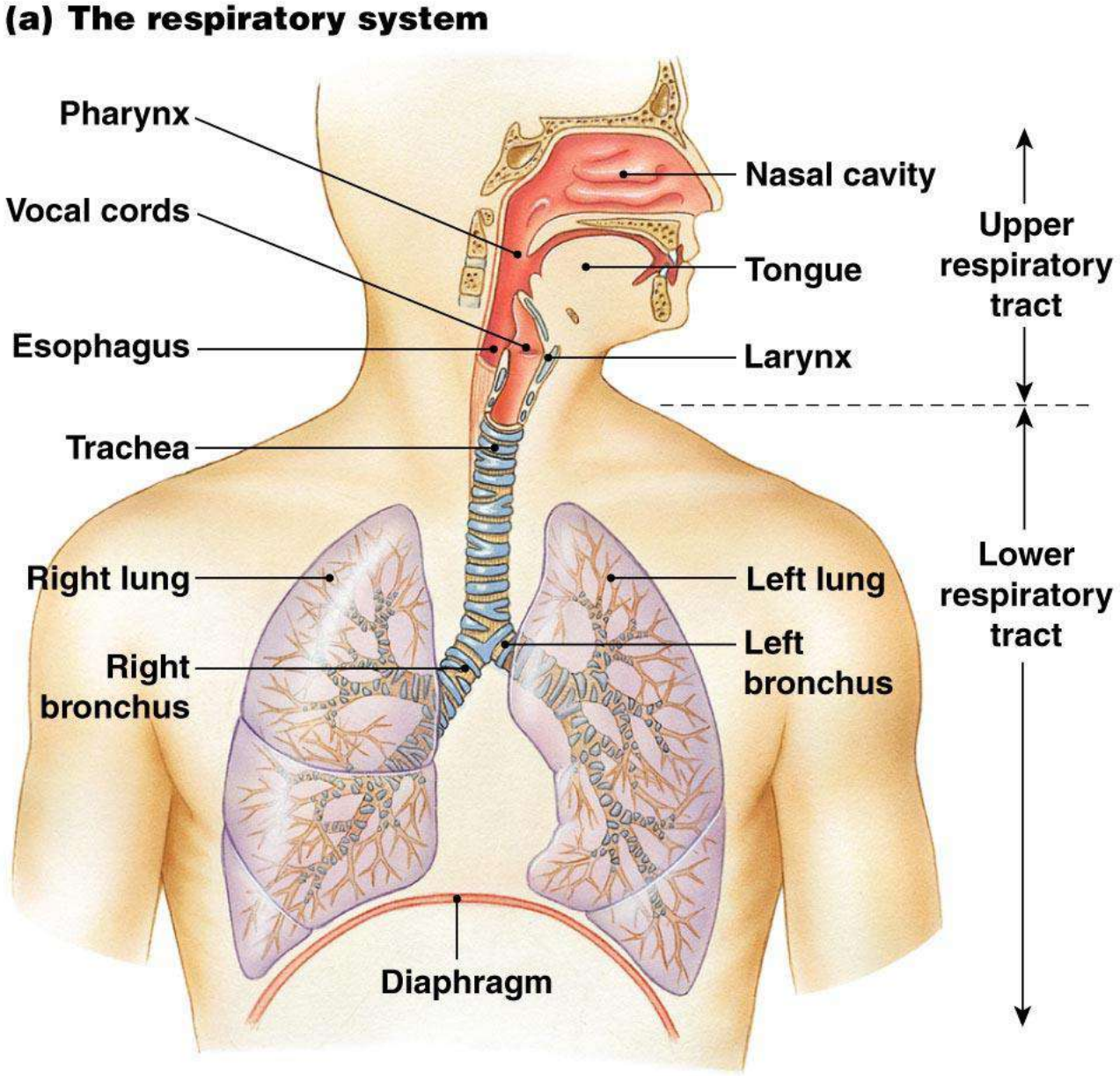

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Figure 17.2a

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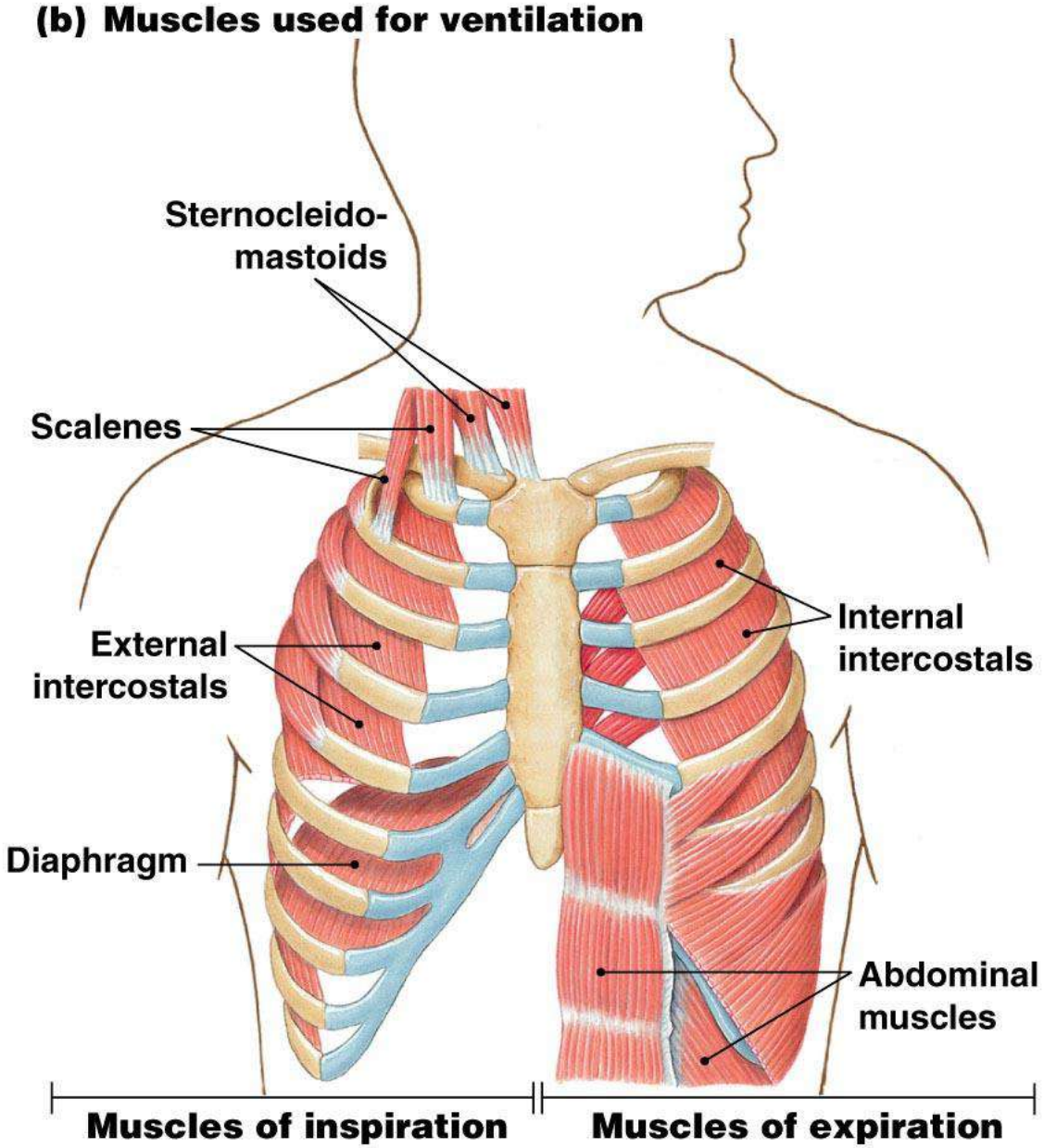

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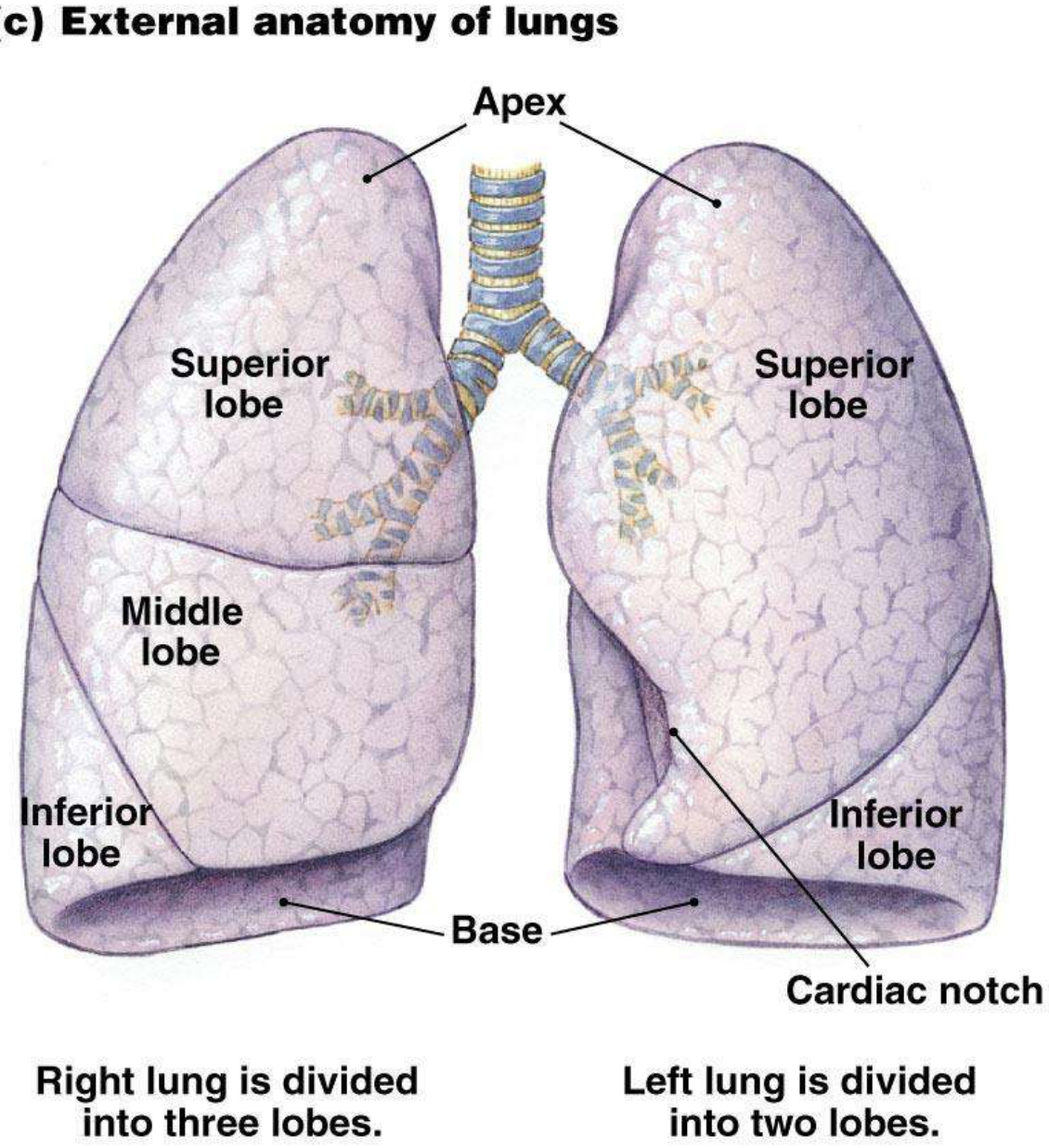

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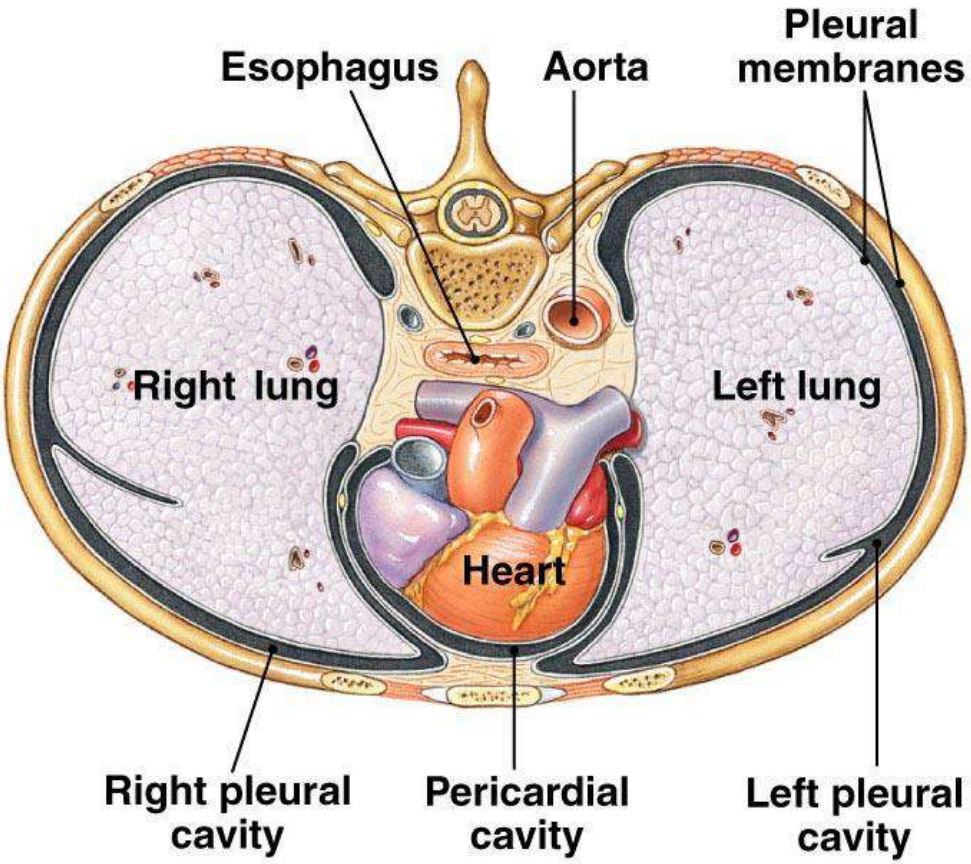
(d) Sectional view of chest
Each lung is enclosed in two pleural membranes. The esophagus and aorta pass through the thorax between the pleural sacs.



