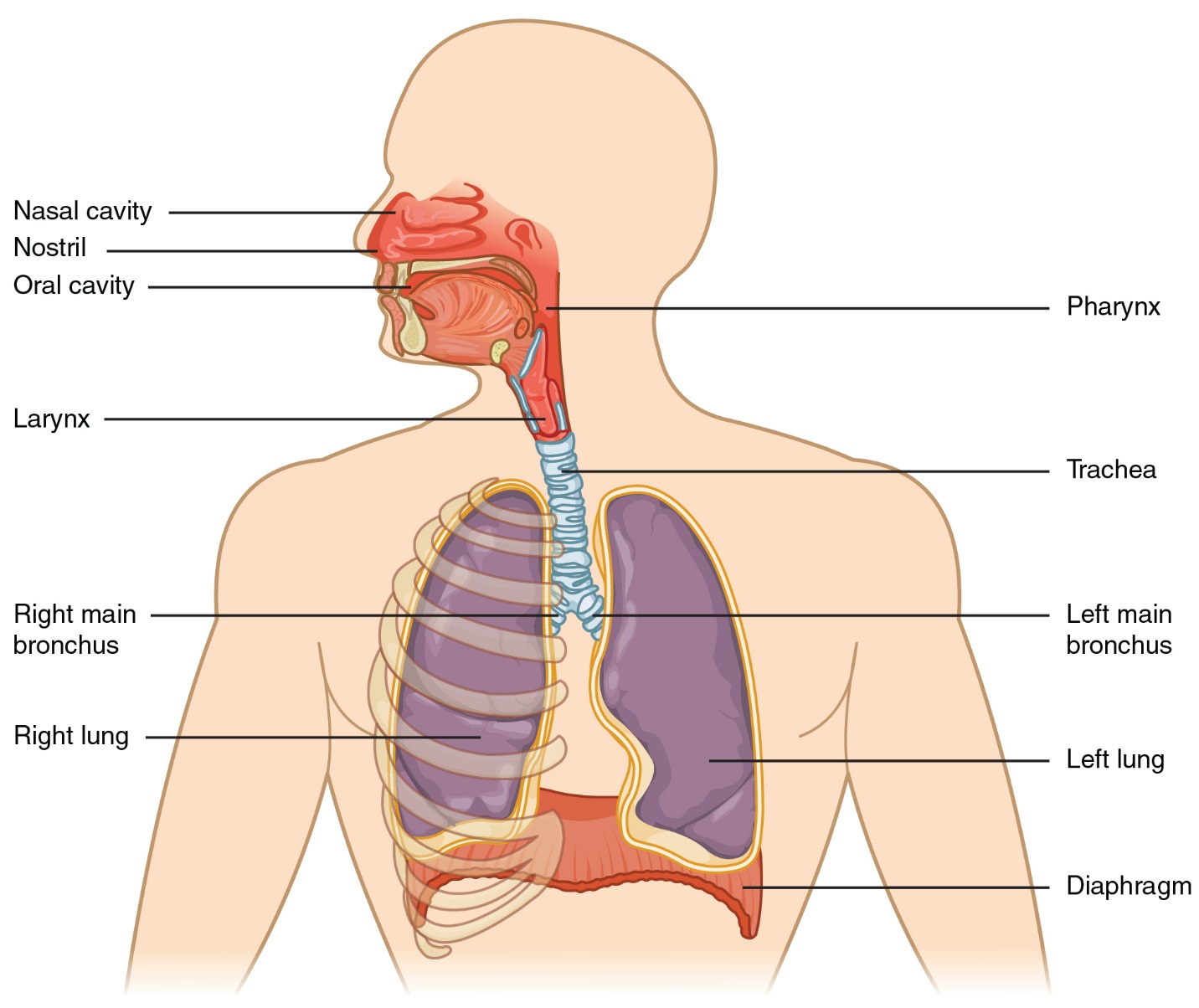
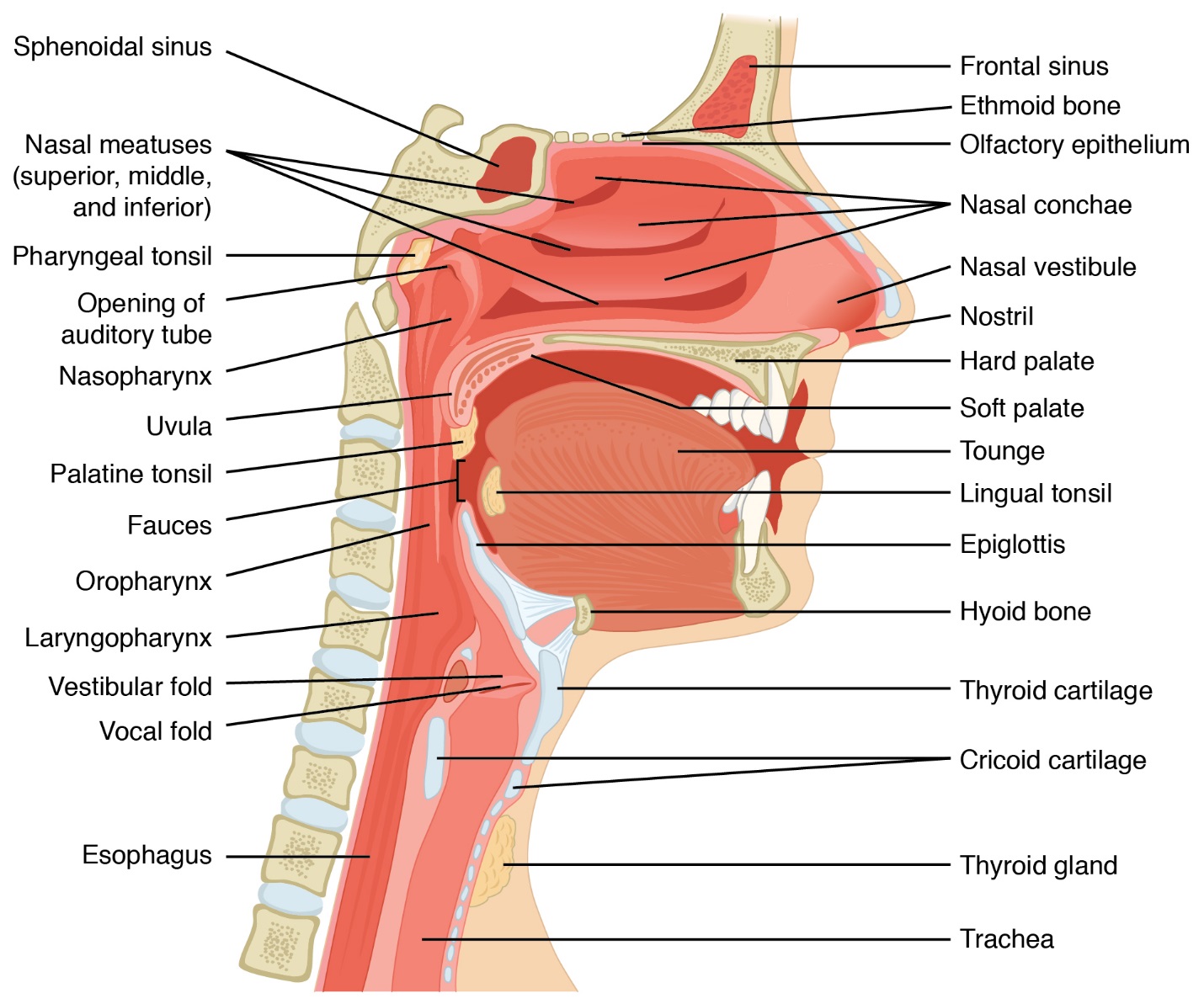
Respiration