Superior view

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Trachea

- Flexible and mobile tube extending from the larynx into the mediastinum
- Composed of three layers
  - **Mucosa** – made up of goblet cells and ciliated epithelium
  - **Submucosa** – connective tissue deep to the mucosa
  - **Adventitia** – outermost layer made of C-shaped rings of hyaline cartilage

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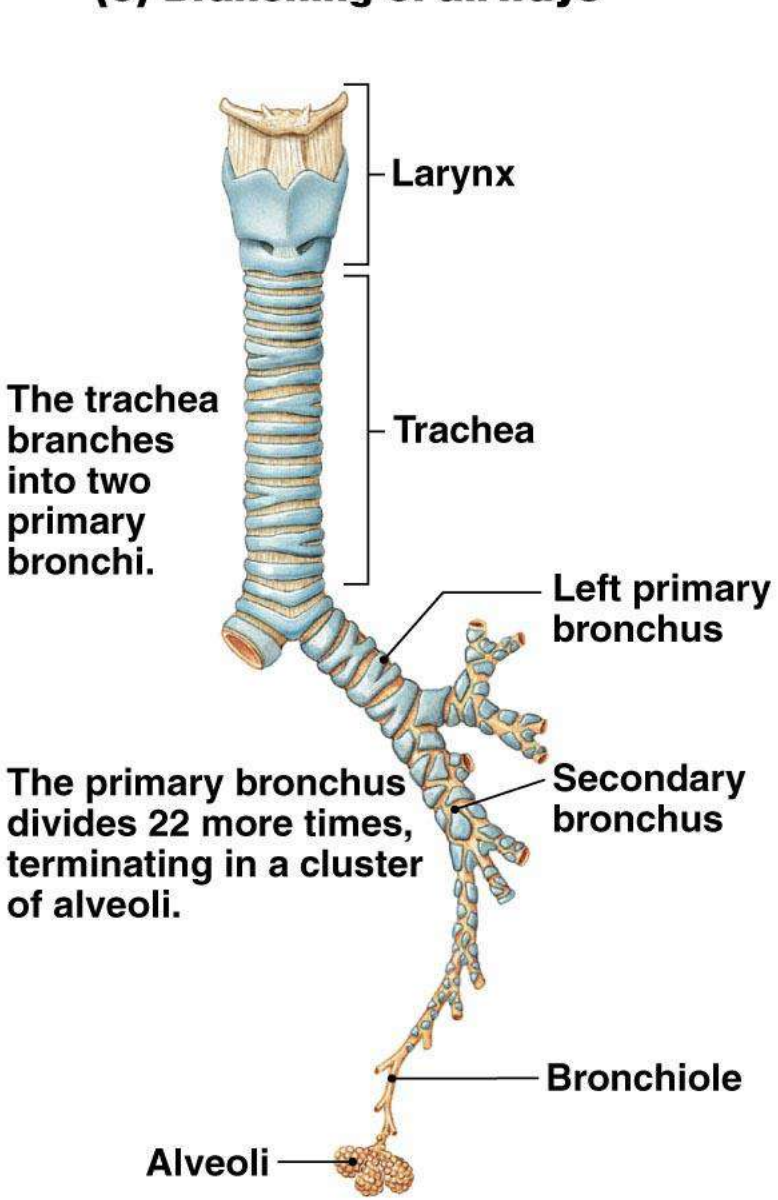

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Trachea

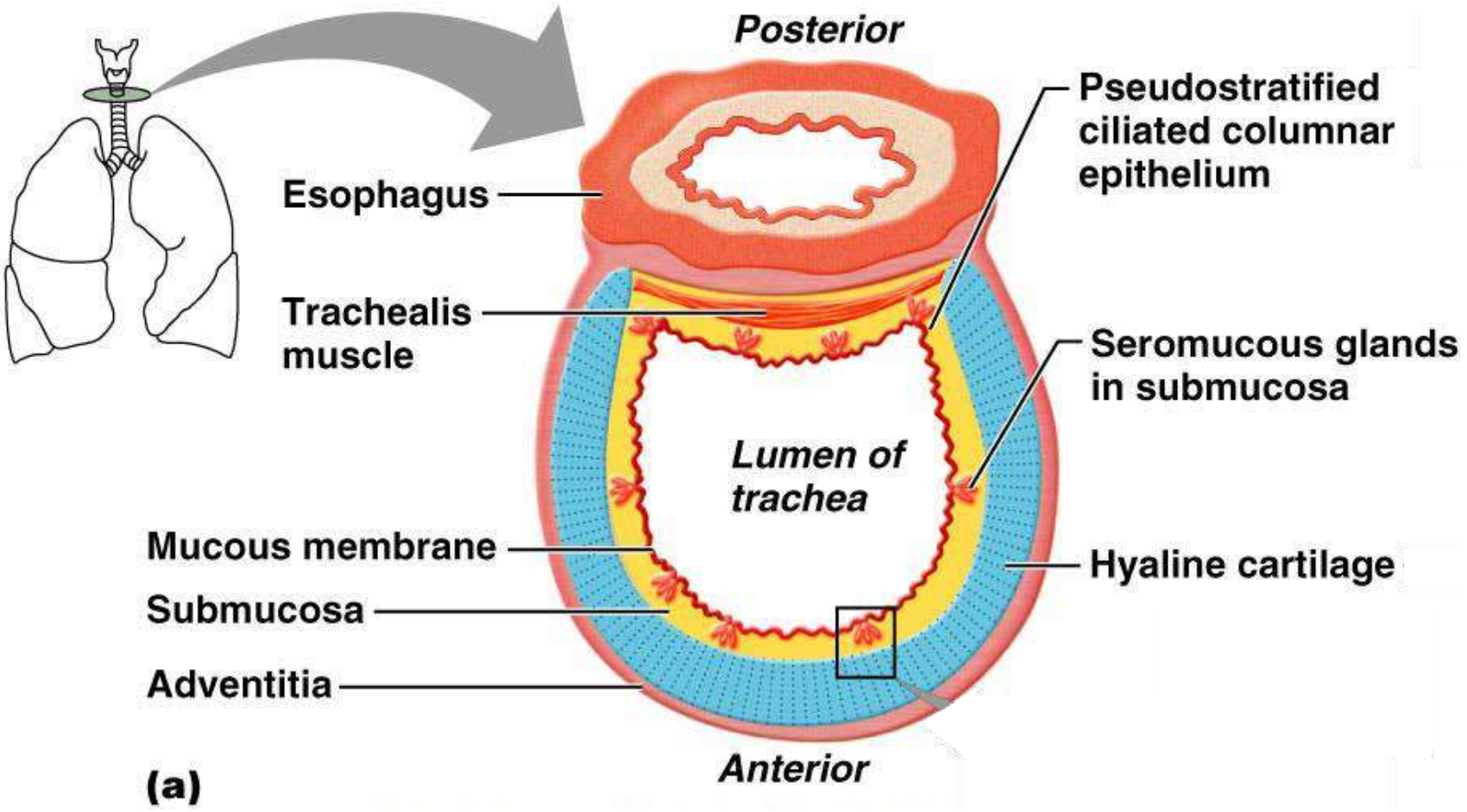

Figure 22.6a

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Conducting Zone

- **Carina** of the last tracheal cartilage marks the end of the trachea and the beginning of the bronchi
- Air reaching the bronchi is:
  - Warm and cleansed of impurities
  - Saturated with water vapor
- Bronchi subdivide into secondary bronchi, each supplying a lobe of the lungs
- Air passages undergo 23 orders of branching

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	Name	Division	Diameter (mm)	How many?	Cross-sectional area (cm^2)
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 ↓ 8×10^7	100 ↓ 5×10^3
Exchange surface	Alveoli	24	0.3	$3–6 \times 10^8$	$>1 \times 10^6$

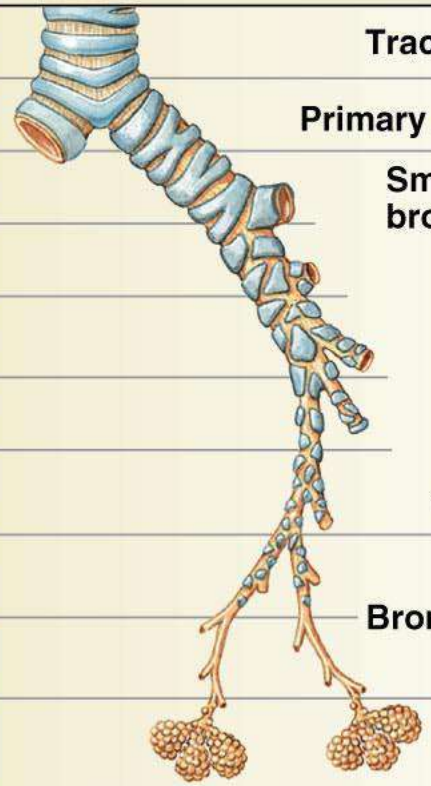

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Figure 17.4

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Conducting Zones

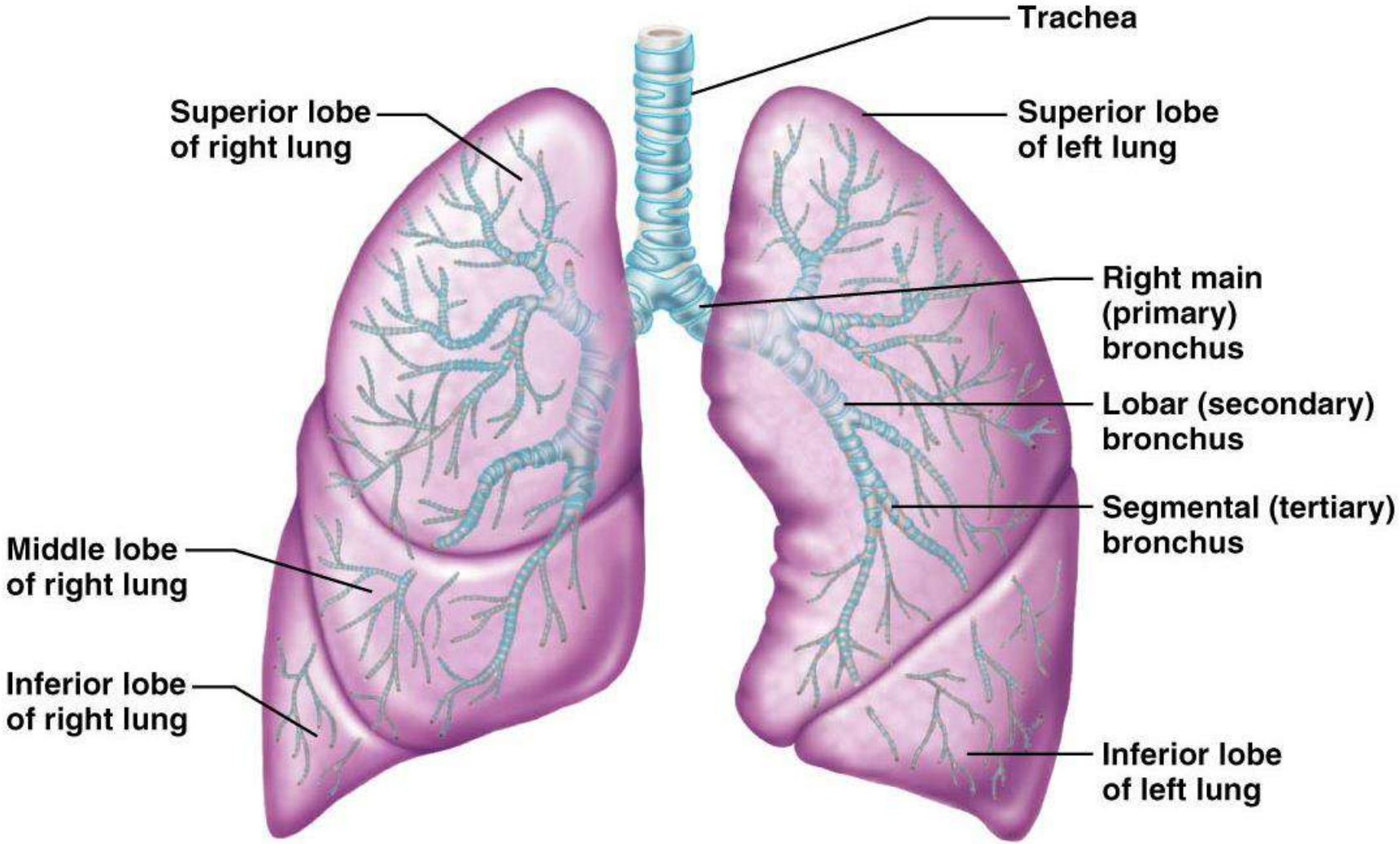

Figure 22.7

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Dead Space

- **Anatomic**
- **Physiologic**

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Respiratory Zone

- Defined by the presence of alveoli; begins as terminal bronchioles feed into respiratory bronchioles
- Respiratory bronchioles lead to alveolar ducts, then to terminal clusters of alveolar sacs composed of alveoli
- Approximately 300 million alveoli:
  - Account for most of the lungs' volume
  - Provide tremendous surface area for gas exchange

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Respiratory Zone

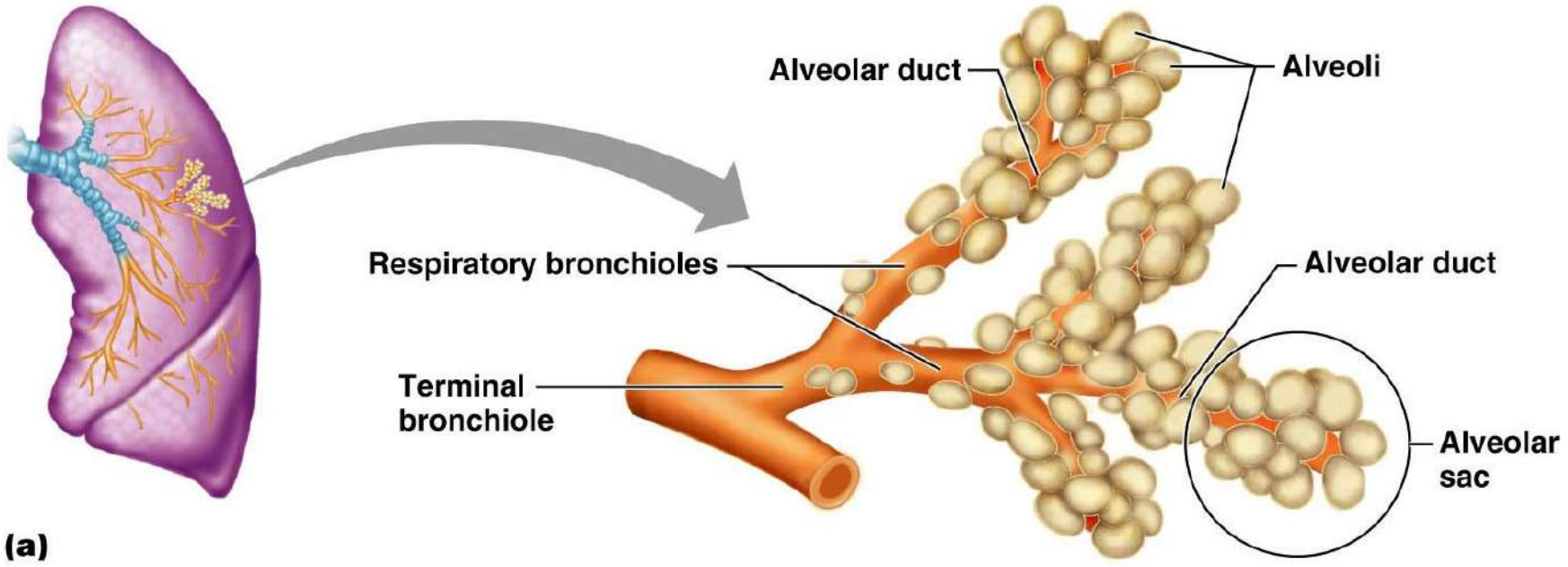

Figure 22.8a

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Alveoli

- Surrounded by fine elastic fibers
- Contain open pores that:
  - Connect adjacent alveoli
  - Allow air pressure throughout the lung to be equalized
- House macrophages that keep alveolar surfaces sterile

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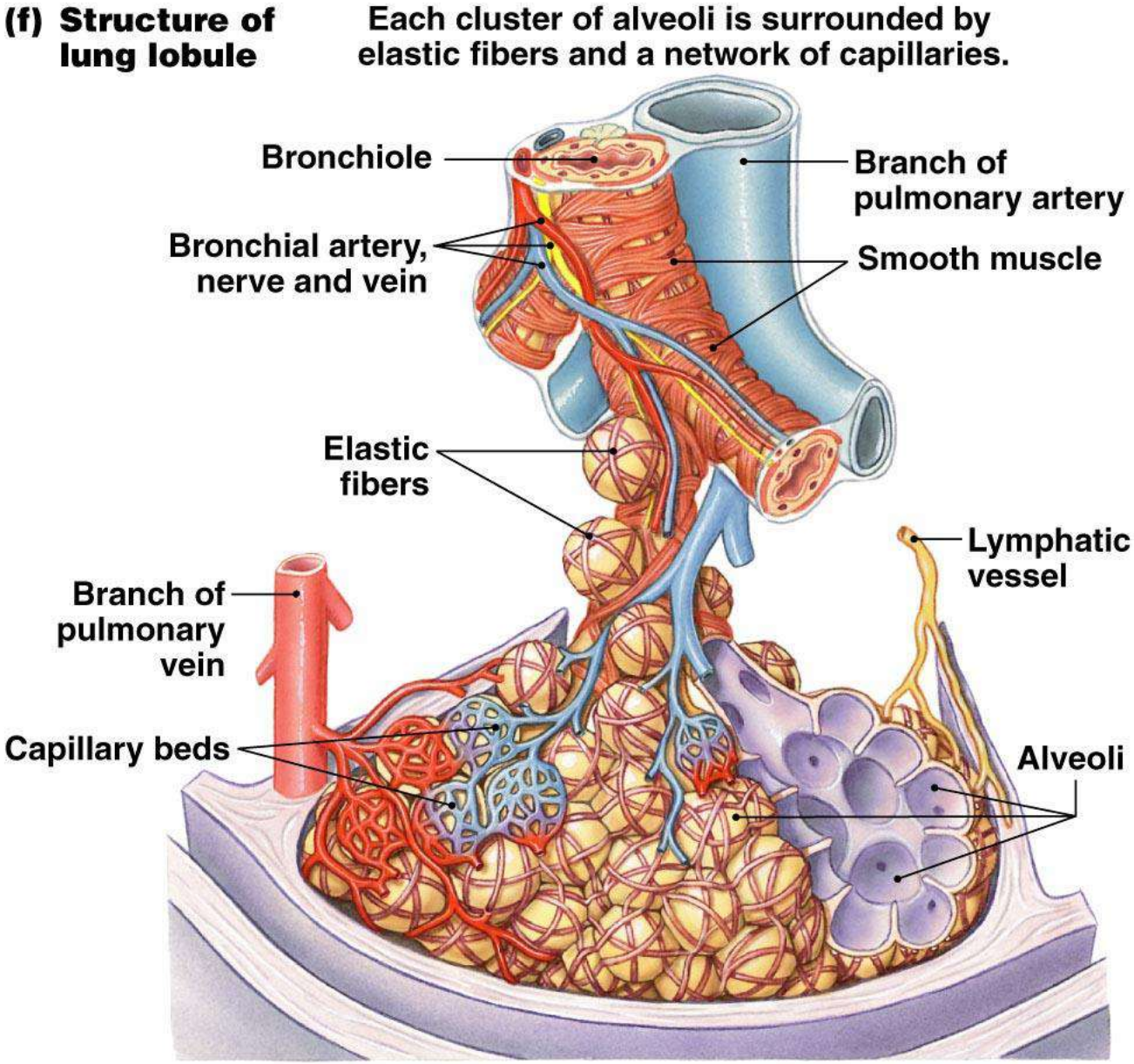

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Figure 17.2f

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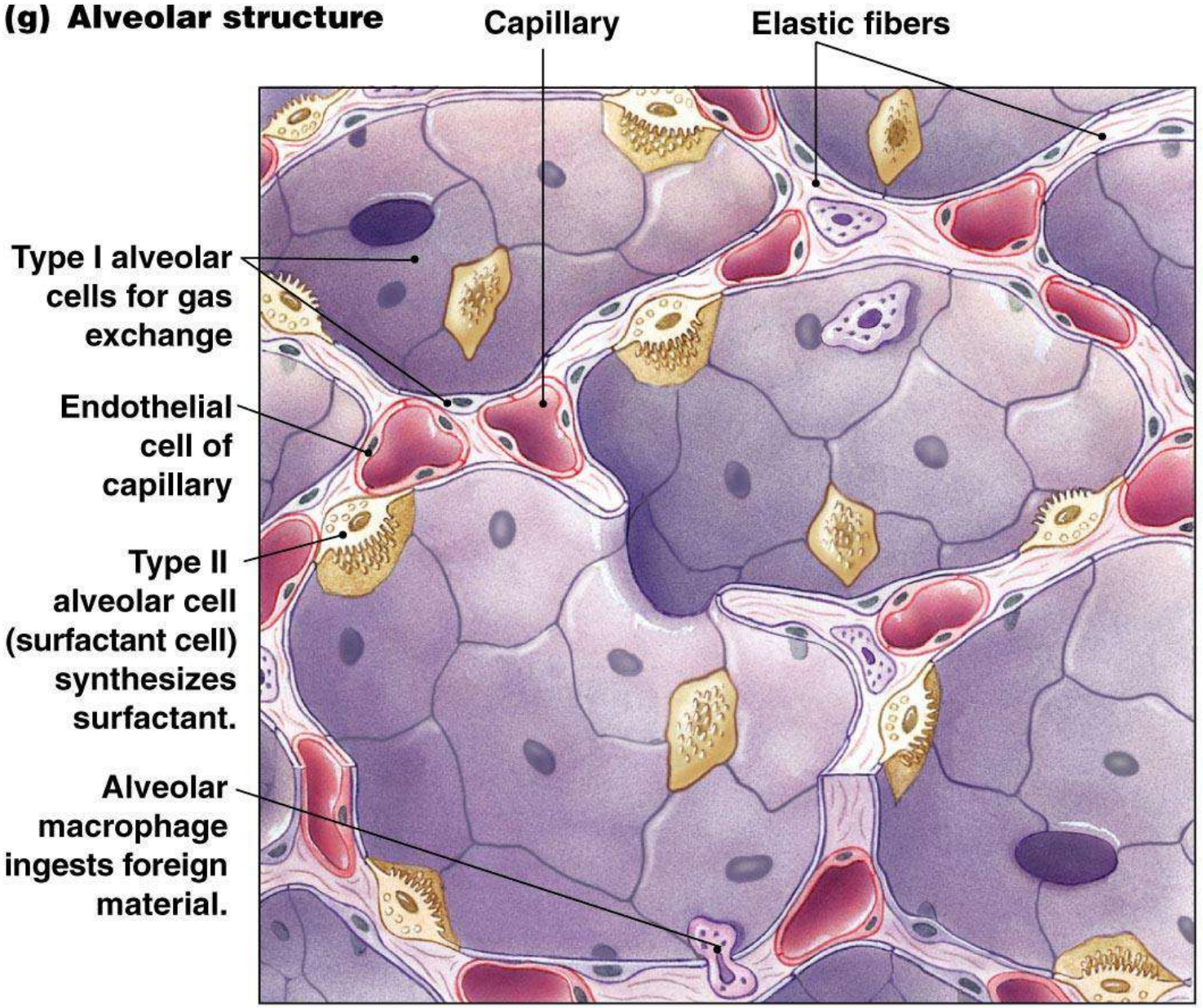

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Figure 17-2g

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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)

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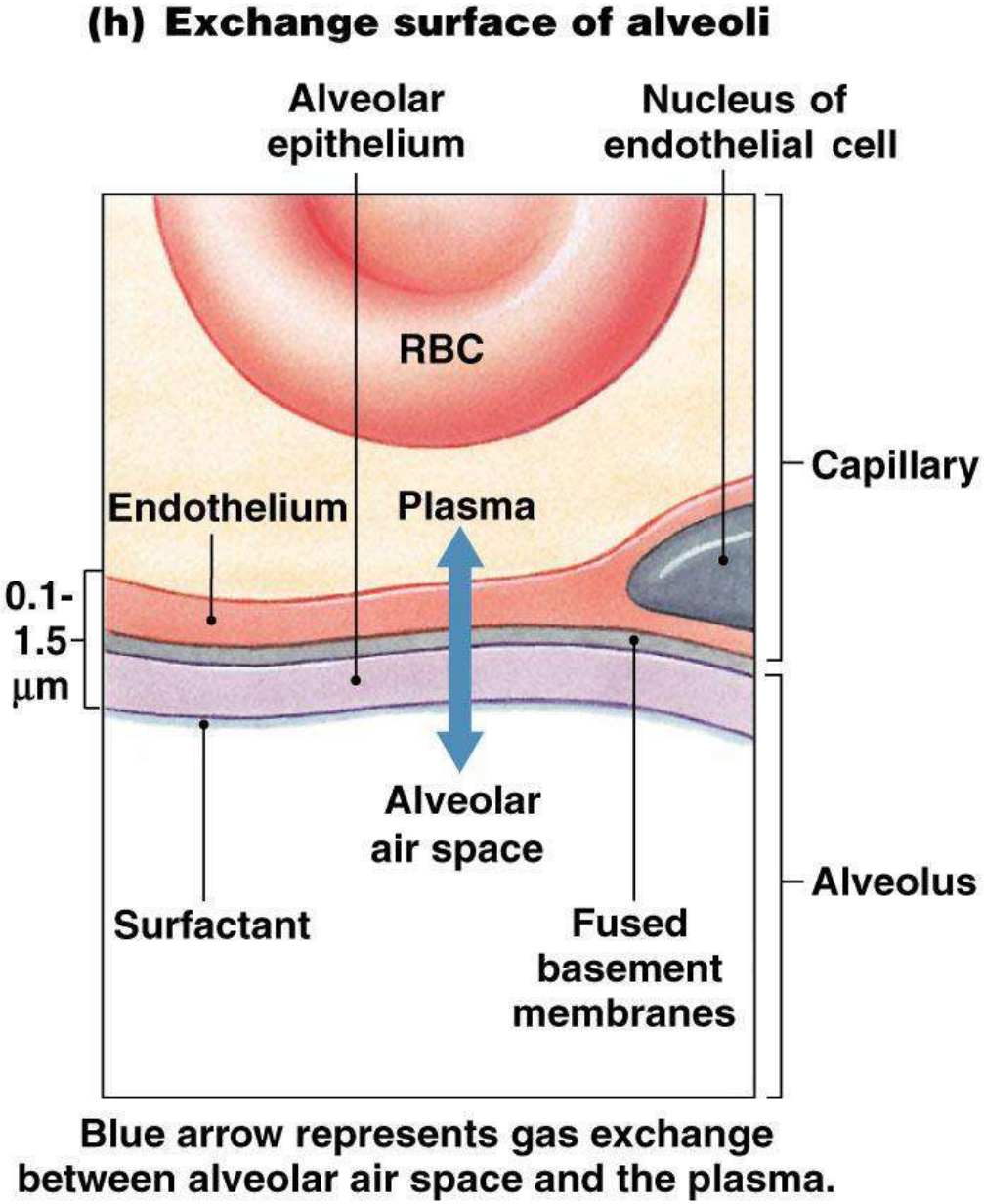

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Figure 17.2h

Pleurae

- Thin, double-layered serosa
- **Parietal pleura**
  - Covers the thoracic wall and superior face of the diaphragm
  - Continues around heart and between lungs
- **Visceral pleura**
- Covers the lungs

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

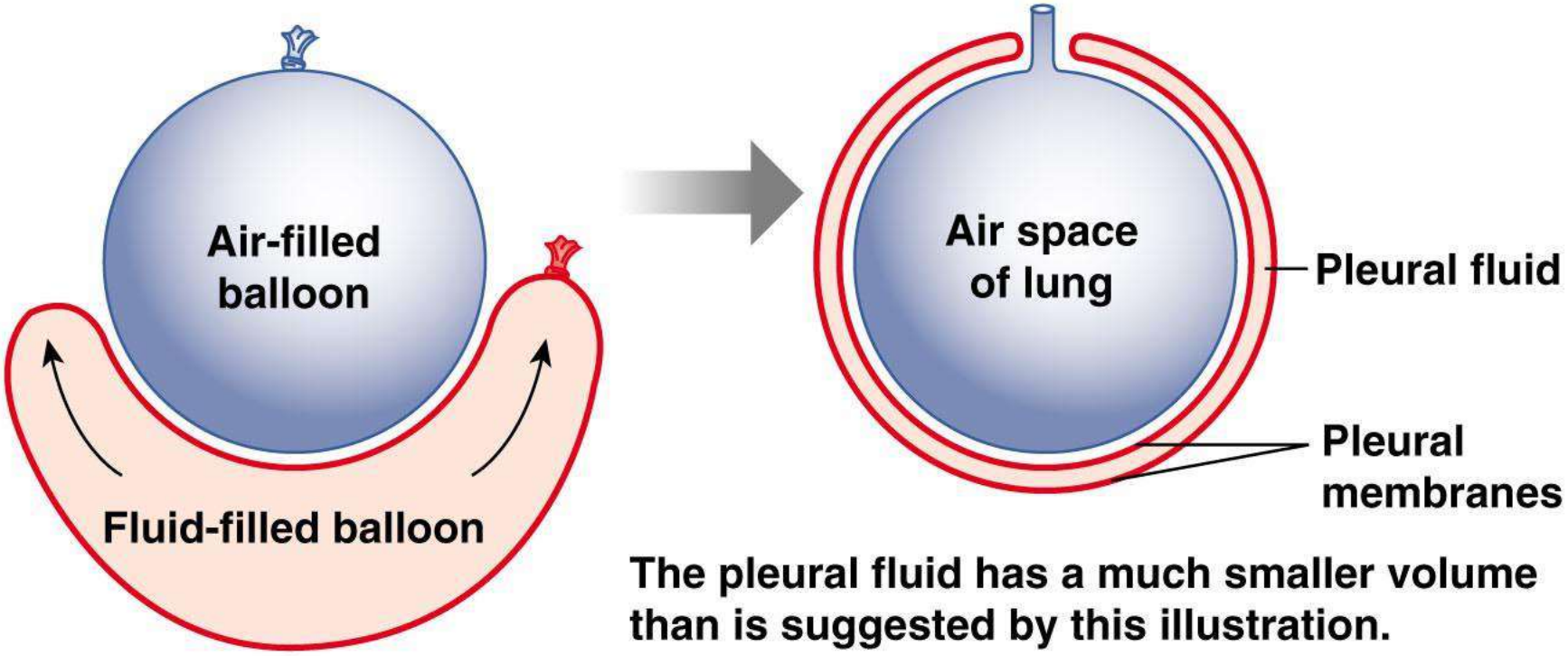

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TABLE 17-1 Gas Laws

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).

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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

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Respiratory Volumes

- **Tidal volume (TV)** – air that moves into and out of the lungs with each breath (approximately 500 ml)
- **Inspiratory reserve volume (IRV)** – air that can be inspired forcibly beyond the tidal volume (2100–3200 ml)
- **Expiratory reserve volume (ERV)** – air that can be evacuated from the lungs after a tidal expiration (1000–1200 ml)
- **Residual volume (RV)** – air left in the lungs after strenuous expiration (1200 ml)

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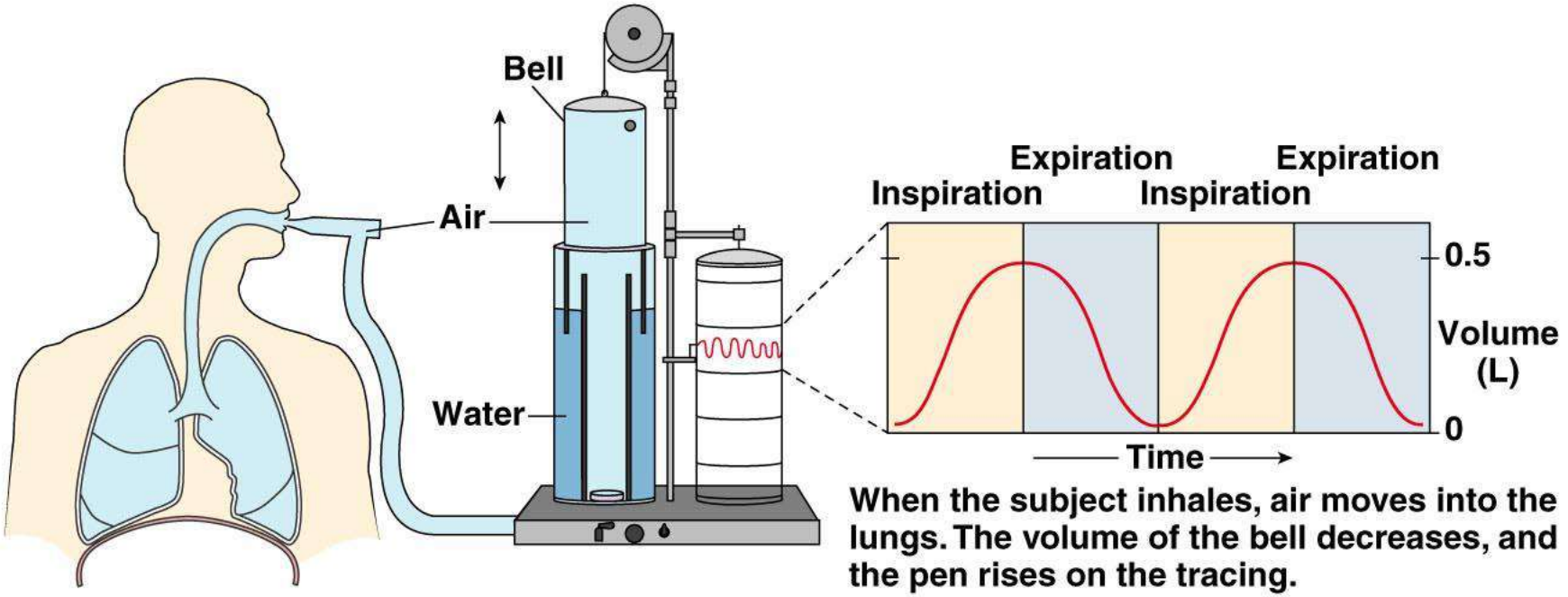

When the subject inhales, air moves into the lungs. The volume of the bell decreases, and the pen rises on the tracing.