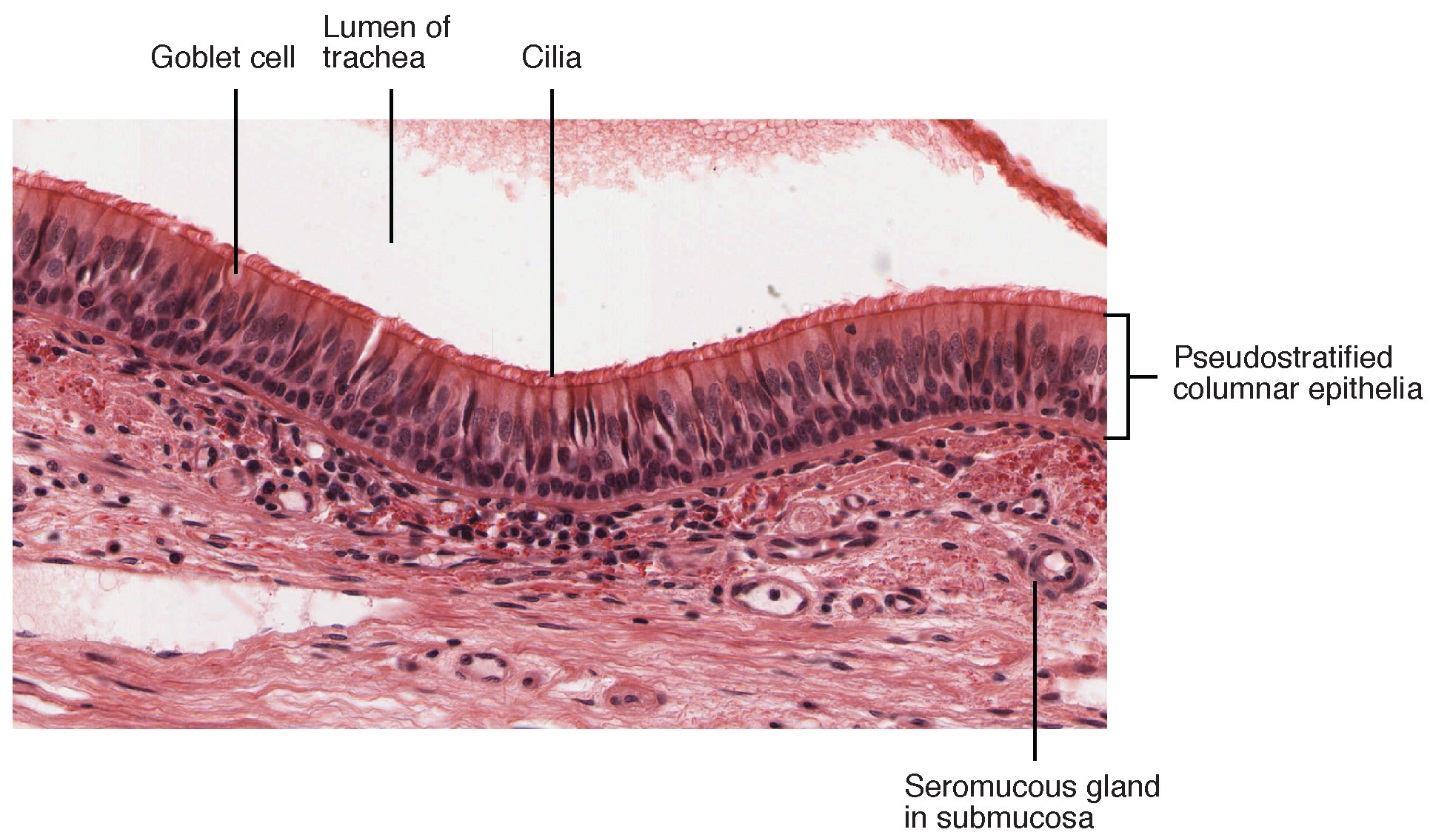


**Figure 1. Major Respiratory Structures.**The major respiratory structures span the nasal cavity to the diaphragm.

Nasal Cavity

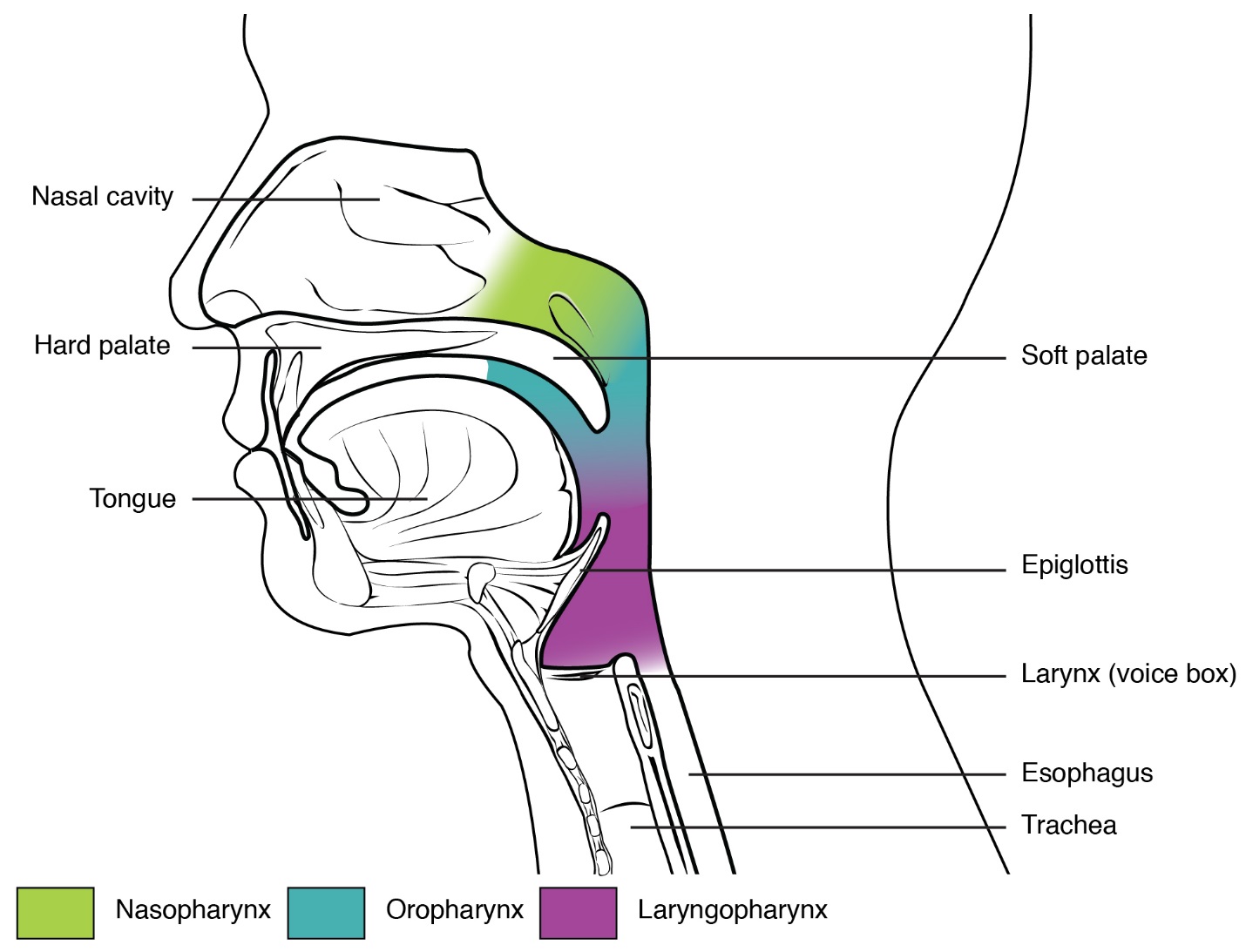


**Figure 3. Upper Airway**



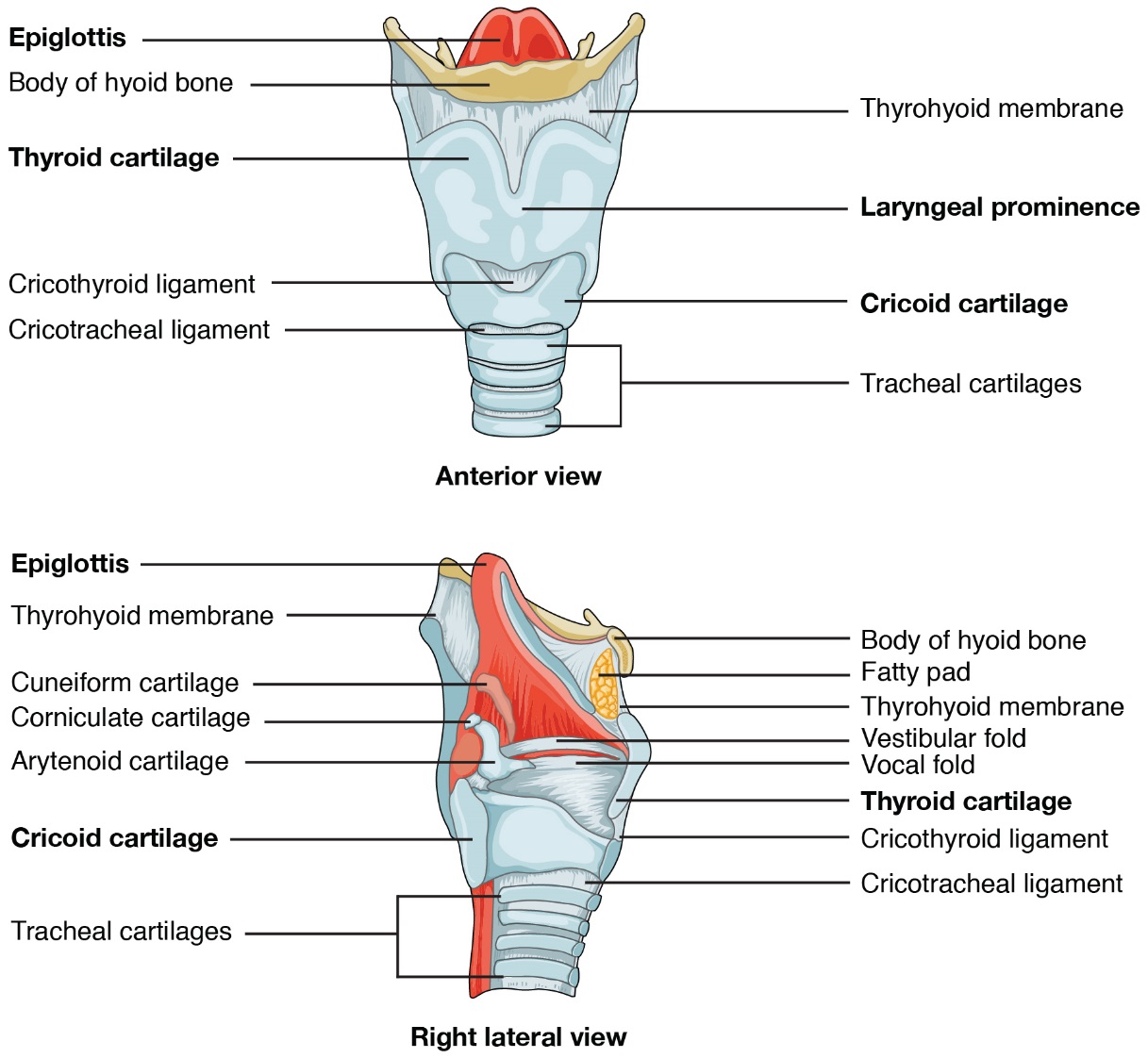
**Figure 4. Pseudostratified Ciliated Columnar Epithelium.**Respiratory epithelium is pseudostratified ciliated columnar epithelium. Seromucous glands provide lubricating mucus. LM × 680. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

Pharynx

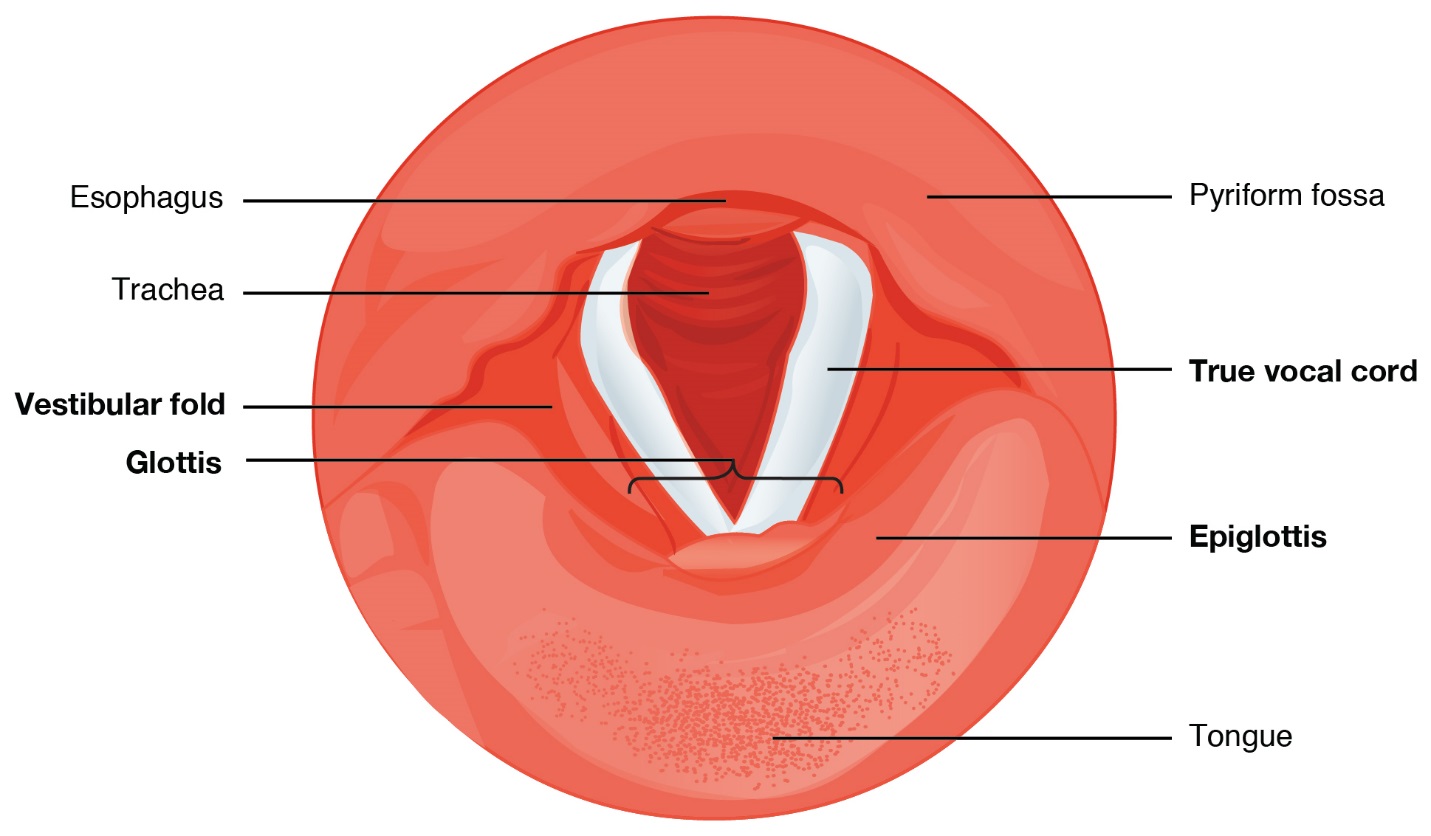


**Figure 5. Divisions of the Pharynx.** The pharynx is divided into three regions: the nasopharynx, the oropharynx, and the laryngopharynx.