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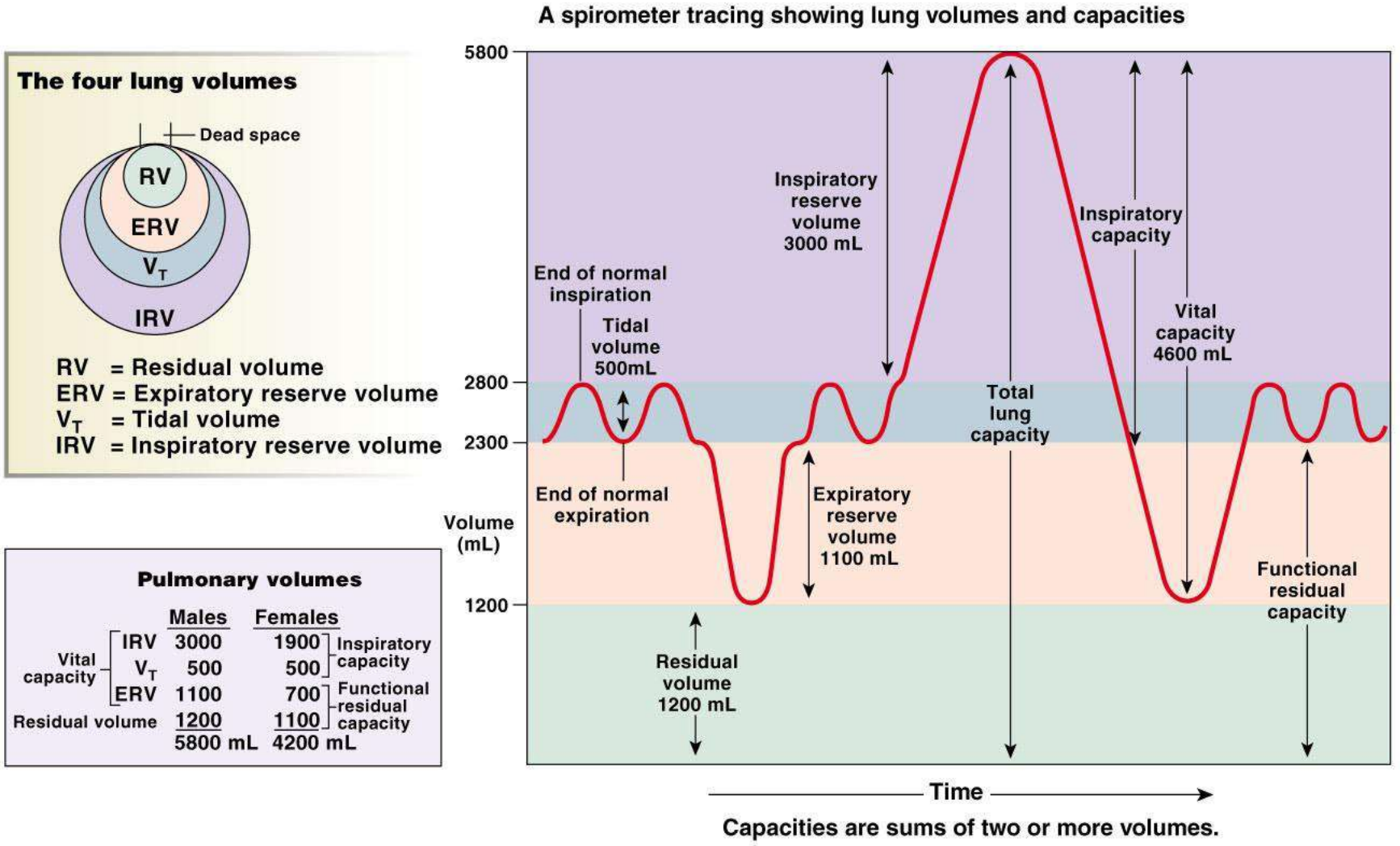

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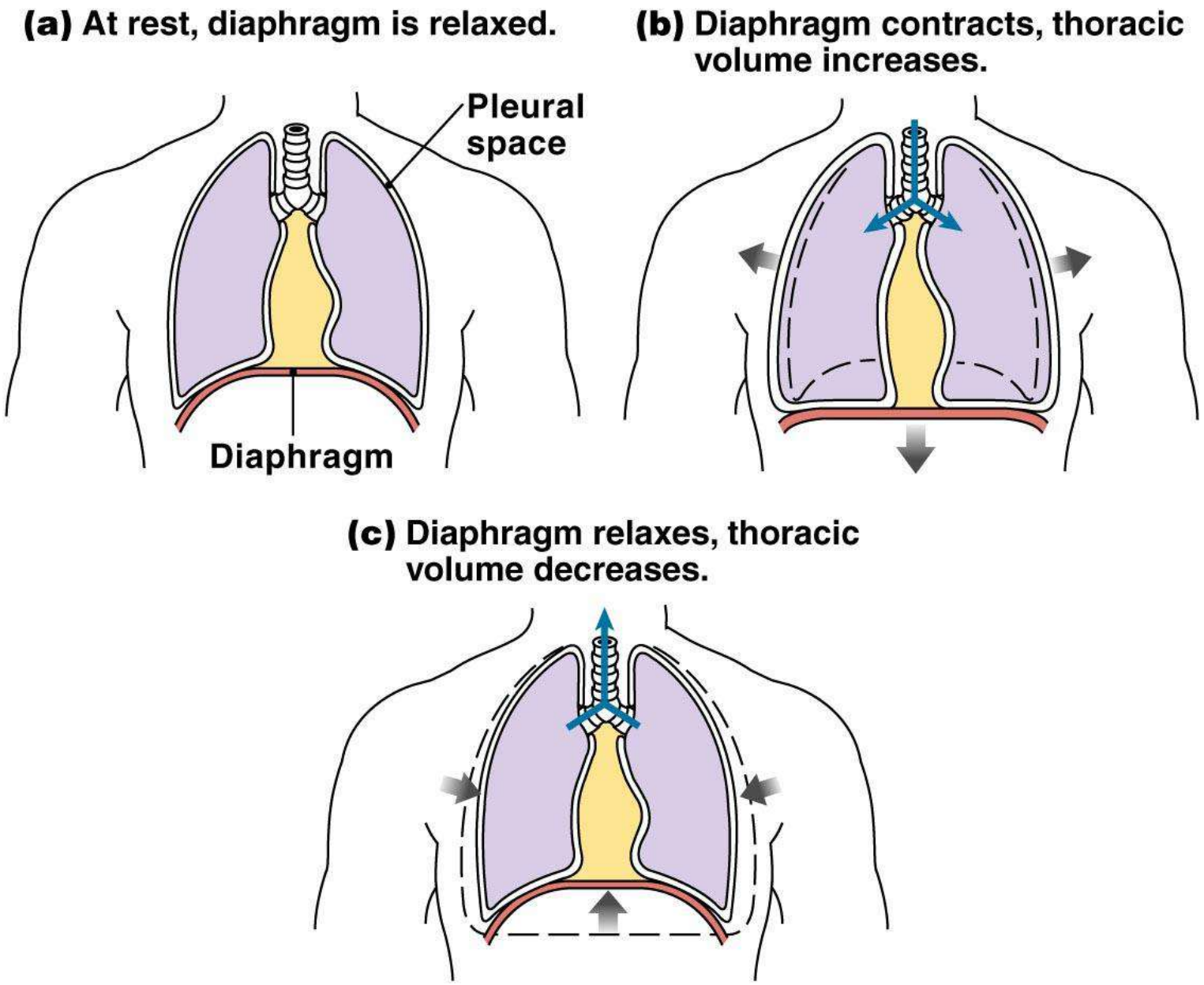

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Figure 27-9 Overview

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

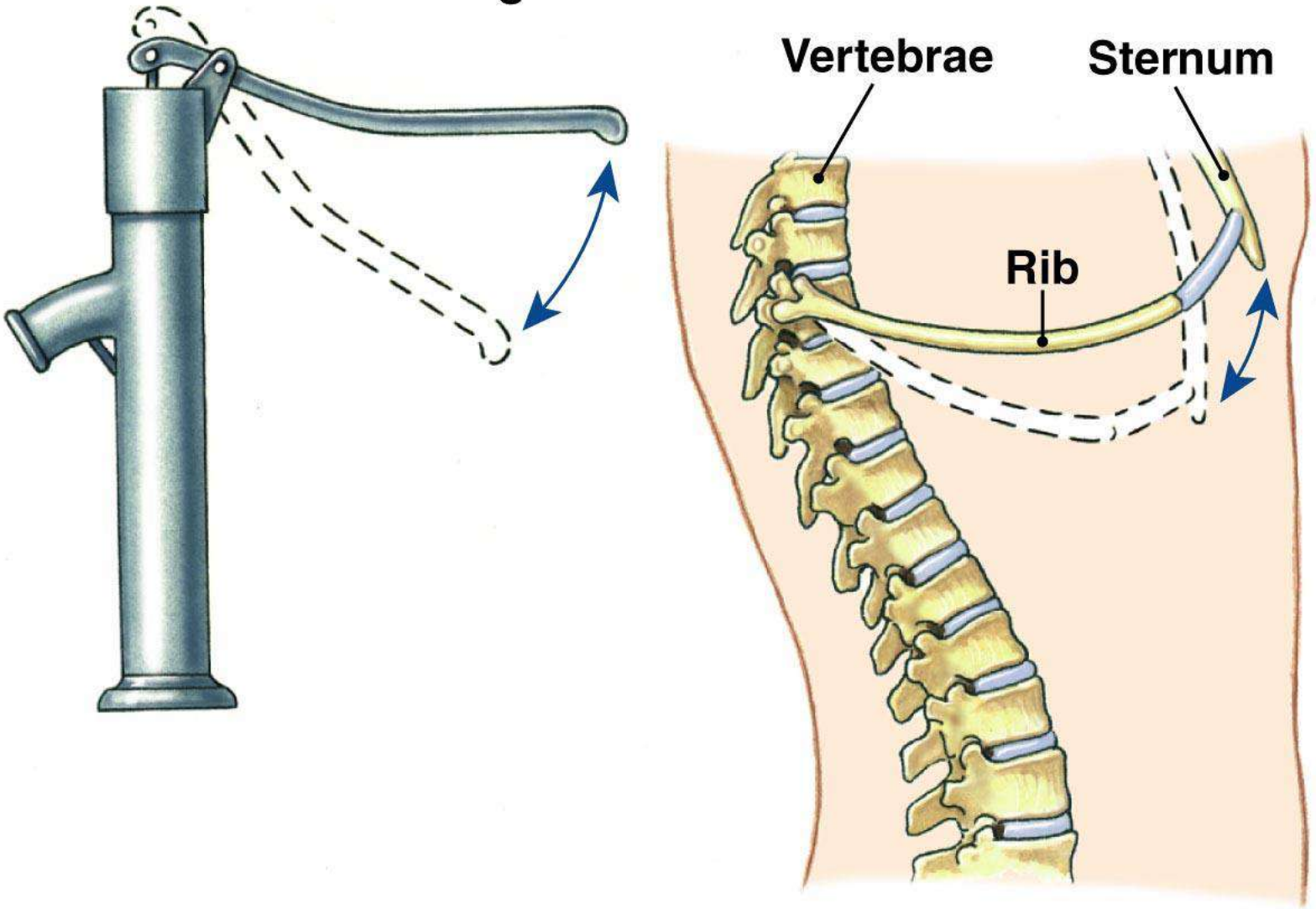

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Figure 17-10a

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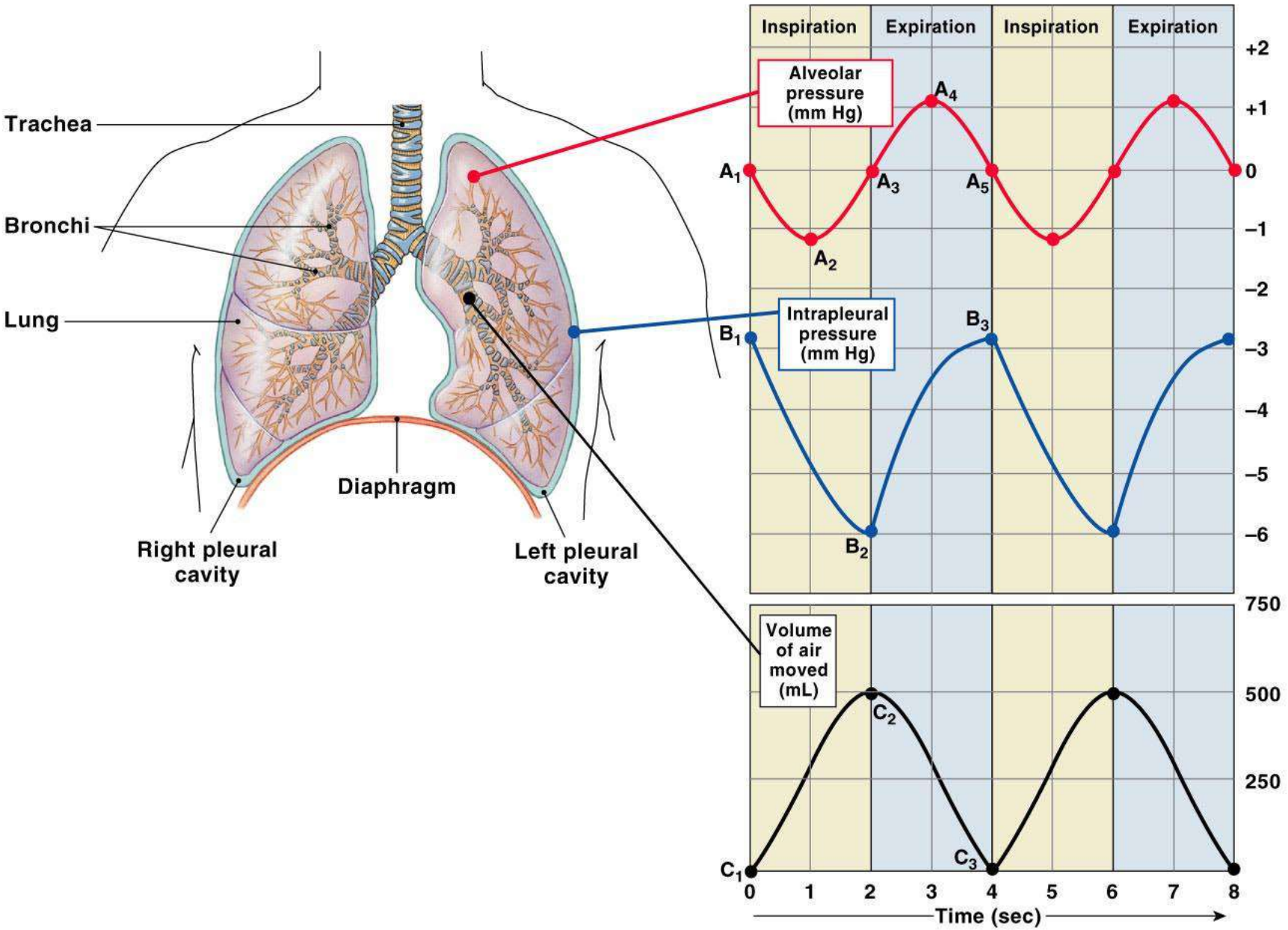

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Lung Collapse

- Caused by equalization of the intrapleural pressure with the intrapulmonary pressure
- Transpulmonary pressure keeps the airways open
  - Transpulmonary pressure – difference between the intrapulmonary and intrapleural pressures
    ($P_{pul} – P_{ip}$)