Larynx

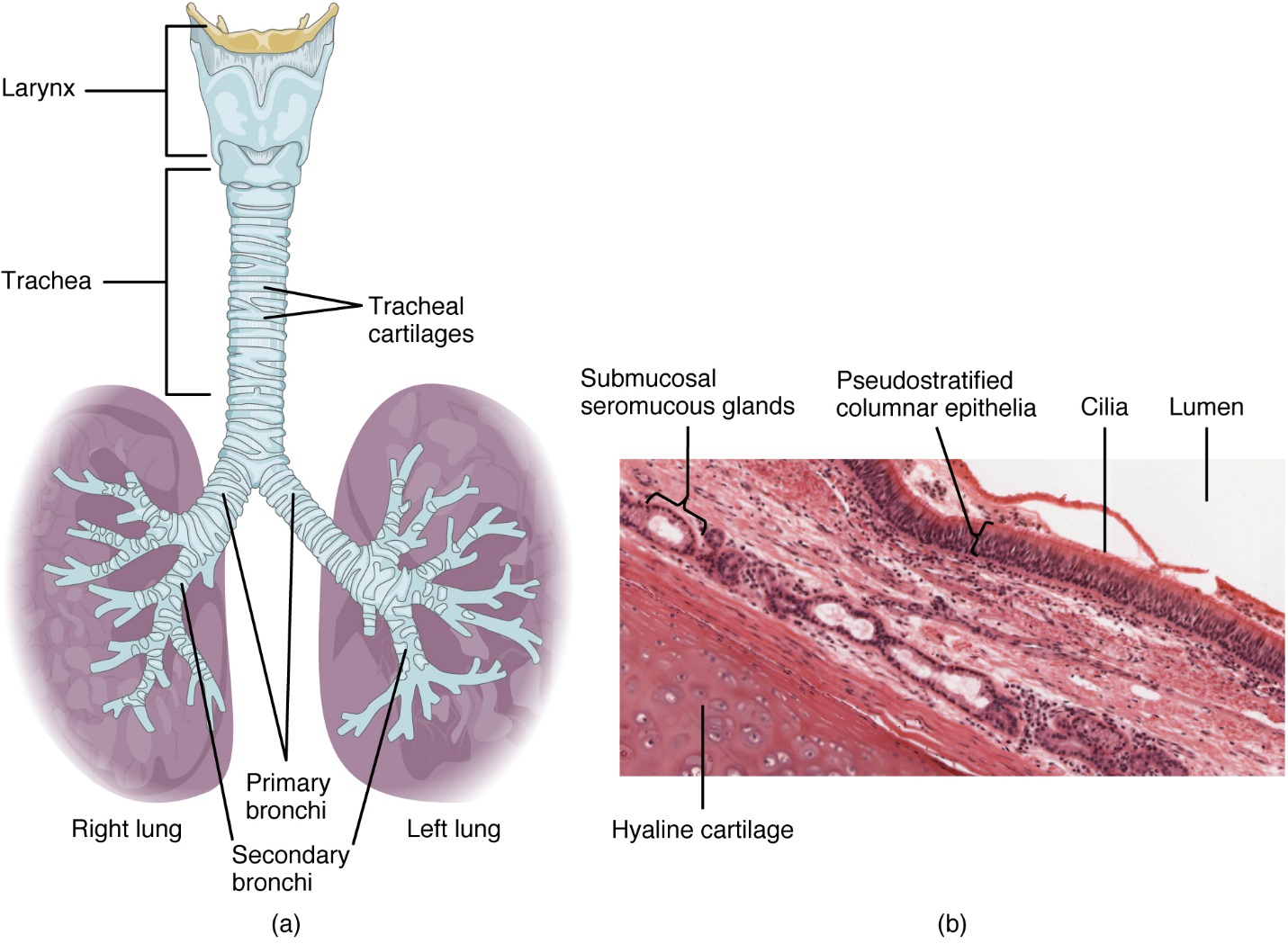


**Figure 6. Larynx.** The larynx extends from the laryngopharynx and the hyoid bone to the trachea.



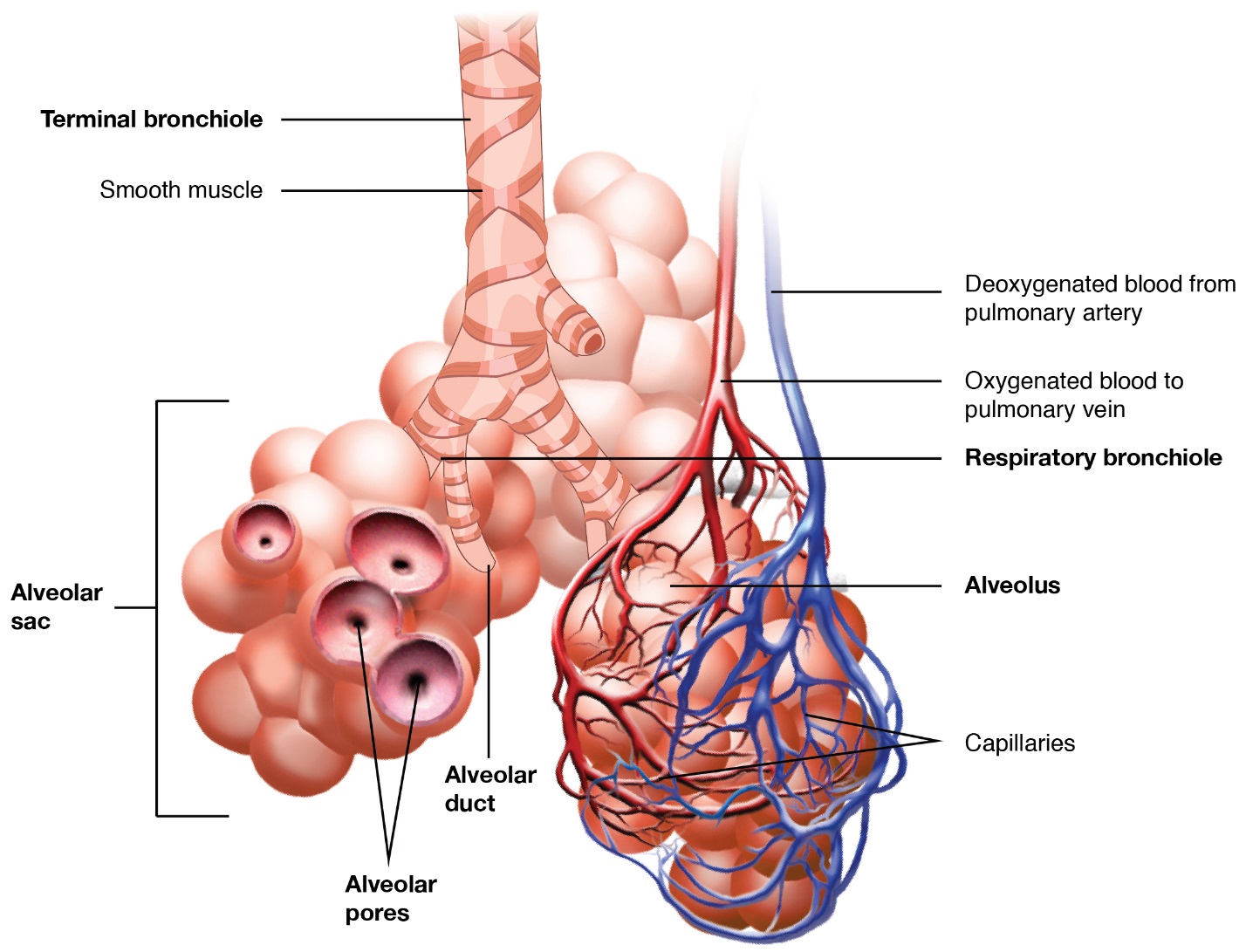
**Figure 7. Vocal Cords.**The true vocal cords and vestibular folds of the larynx are viewed inferiorly from the laryngopharynx.

Trachea

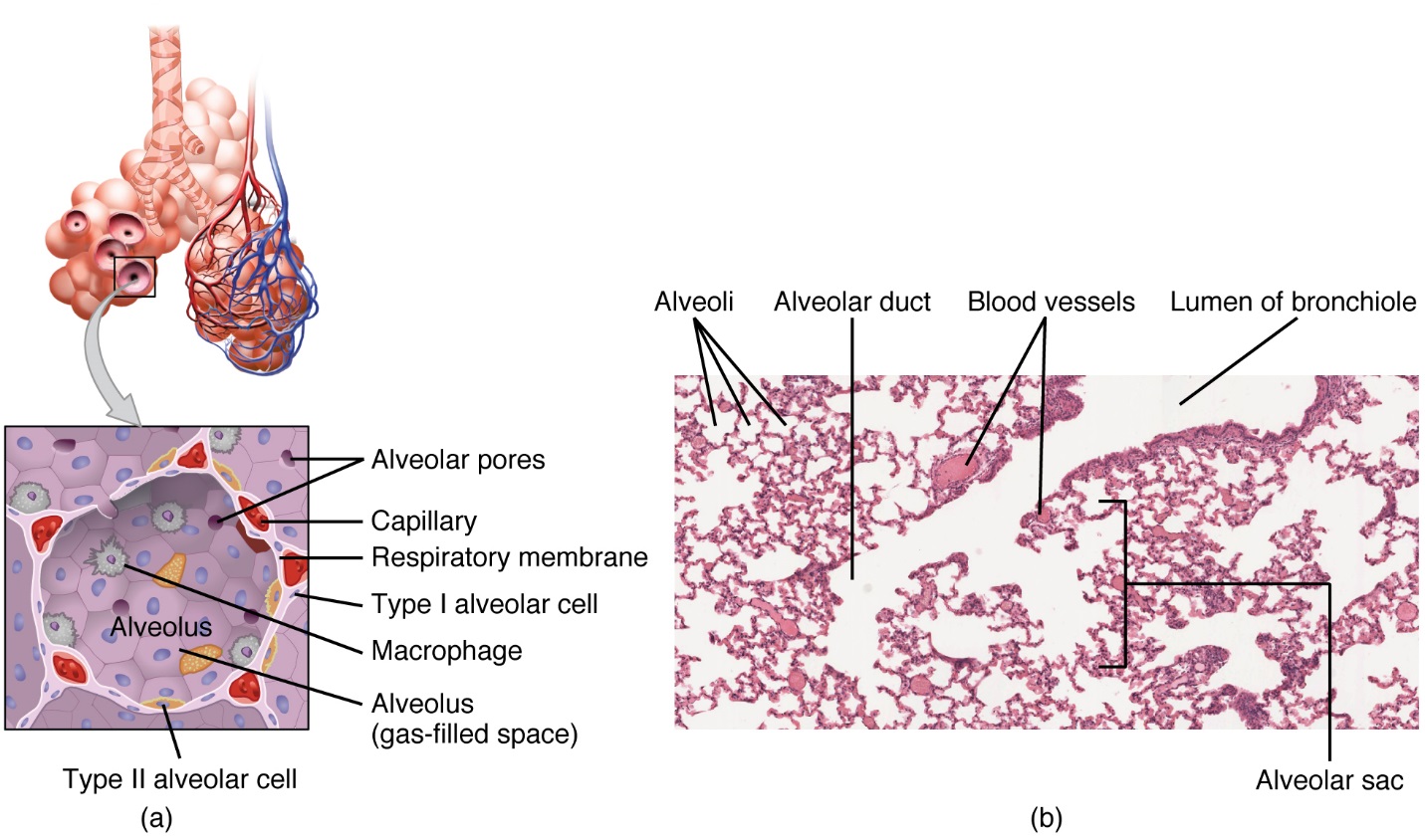


**Figure 8. Trachea.**(a) The tracheal tube is formed by stacked, C-shaped pieces of hyaline cartilage. (b) The layer visible in this cross-section of tracheal wall tissue between the hyaline cartilage and the lumen of the trachea is the mucosa, which is composed of pseudostratified ciliated columnar epithelium that contains goblet cells. LM × 1220. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

Respiratory Membrane

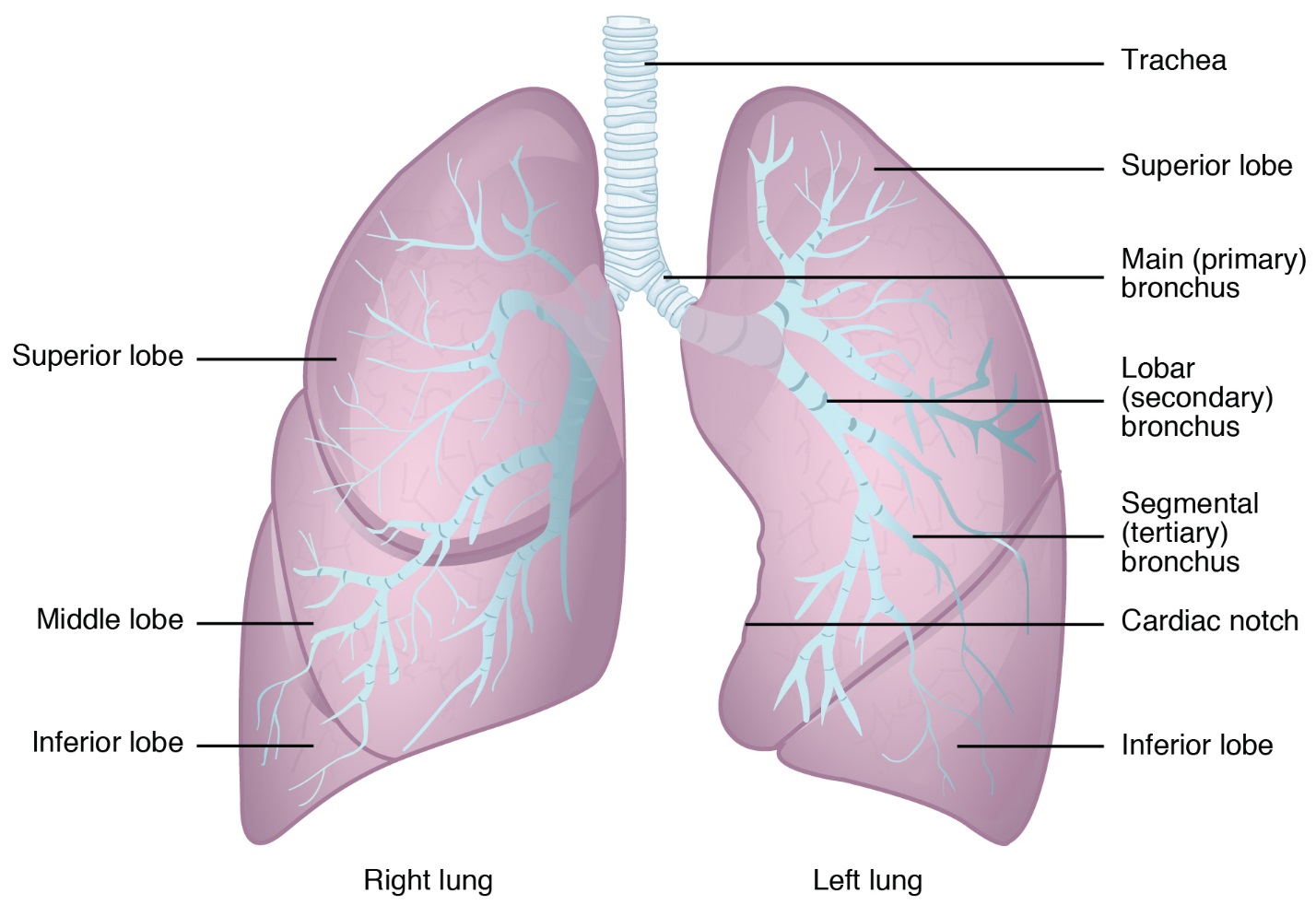


**Figure 9. Respiratory Zone.** Bronchioles lead to alveolar sacs in the respiratory zone, where gas exchange occurs.

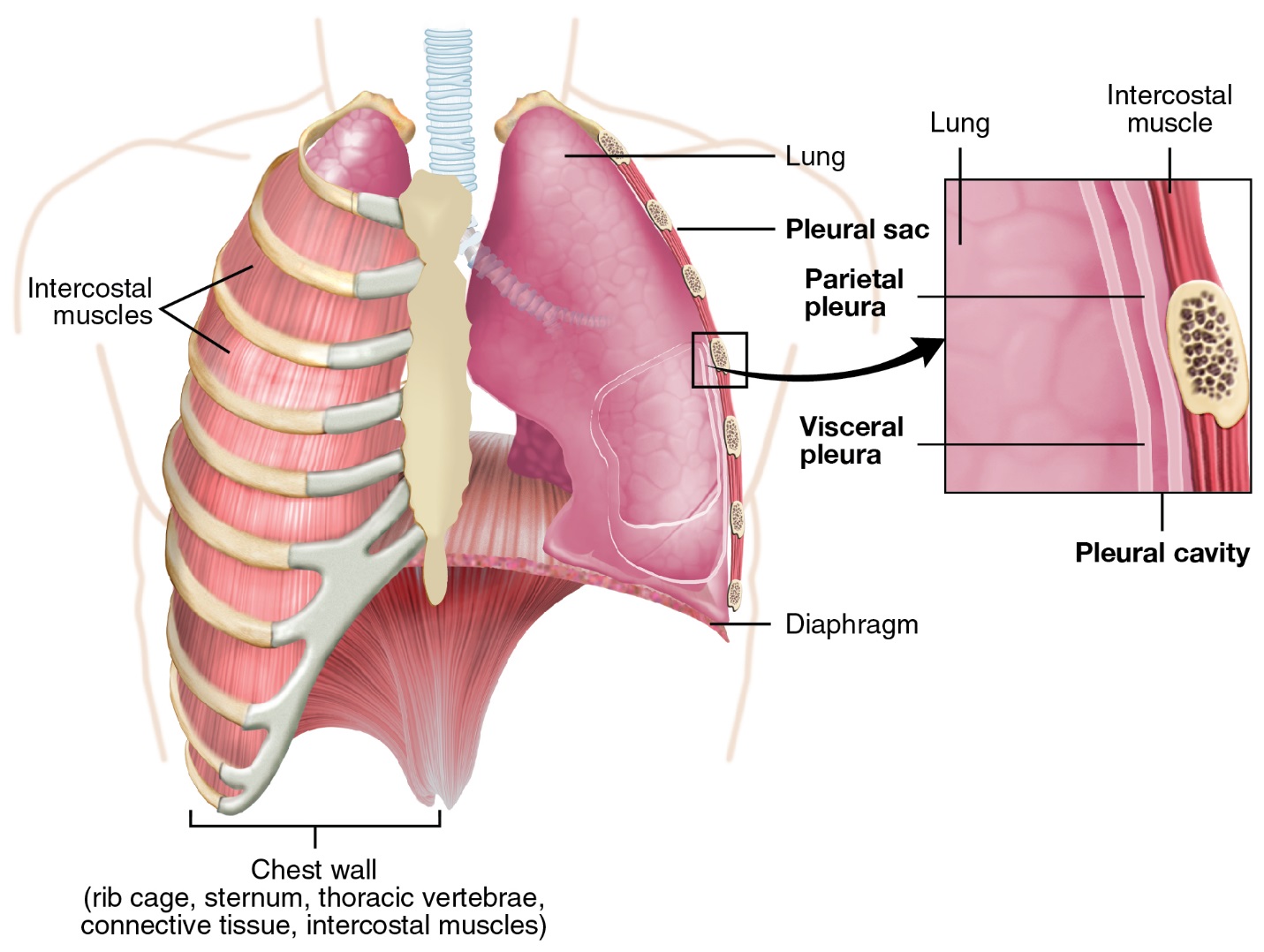


**Figure 10. Structures of the Respiratory Zone.**(a) The alveolus is responsible for gas exchange. (b) A micrograph shows the alveolar structures within lung tissue. LM × 178. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