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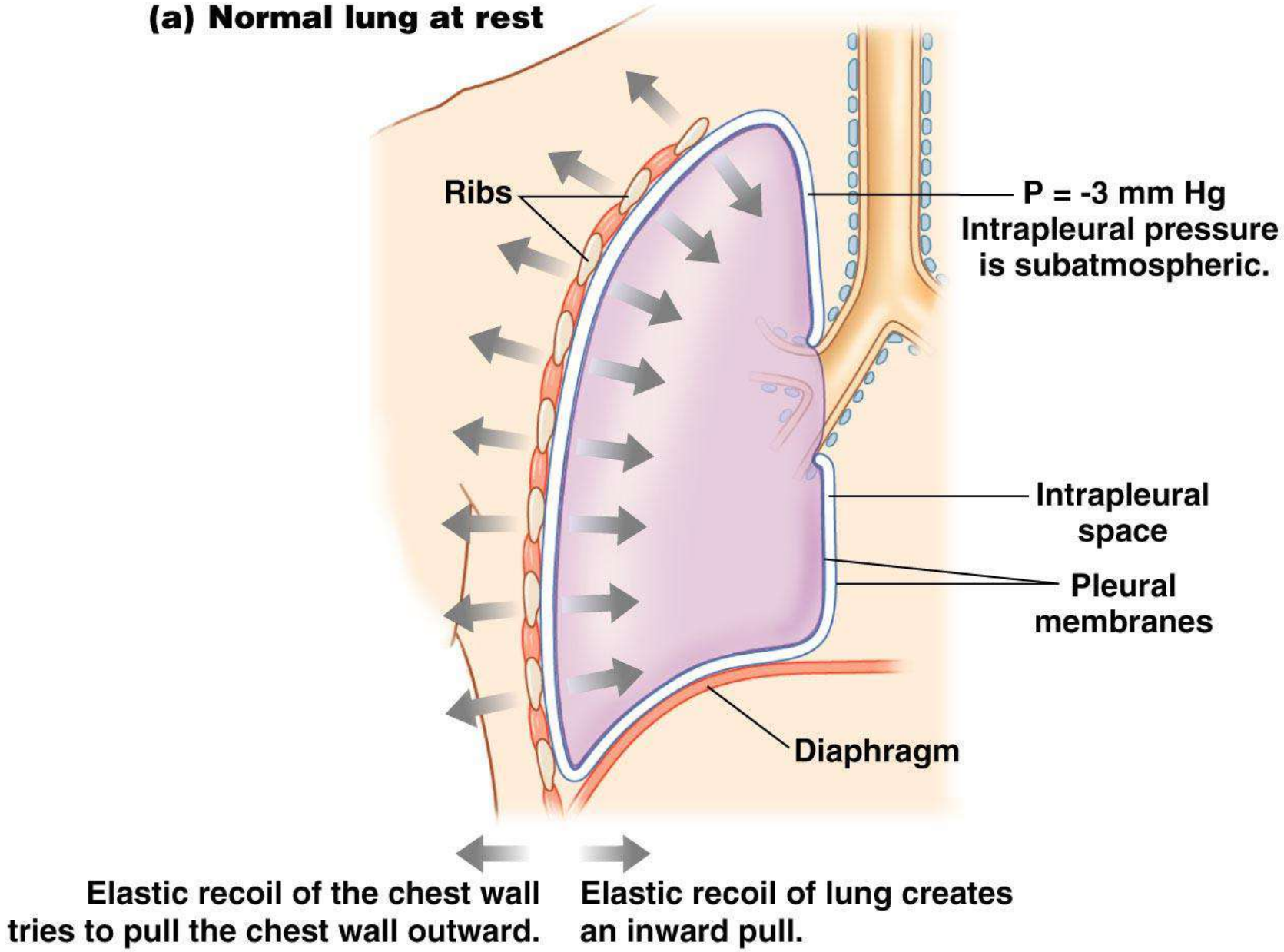

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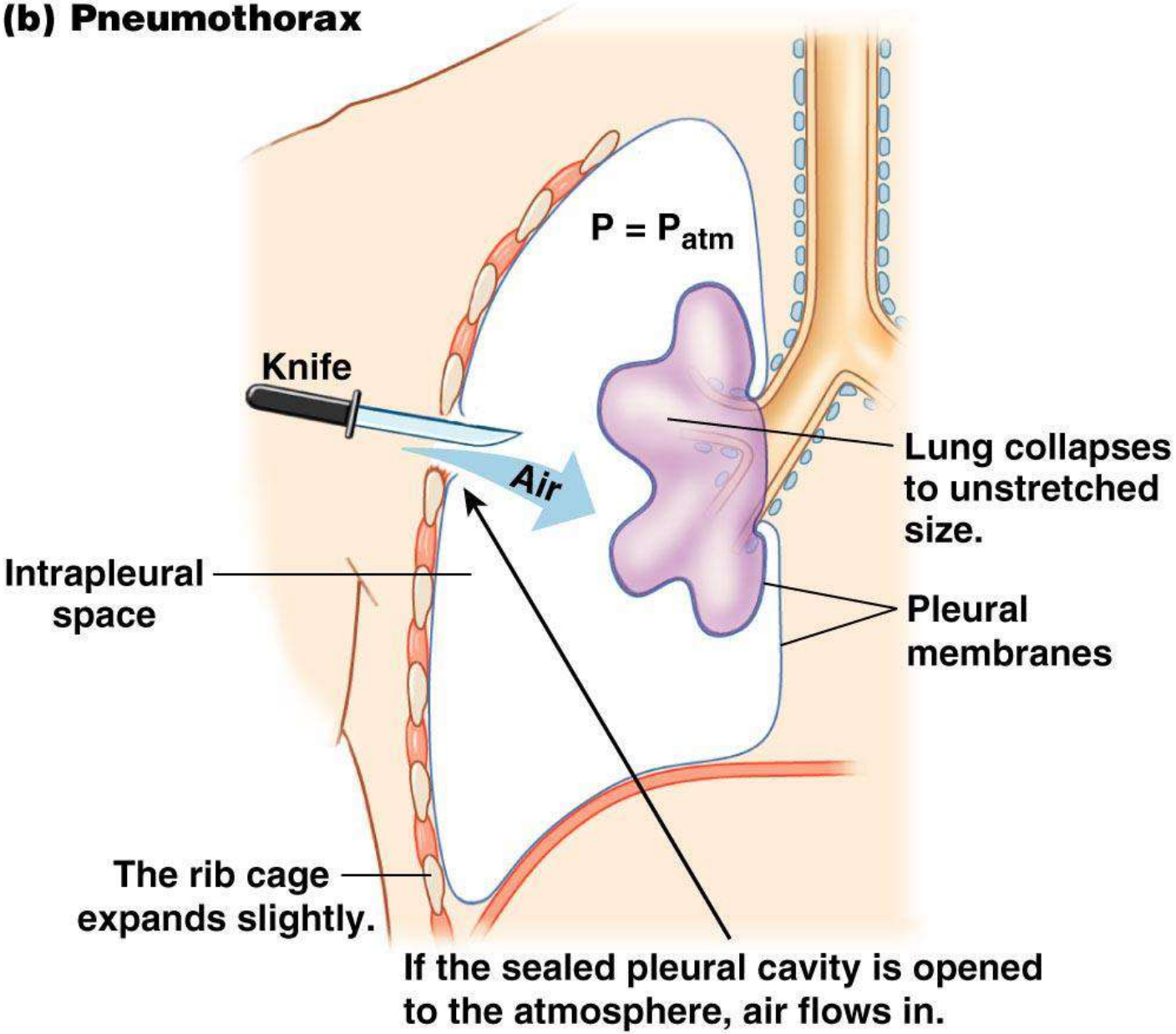

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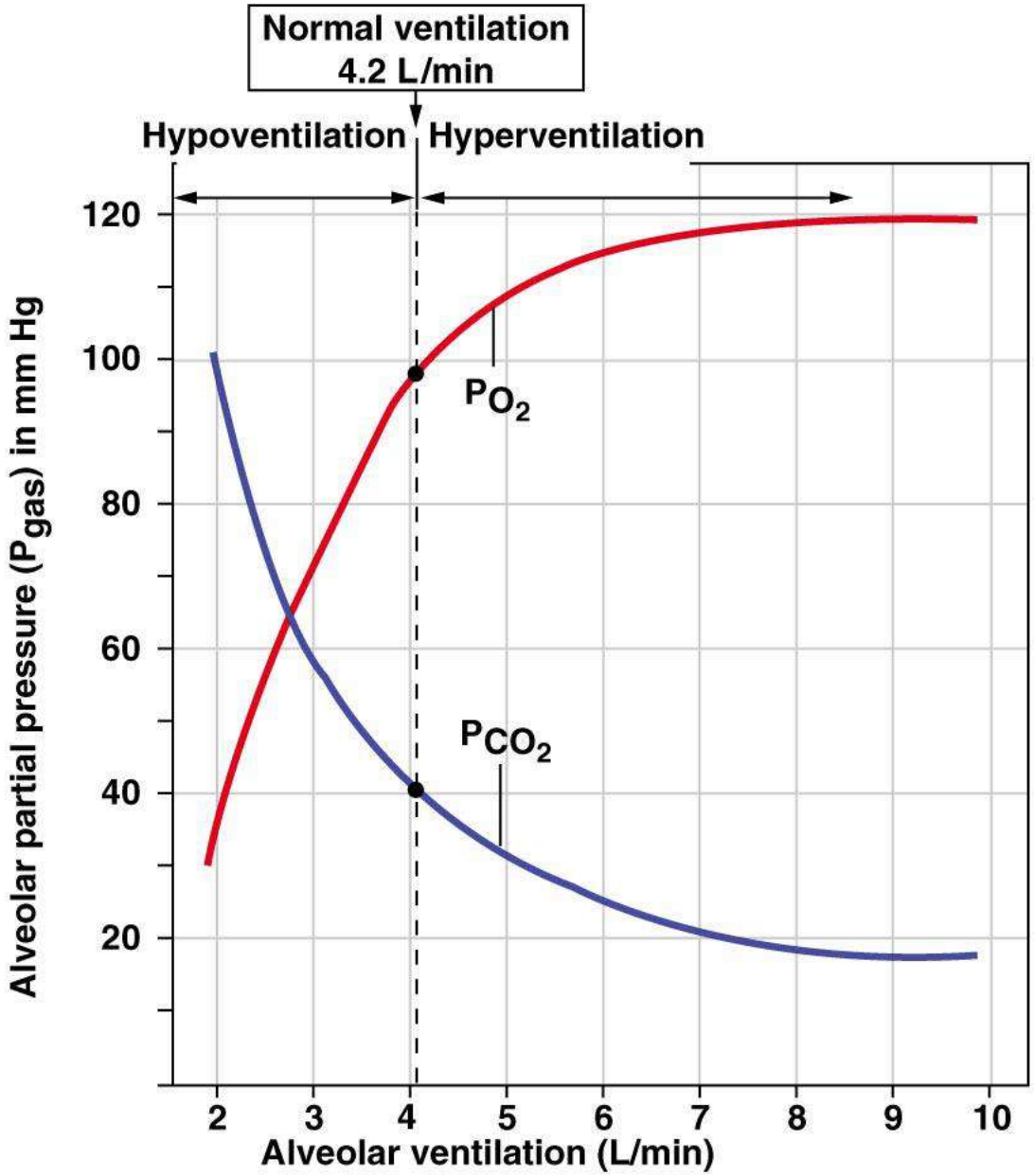

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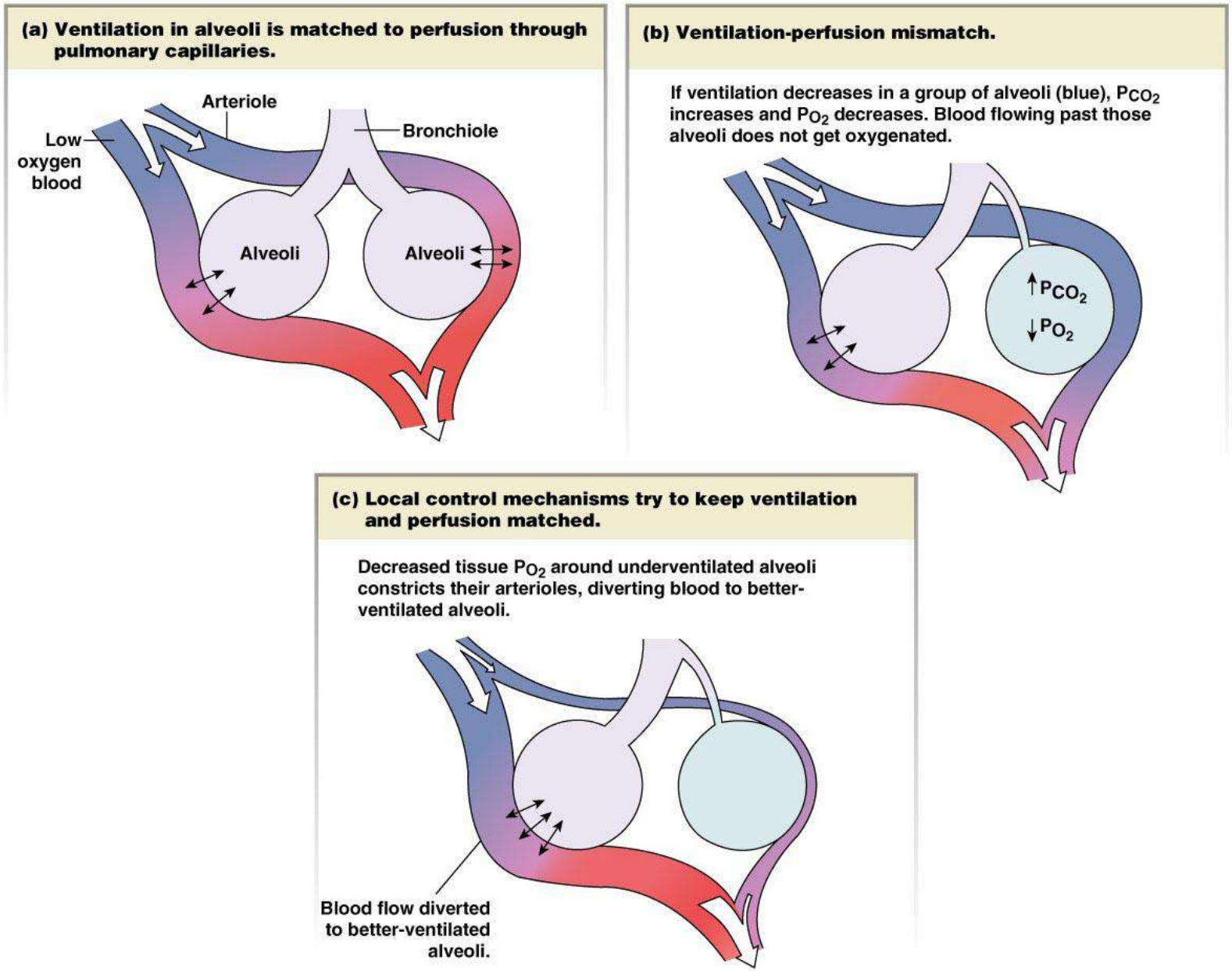

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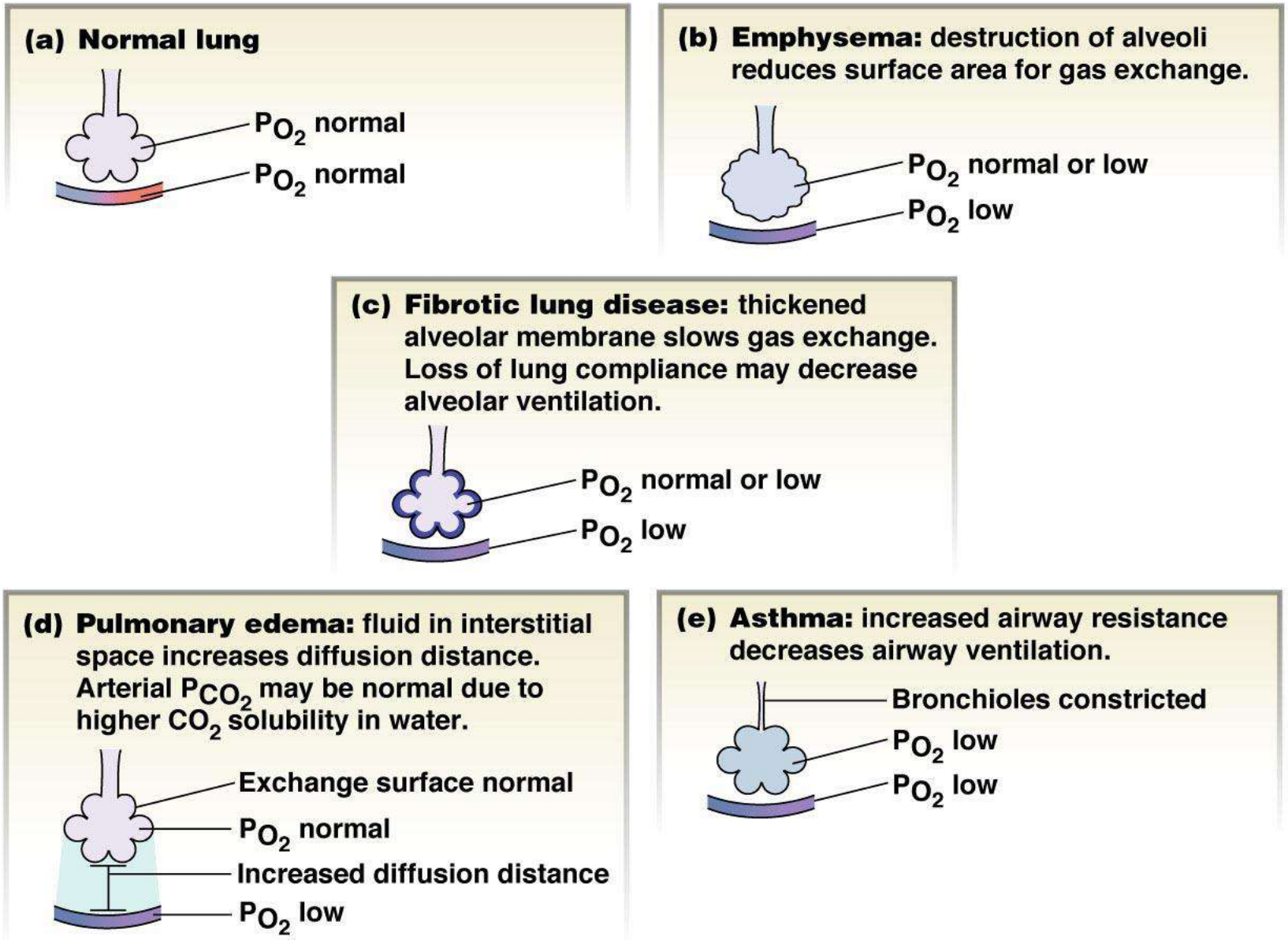

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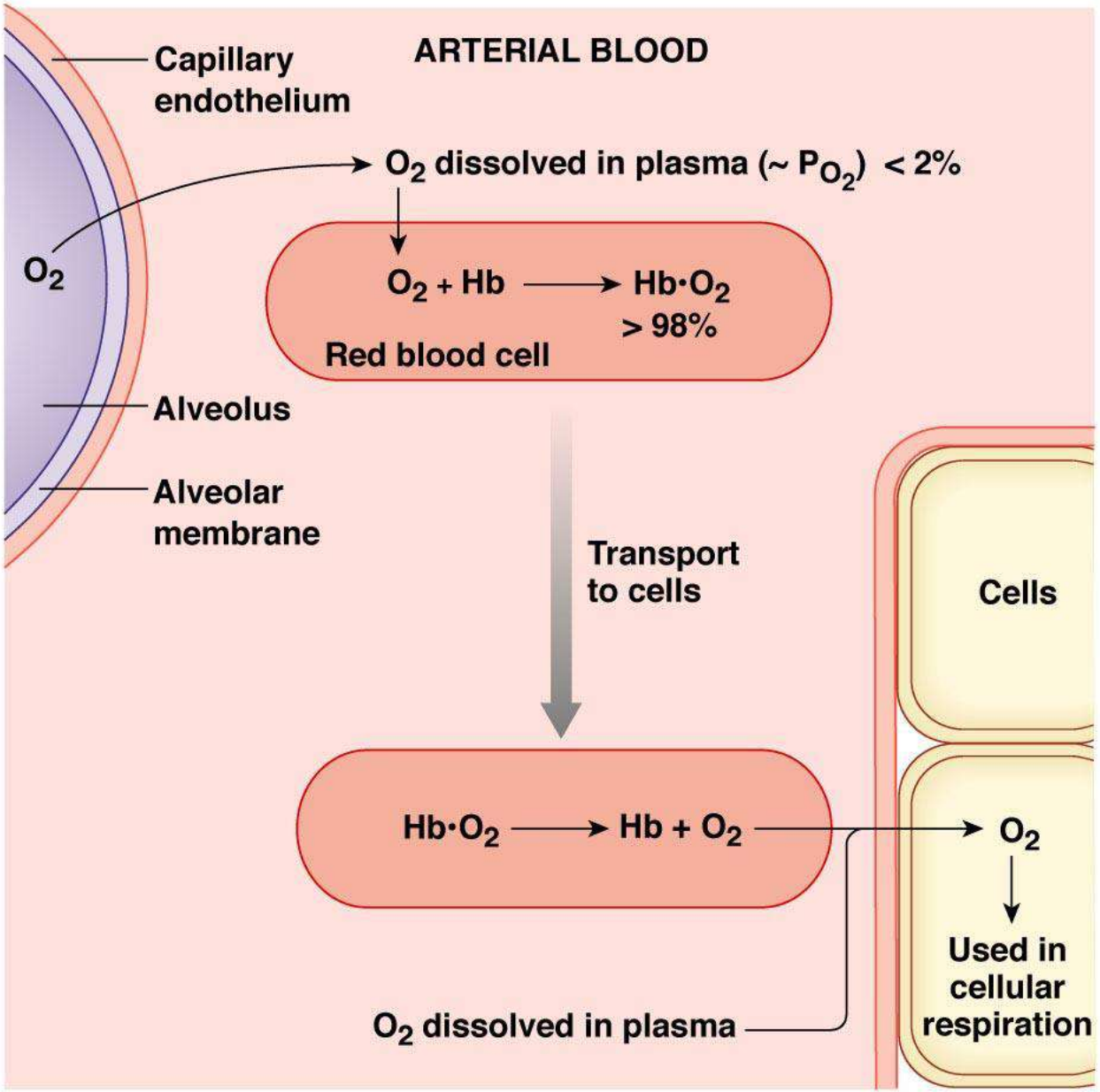

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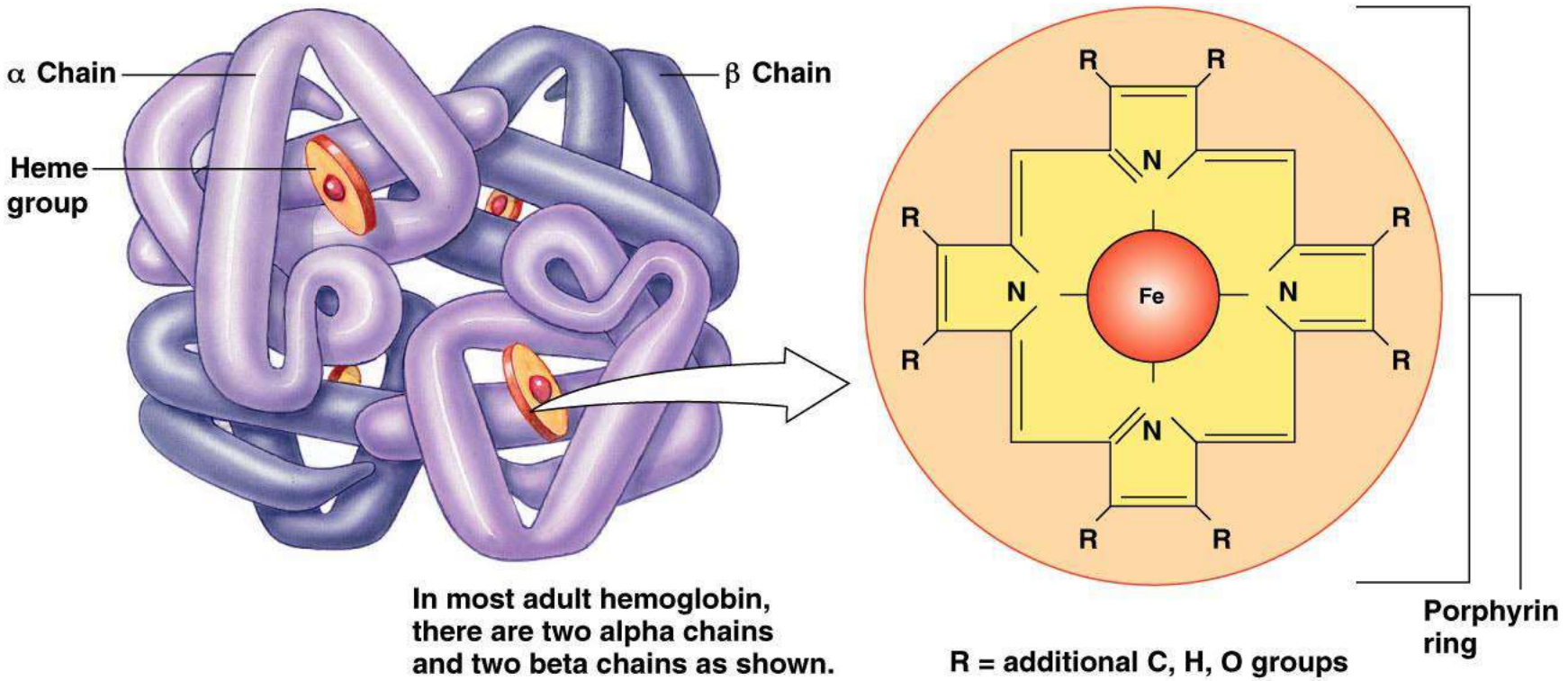

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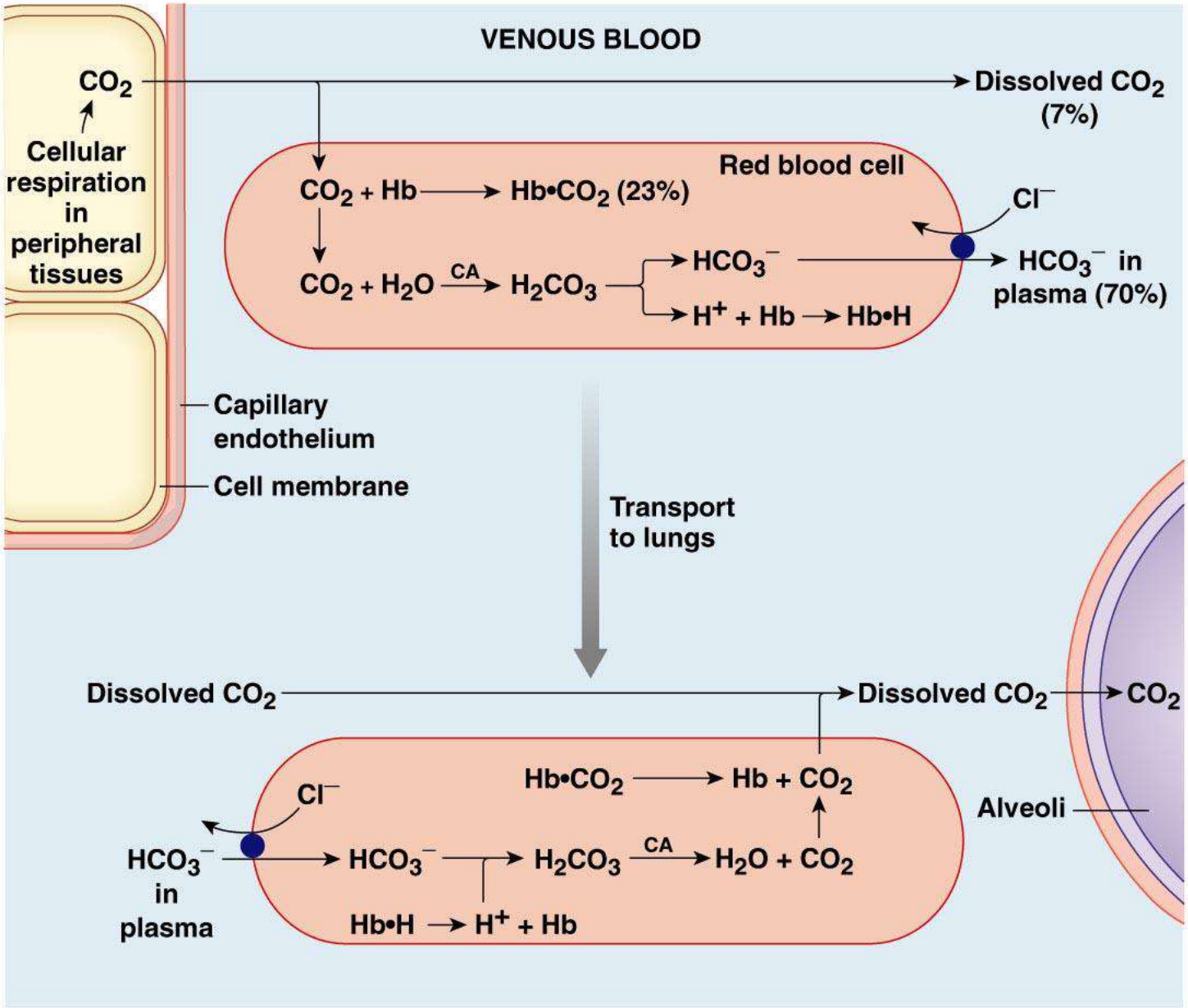
Figure 23-8 Overview



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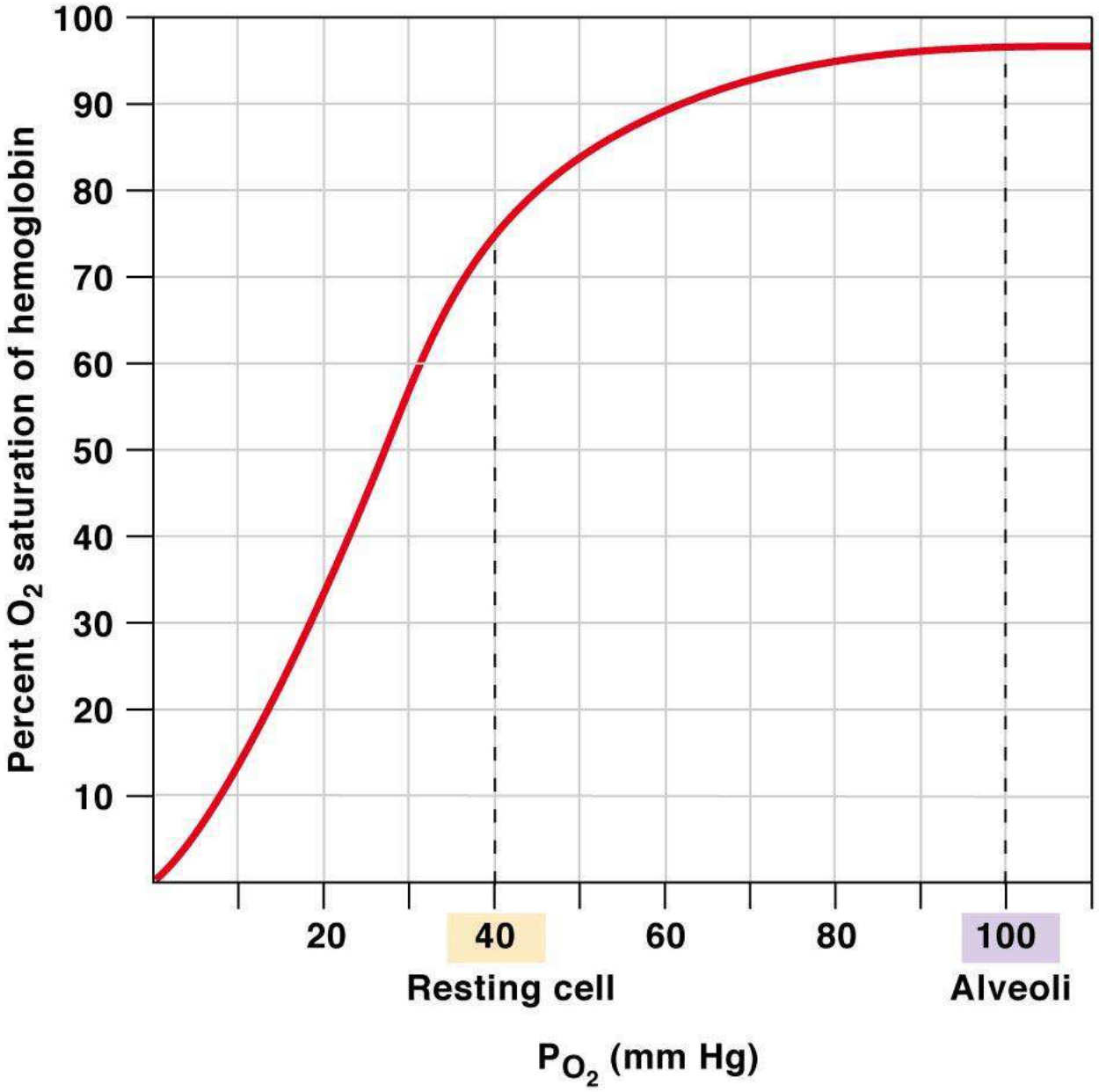