Anatomy of the Lungs

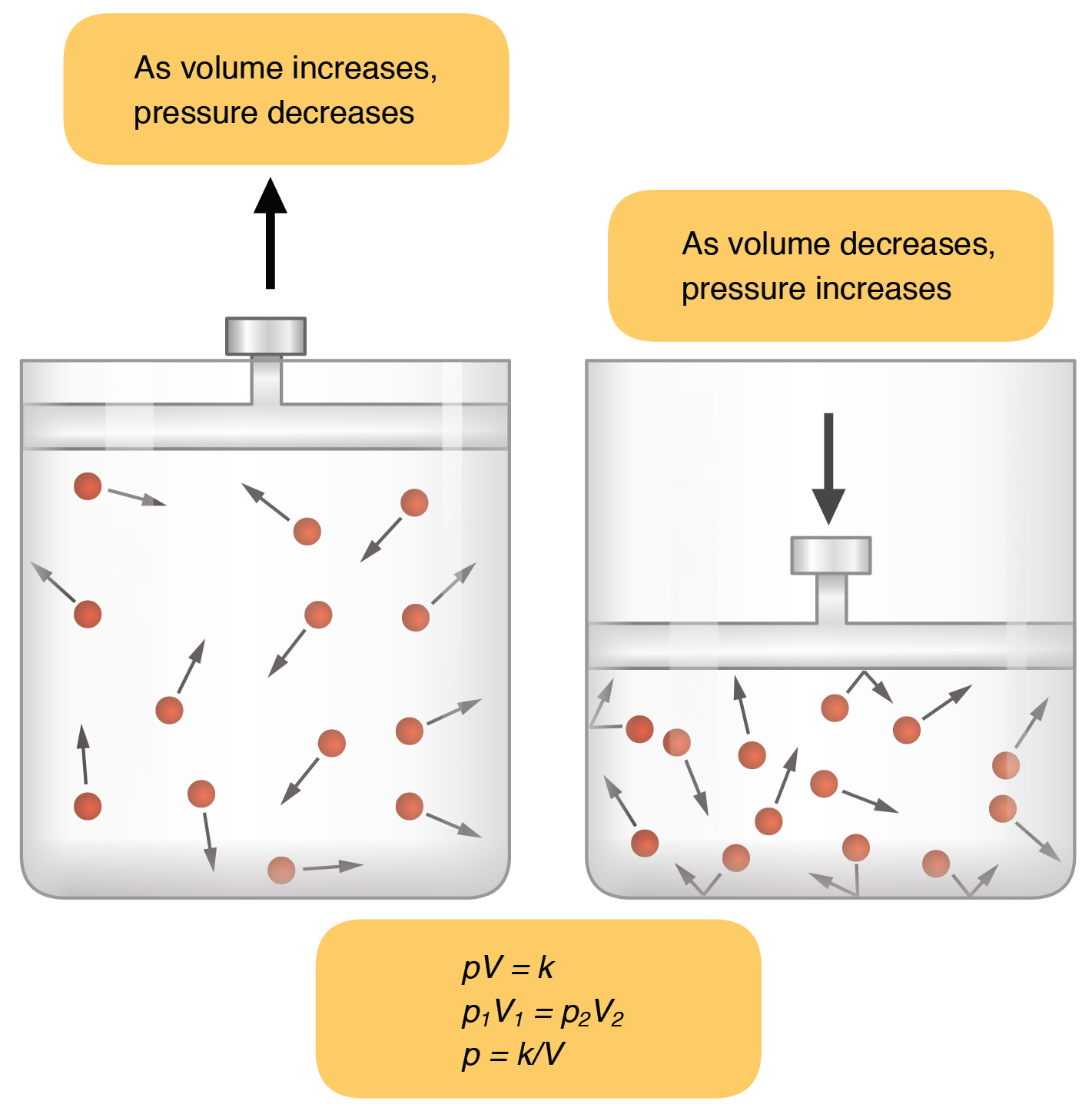


**Figure 1. Gross Anatomy of the Lungs.**



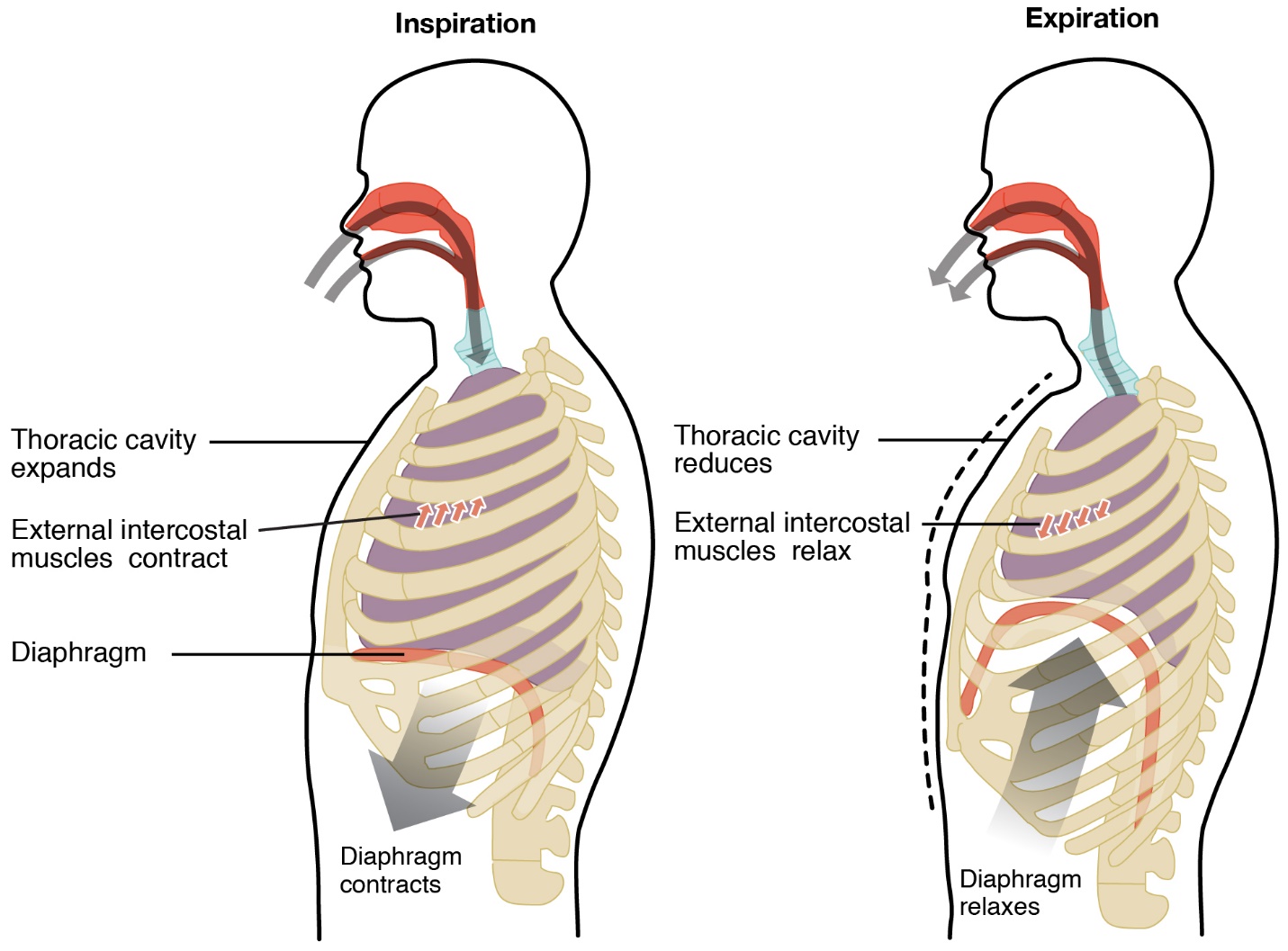
**Figure 2. Parietal and Visceral Pleurae of the Lungs.**

Lung Pressures



**Figure 1. Boyle’s Law.** In a gas, pressure increases as volume decreases.

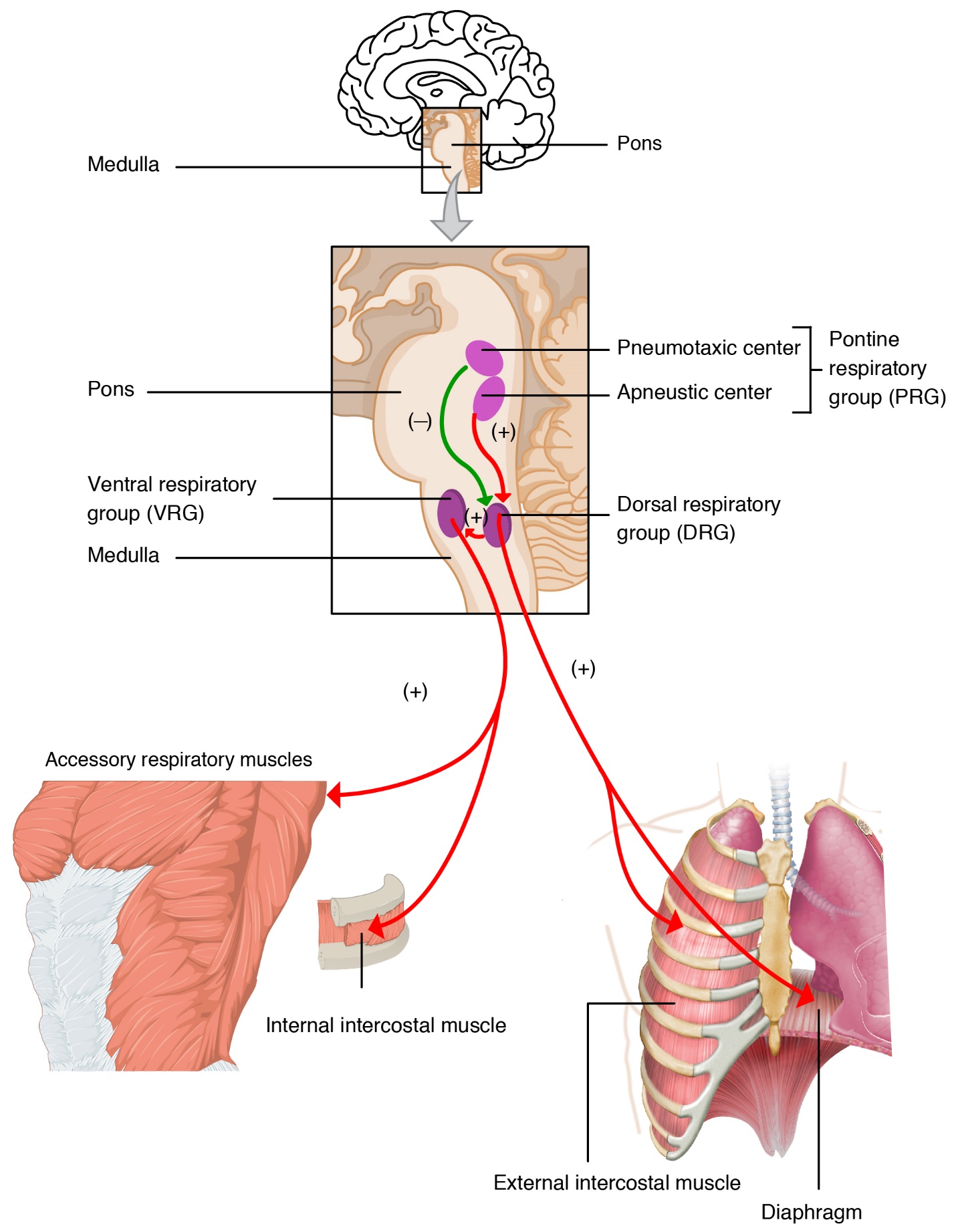
Pulmonary Ventilation



**Figure 3. Inspiration and Expiration.**Inspiration and expiration occur due to the expansion and contraction of the thoracic cavity, respectively.