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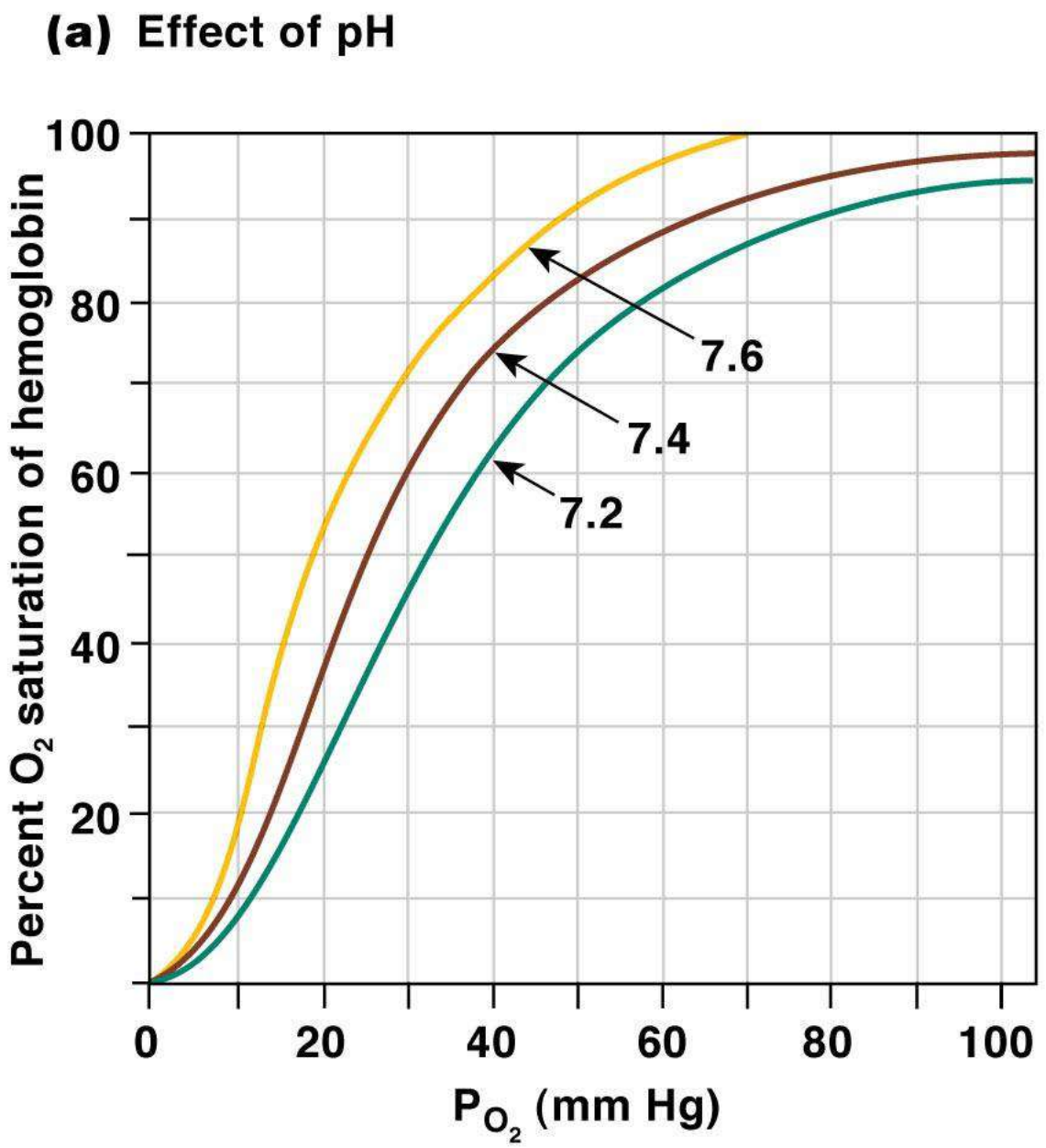

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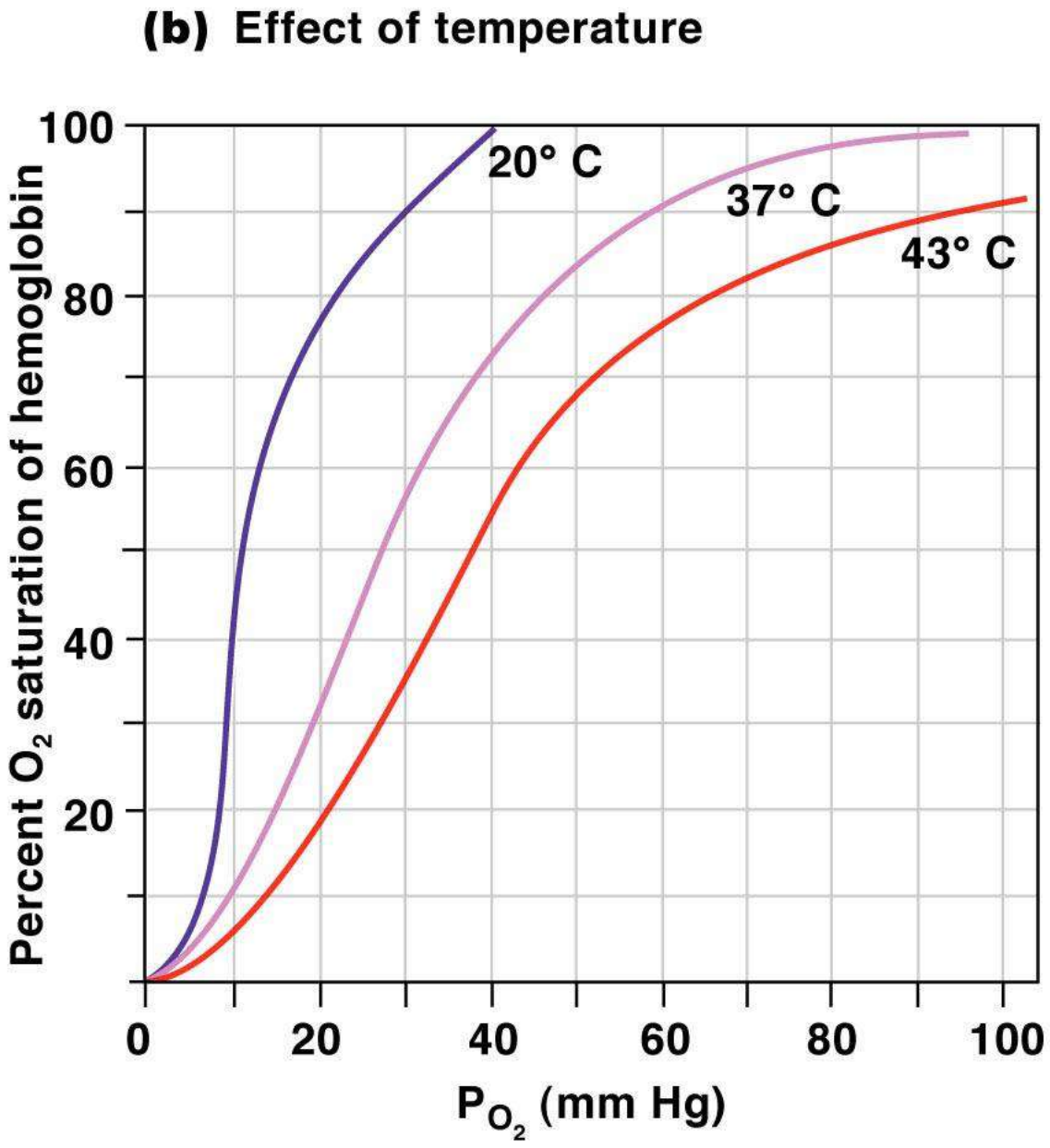

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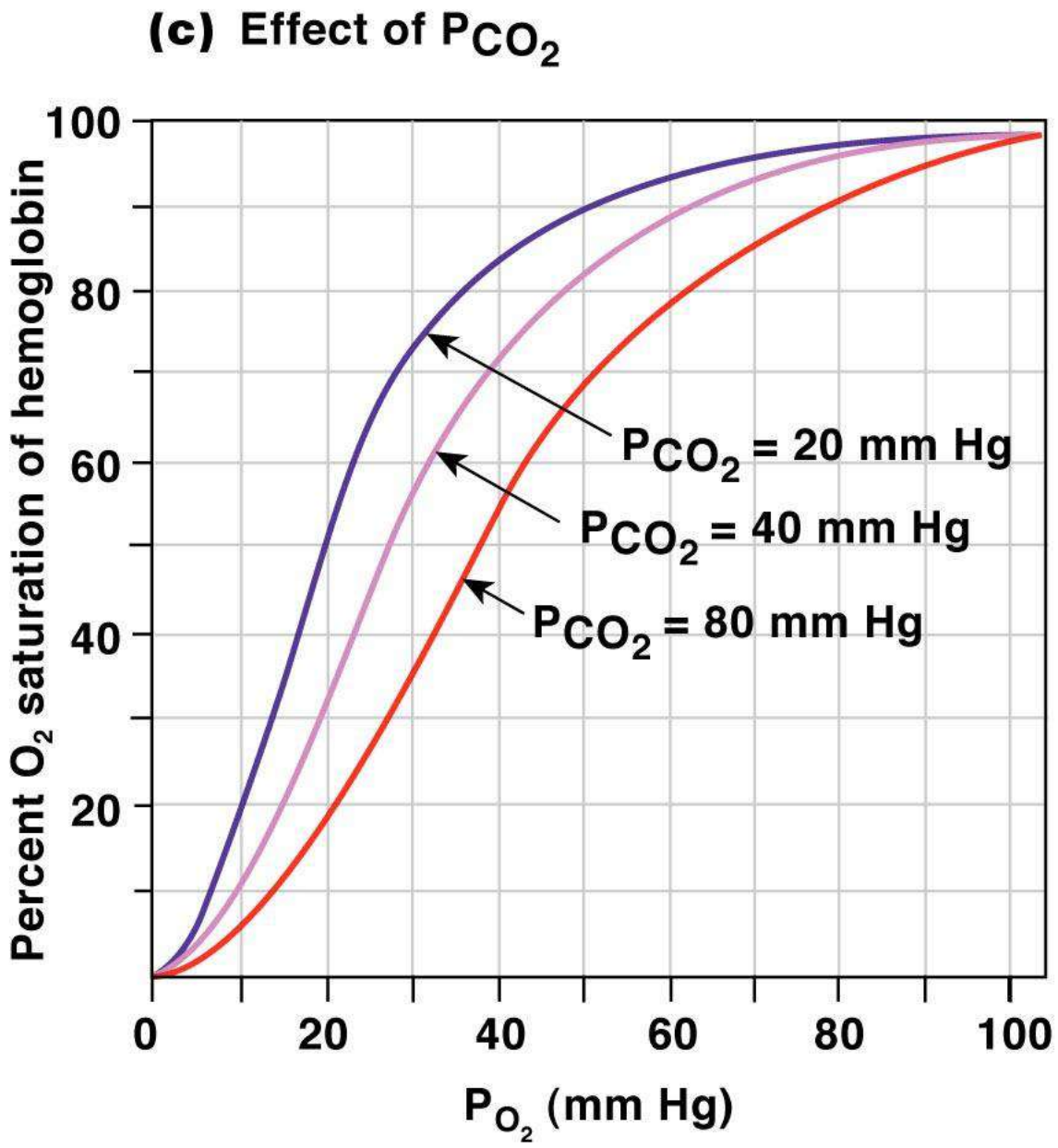

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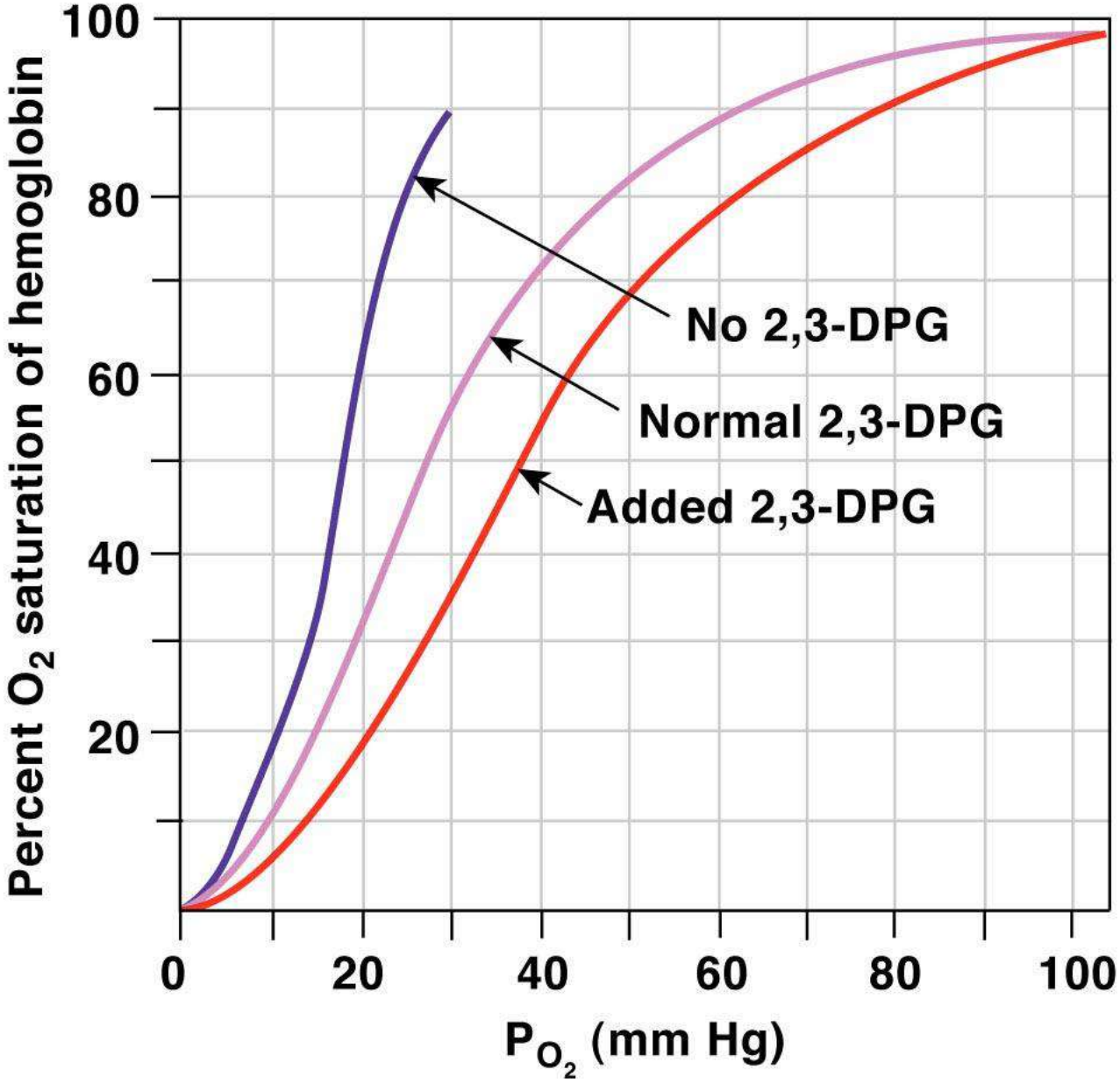

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Figure 18.11

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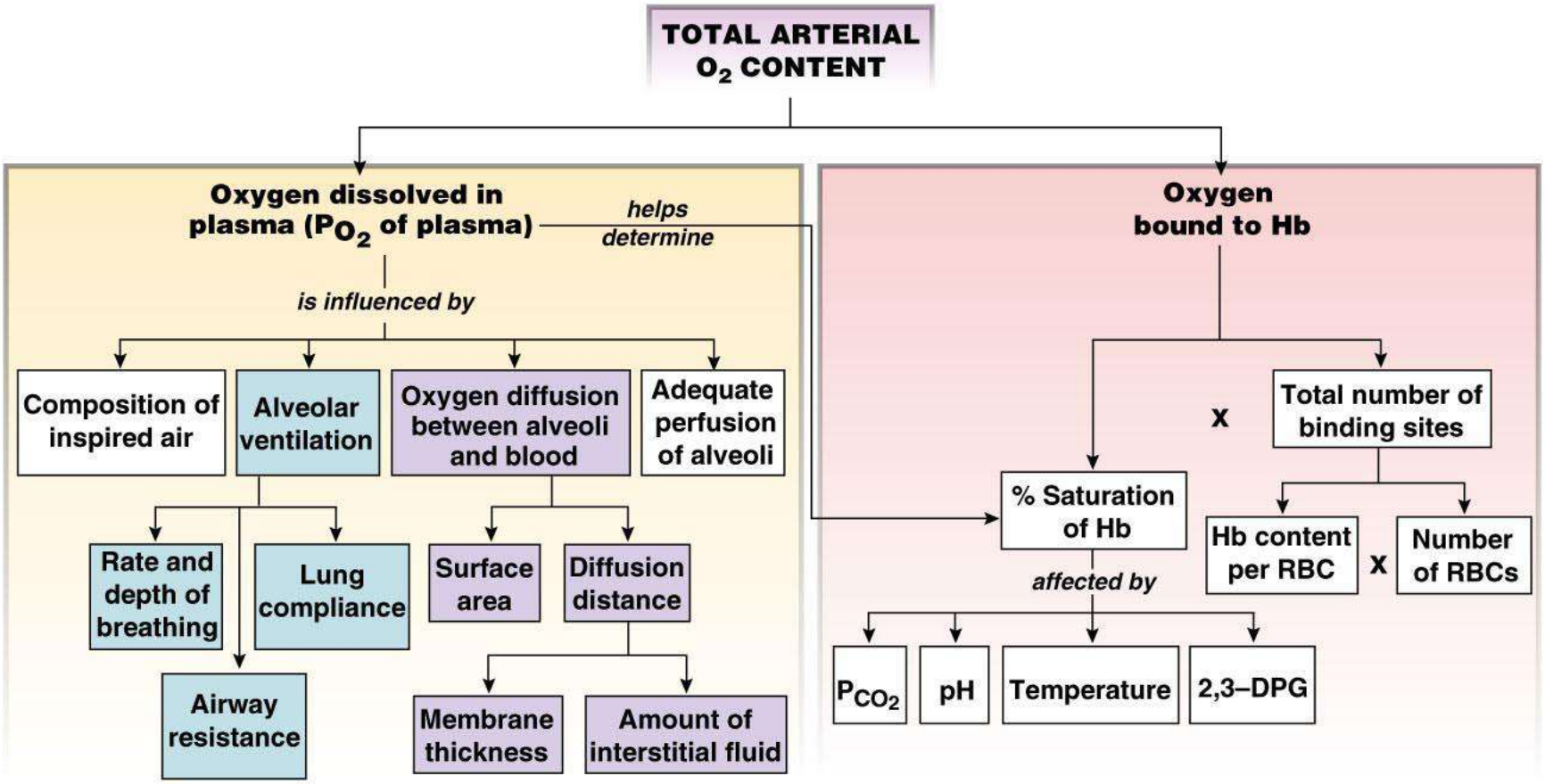