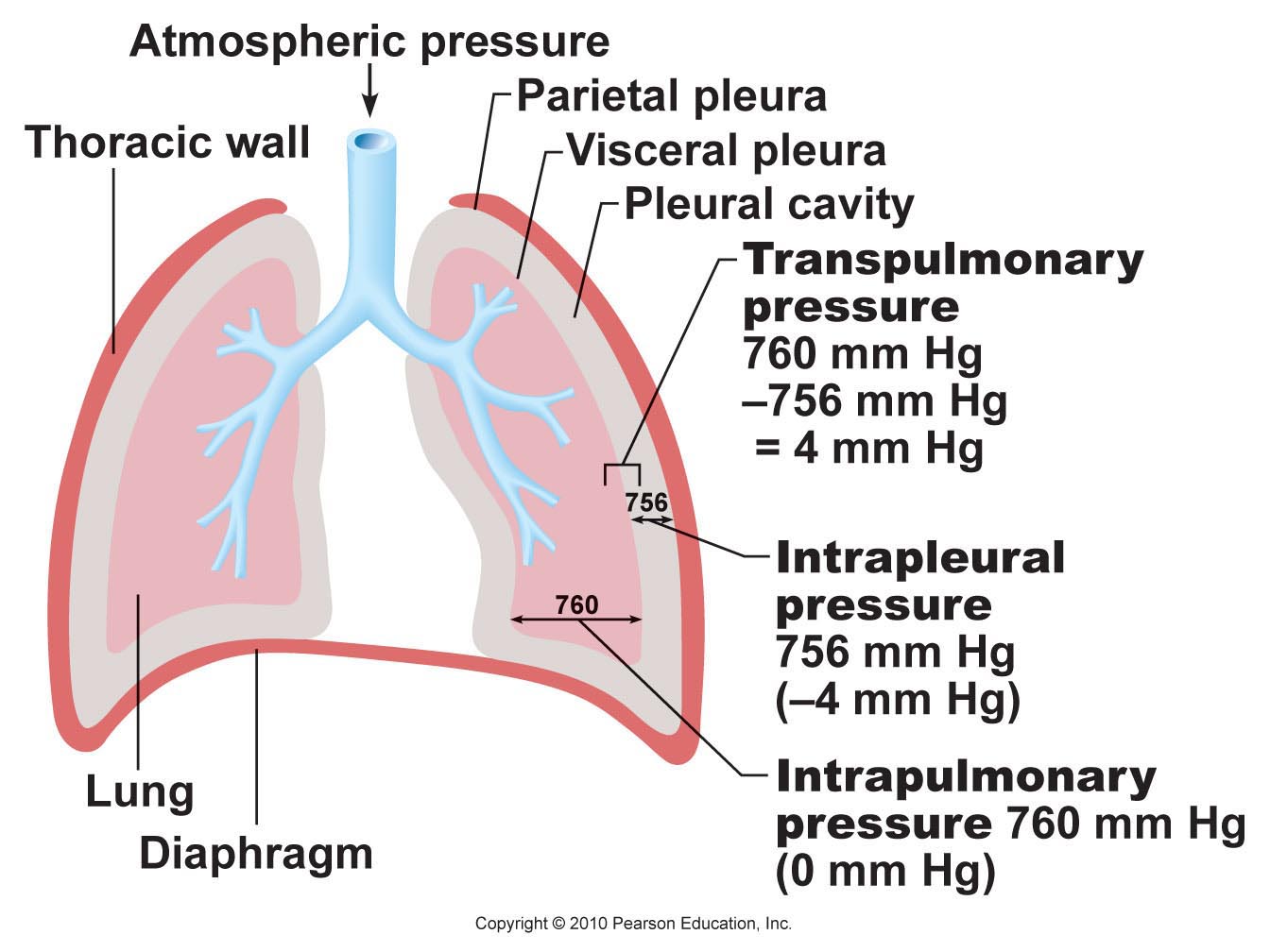
Control of Ventilation

| **Summary of Ventilation Regulation (Table 1)** | |
| --- | --- |
| **System component** | **Function** |
| Medullary respiratory renter | Sets the basic rhythm of breathing |
| Ventral respiratory group (VRG) | Generates the breathing rhythm and integrates data coming into the medulla |
| Dorsal respiratory group (DRG) | Integrates input from the stretch receptors and the chemoreceptors in the periphery |
| Pontine respiratory group (PRG) | Influences and modifies the medulla oblongata’s functions |
| Aortic body | Monitors blood PCO2, PO2, and pH |
| Carotid body | Monitors blood PCO2, PO2, and pH |
| Hypothalamus | Monitors emotional state and body temperature |
| Cortical areas of the brain | Control voluntary breathing |
| Proprioceptors | Send impulses regarding joint and muscle movements |
| Pulmonary irritant reflexes | Protect the respiratory zones of the system from foreign material |
| Inflation reflex | Protects the lungs from over-inflating |

**Figure 6. Respiratory Centers of the Brain.** **Figure 6. Respiratory Centers of the Brain.**

Apnea

Intrapleural Pressure

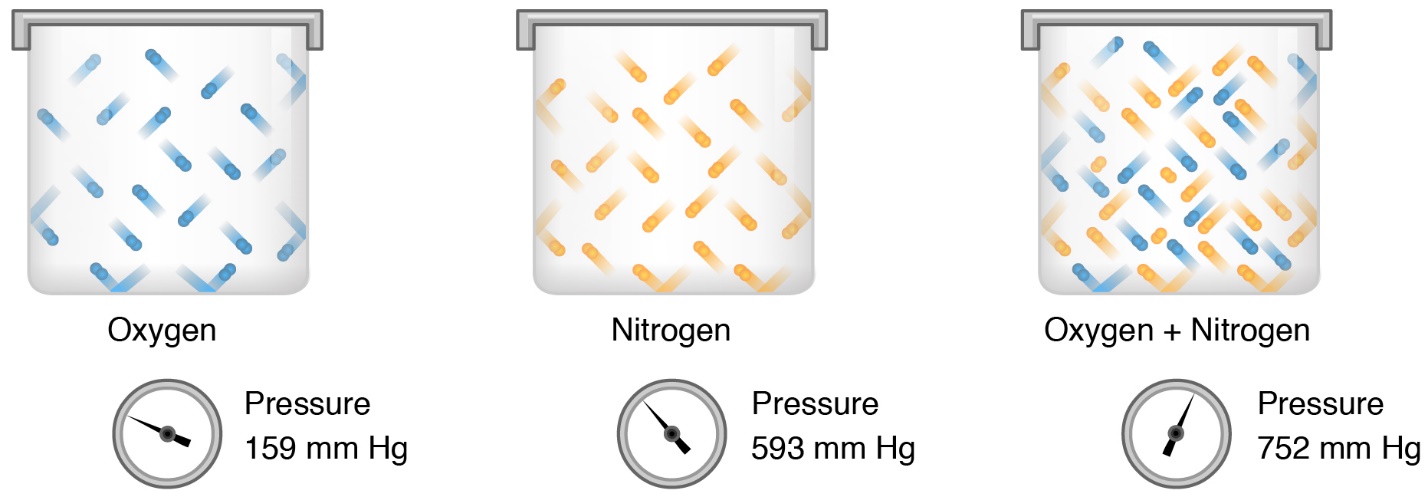


**Figure 2.** Intrapulmonary and Intrapleural Pressure Relationships. Alveolar pressure changes during the different phases of the cycle. It equalizes at 760 mm Hg but does not remain at 760 mm Hg.

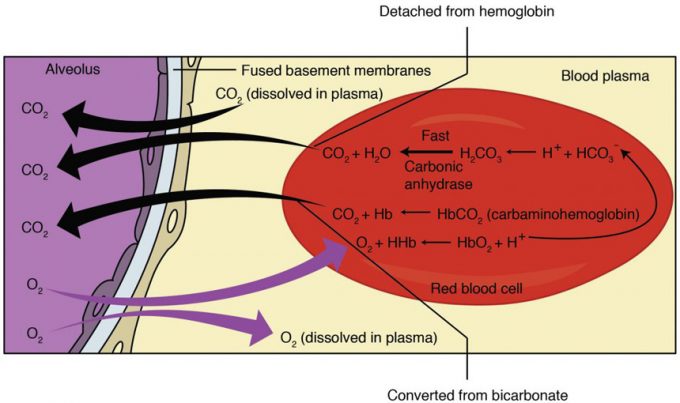
Gas Exchange

| **Partial Pressures of Atmospheric Gases (Table 2)** | | |
| --- | --- | --- |
| **Gas** | **Percent of total composition** | **Partial pressure**  **(mm Hg)** |
| Nitrogen (N2) | 78.6 | 597.4 |
| Oxygen (O2) | 20.9 | 158.8 |
| Water (H2O) | 0.04 | 3.0 |
| Carbon dioxide (CO2) | 0.004 | 0.3 |
| Others | 0.0006 | 0.5 |
| Total composition/total atmospheric pressure | 100% | 760.0 |

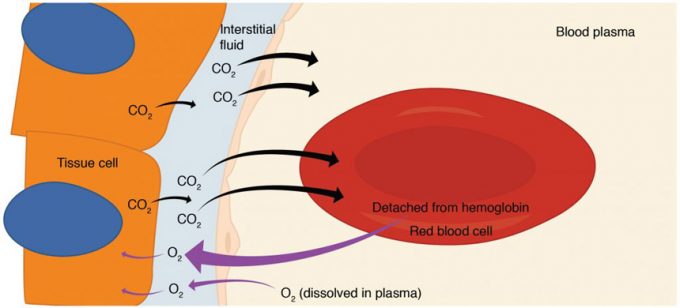
Figure 1. Partial and Total Pressures of a Gas. Partial pressure is the force exerted by a gas. The sum of the partial pressures of all the gases in a mixture equals the total pressure.



**Figure 1. Partial and Total Pressures of a Gas.** Partial pressure is the force exerted by a gas. The sum of the partial pressures of all the gases in a mixture equals the total pressure.

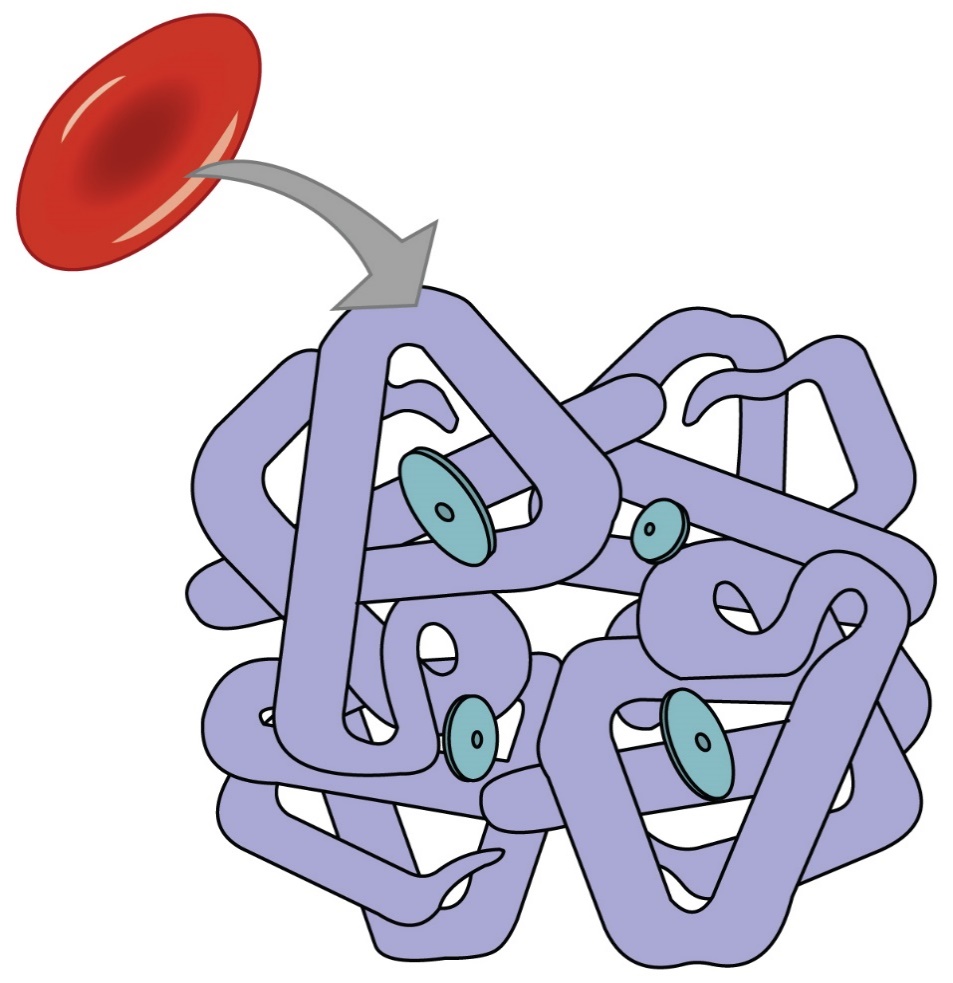


**Figure 3. External Respiration.** In external respiration, oxygen diffuses across the respiratory membrane from the alveolus to the capillary, whereas carbon dioxide diffuses out of the capillary into the alveolus.

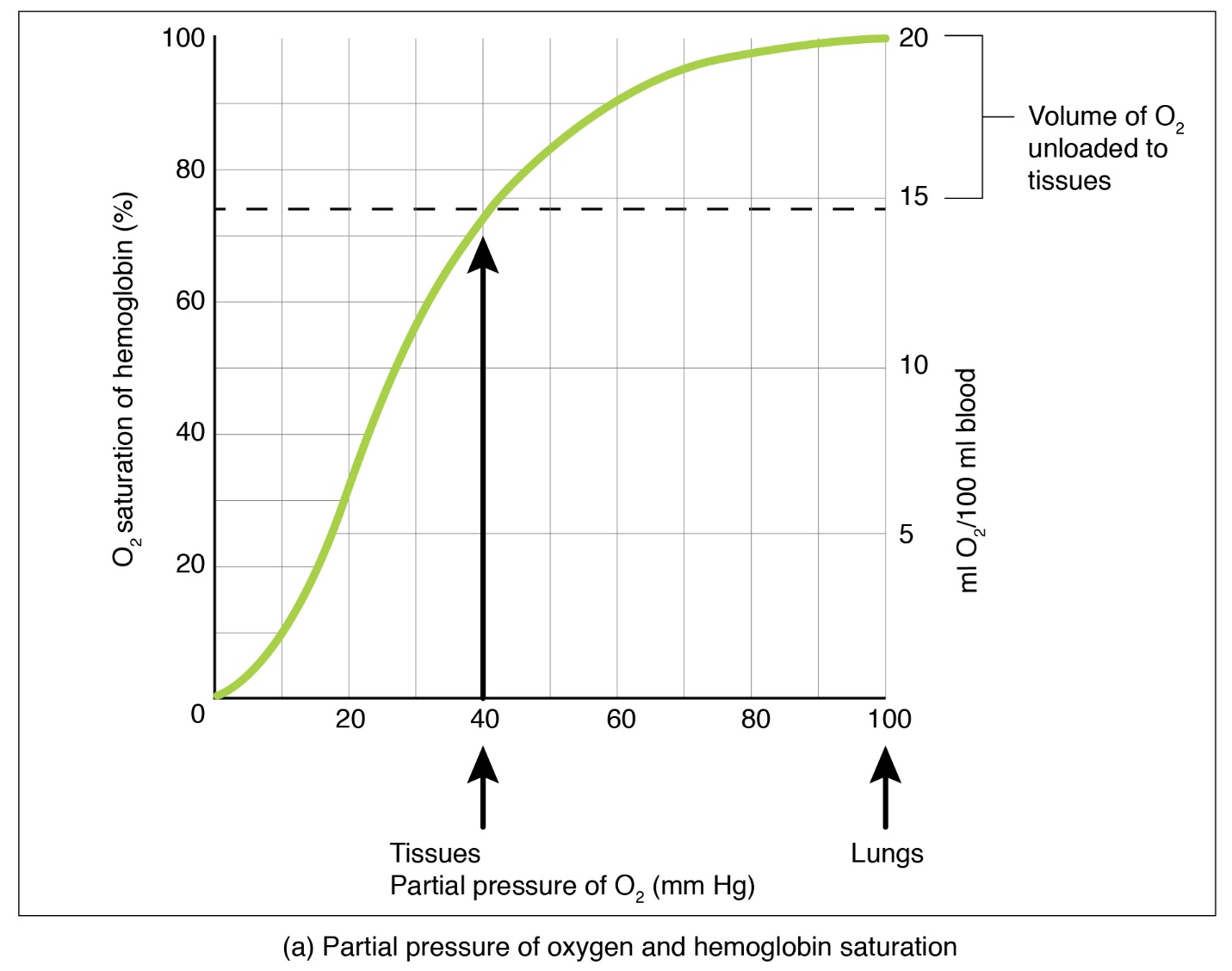


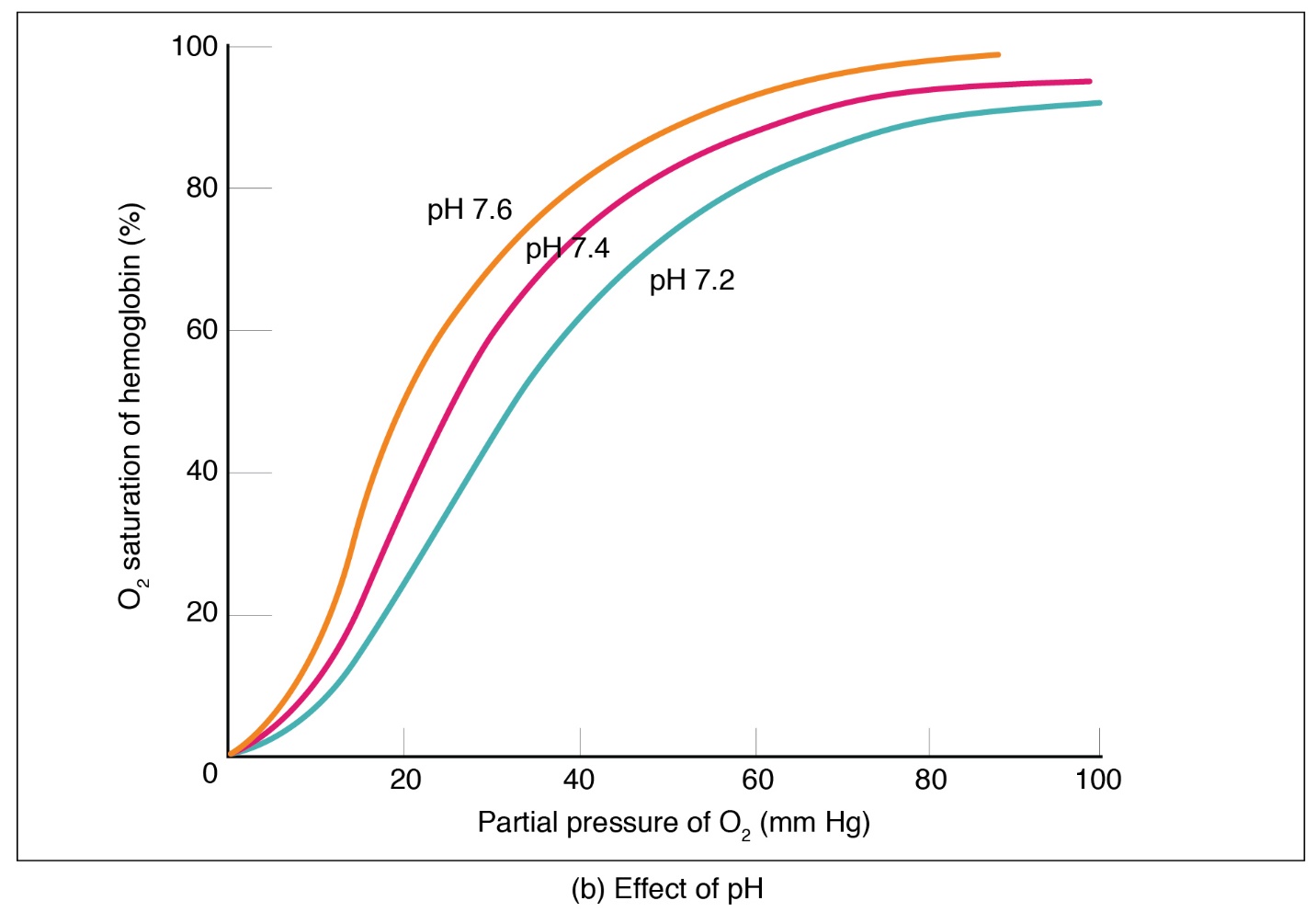
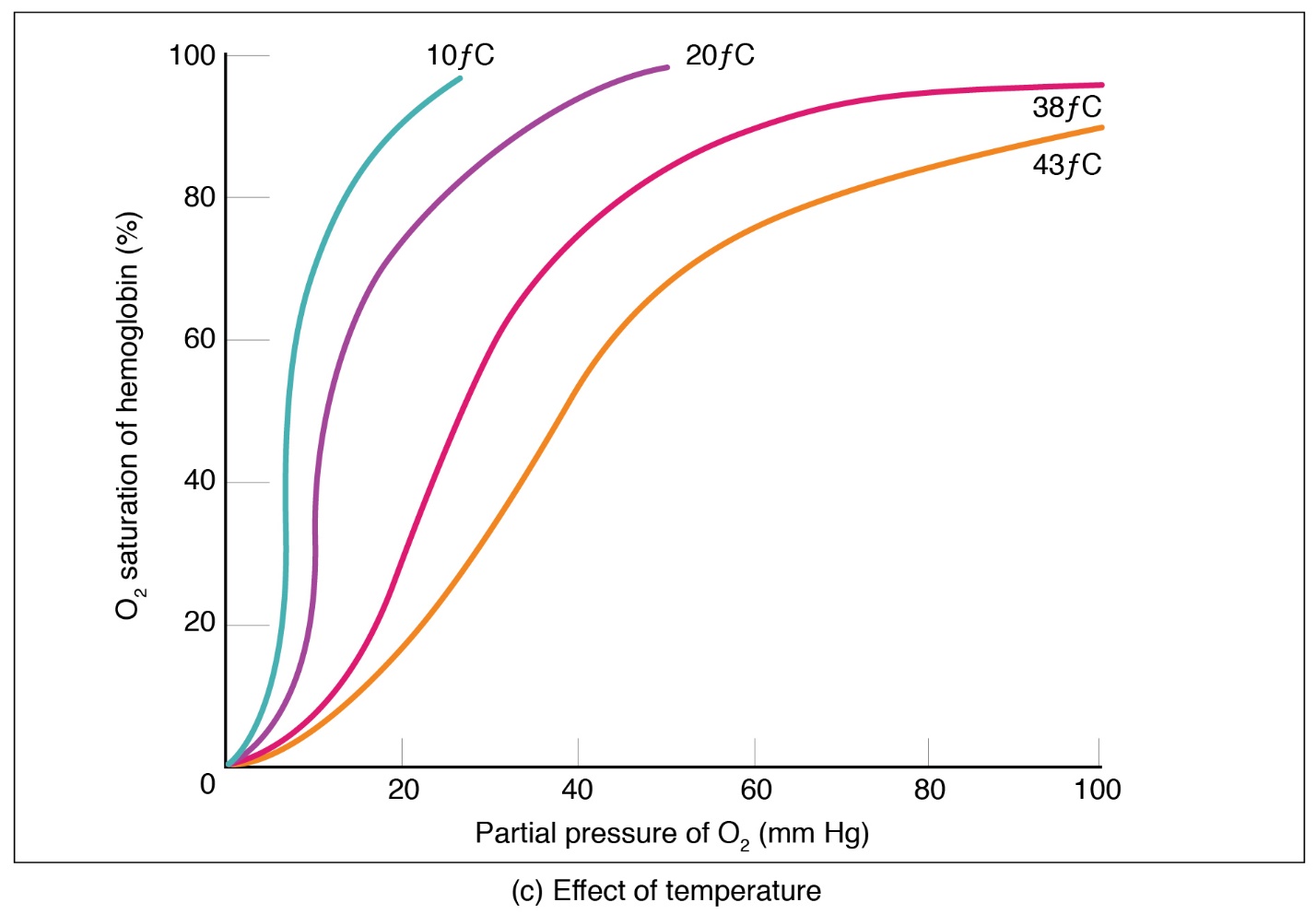
**Figure 3. Internal Respiration.** Oxygen diffuses out of the capillary and into cells, whereas carbon dioxide diffuses out of cells and into the capillary.