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Figure 18.13

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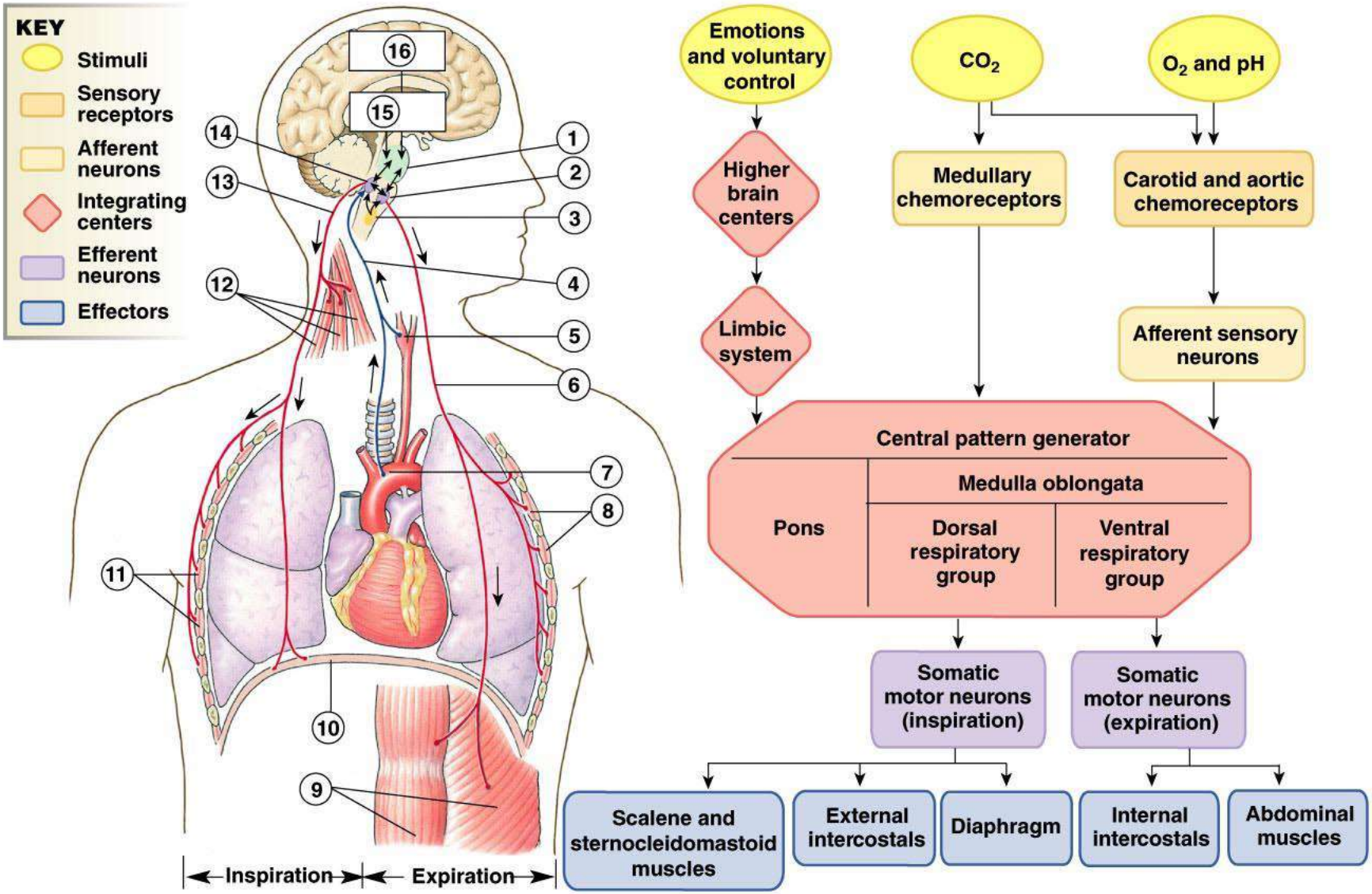

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Figure 18.16

Medullary Respiratory Centers

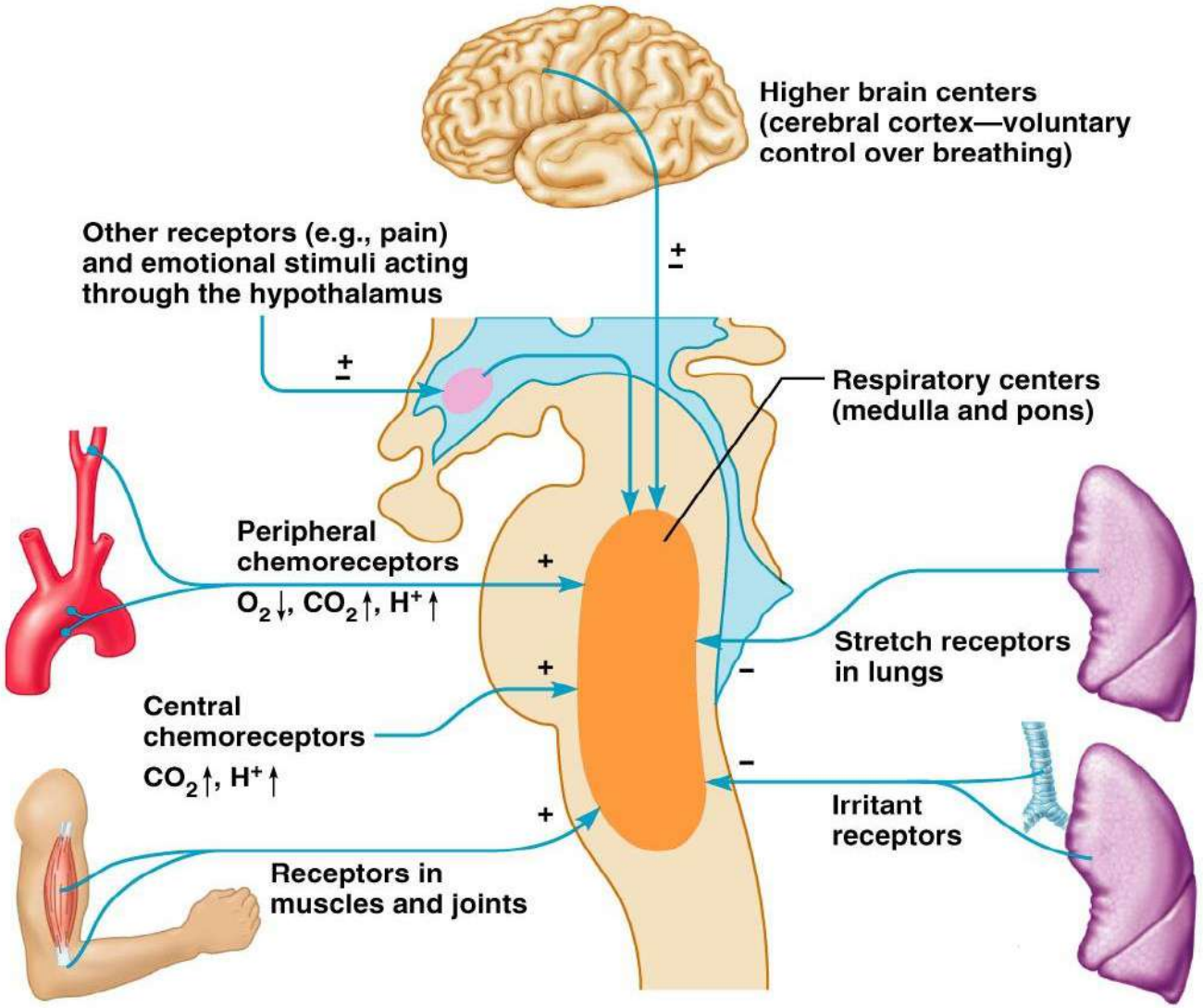

Figure 22.25

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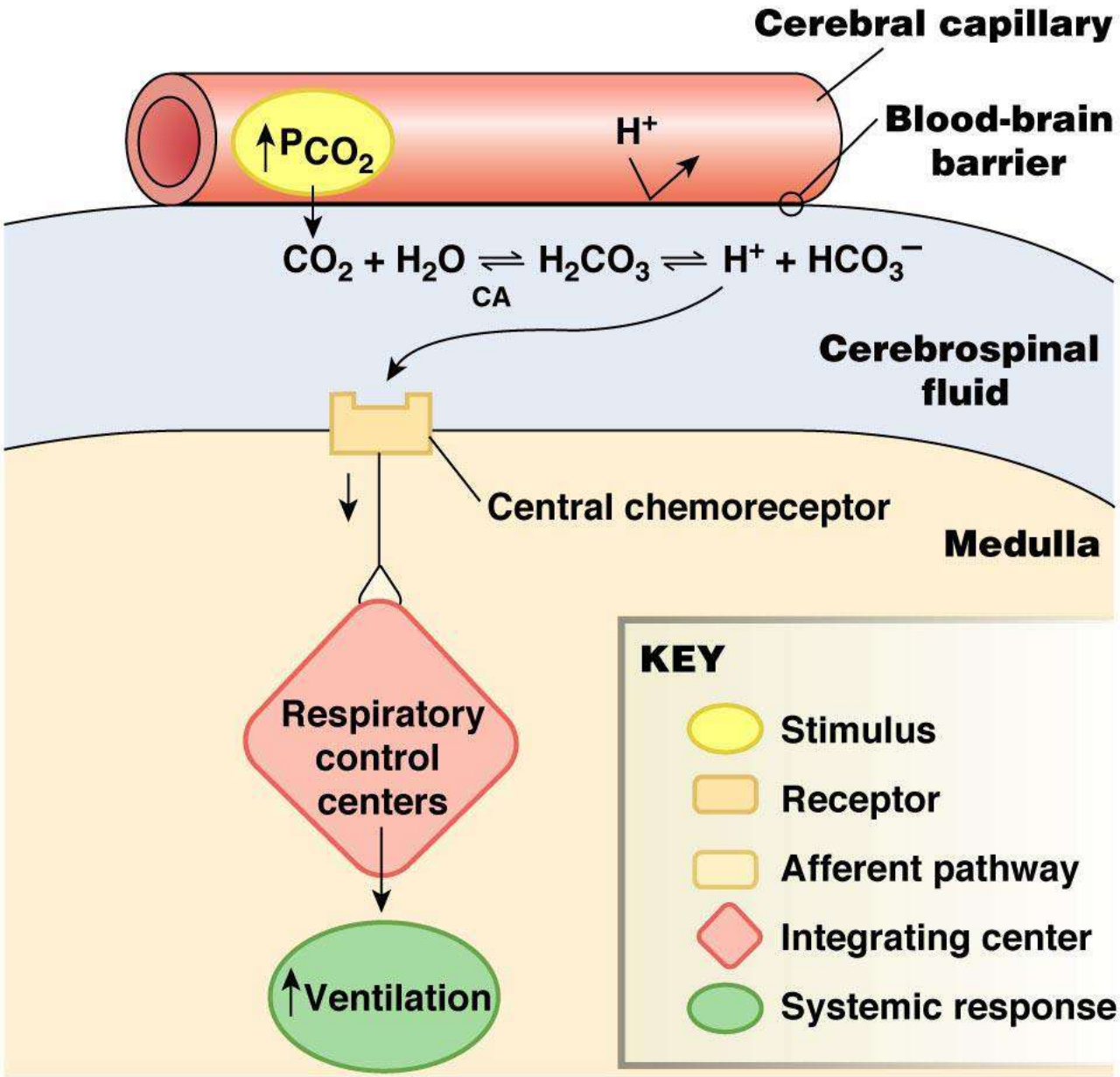

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Figure 19.19

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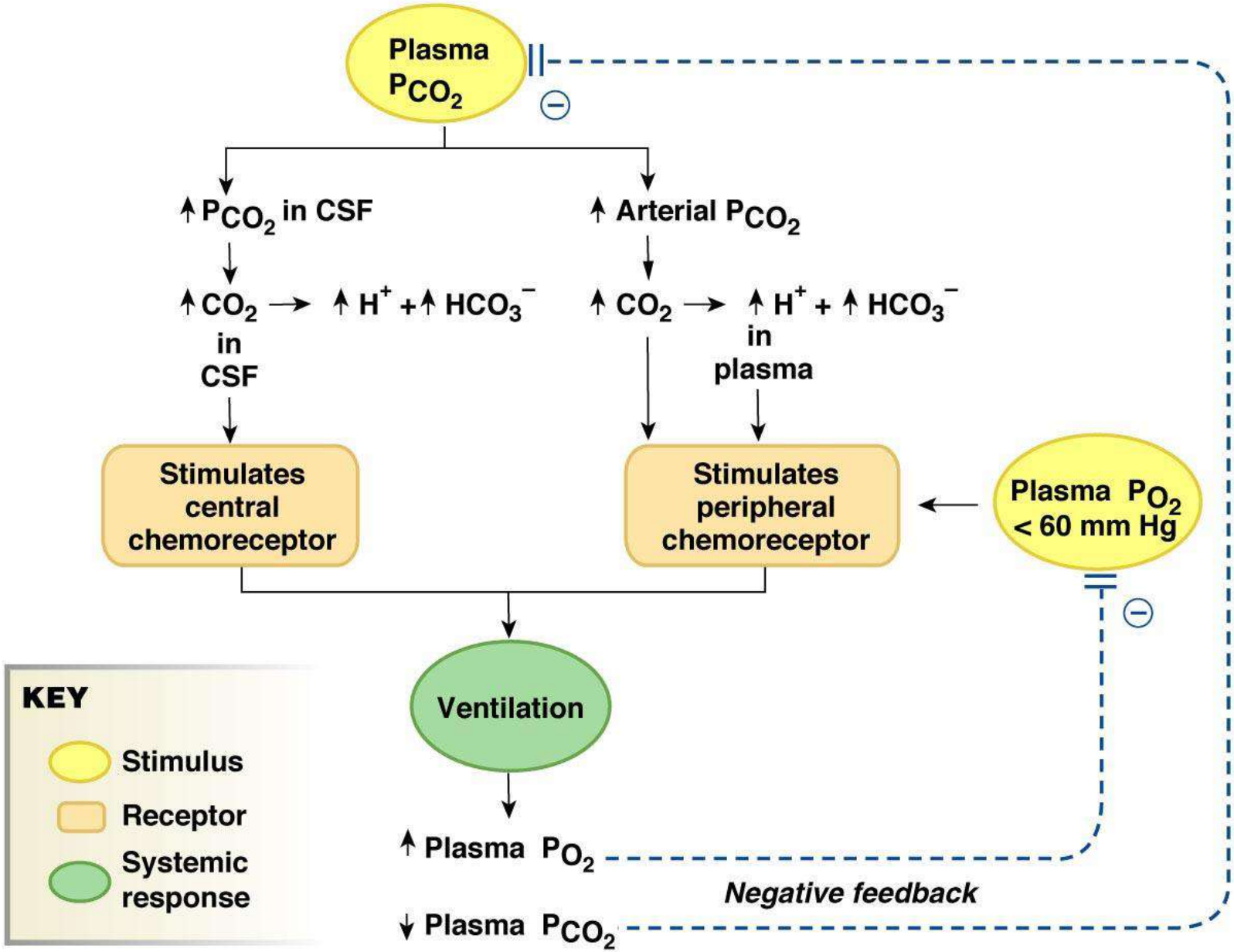

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Figure 18.20

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