Transport of Gases

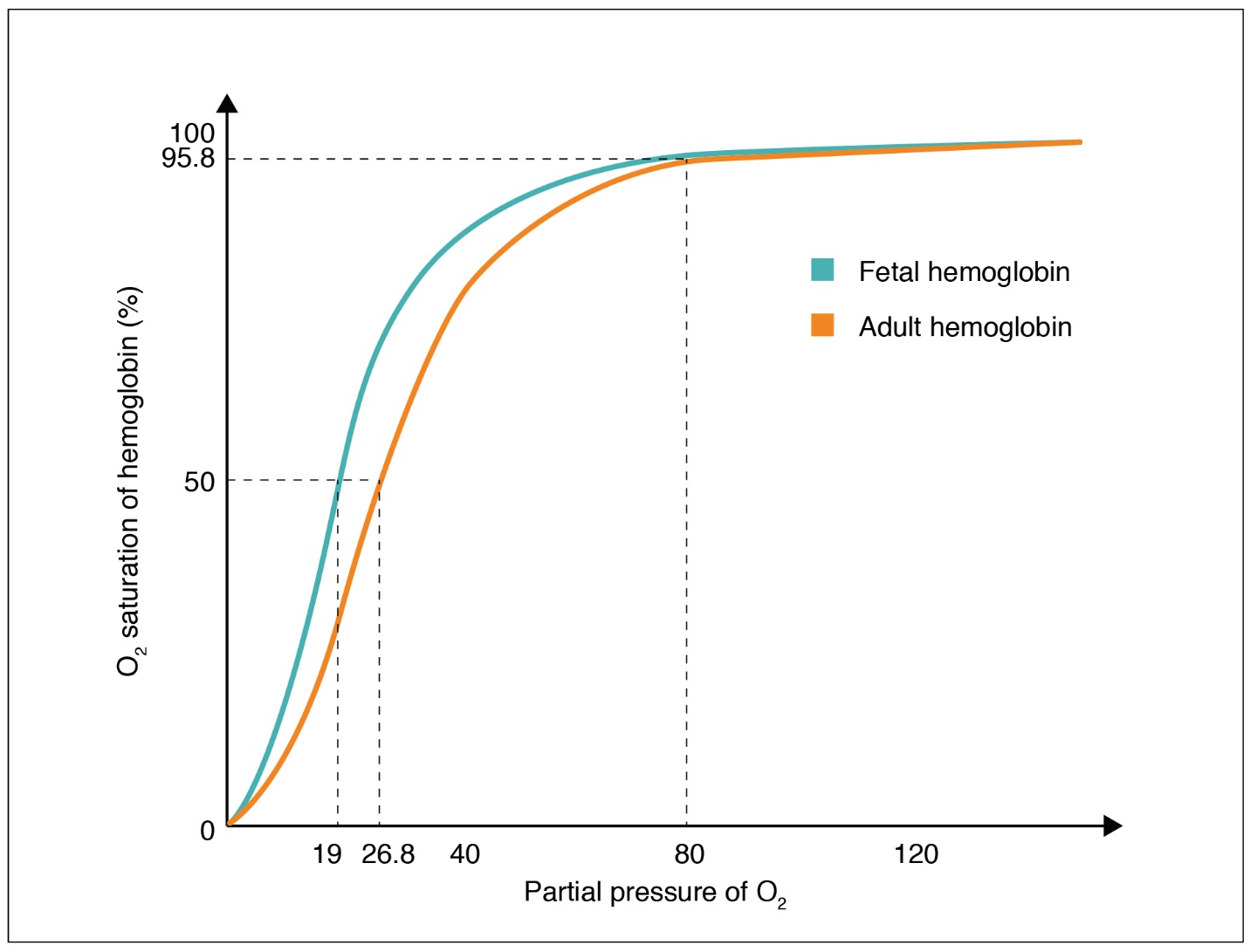


**Figure 1. Erythrocyte and Hemoglobin.** Hemoglobin consists of four subunits, each of which contains one molecule of iron.



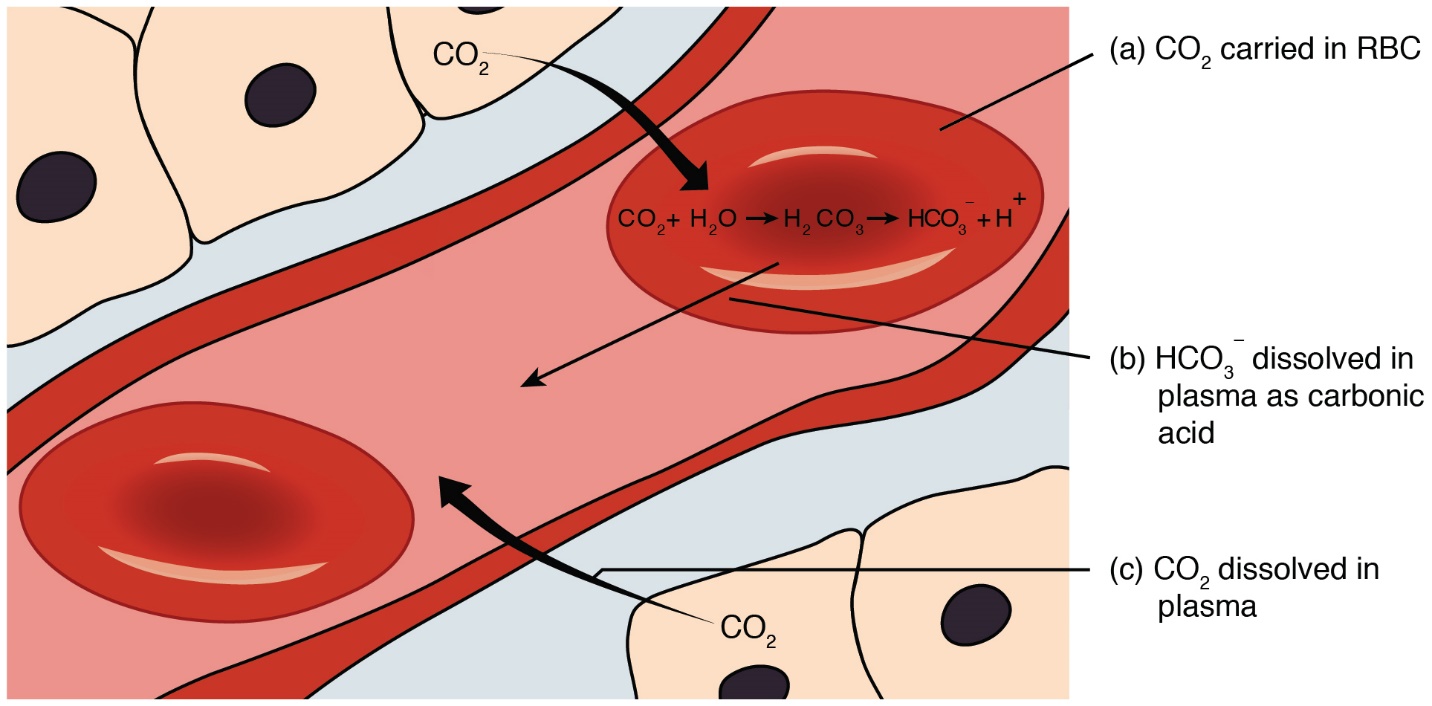
 

Fetal Hemoglobin



**Figure 3. Oxygen-Hemoglobin Dissociation Curves in Fetus and Adult.** Fetal hemoglobin has a greater affinity for oxygen than does adult hemoglobin.

CO2 Transport

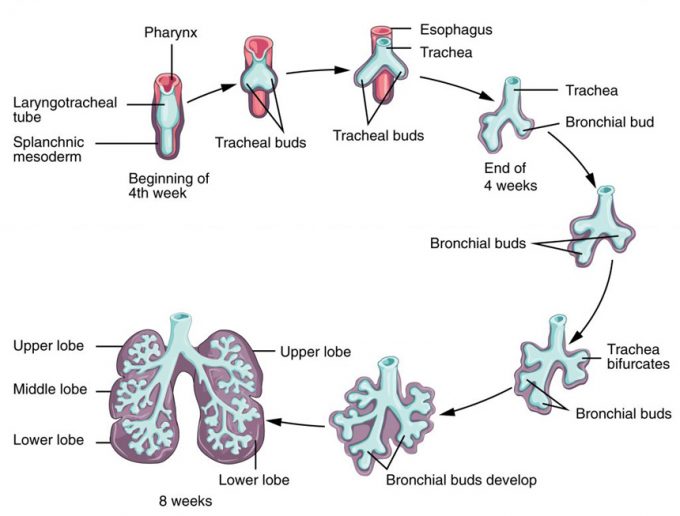


**Carbon Dioxide Transport Carbon dioxide is transported by three different methods:** (a) in erythrocytes; (b) after forming carbonic acid (H2CO3 ), which is dissolved in plasma; (c) and in plasma.

Modifications of Respiration

| **Partial Pressure of Oxygen at Different Altitudes (Table 4)** | | | |
| --- | --- | --- | --- |
| **Example location** | **Altitude (feet above sea level)** | **Atmospheric pressure (mm Hg)** | **Partial pressure of oxygen (mm Hg)** |
| New York City, New York | 0 | 760 | 159 |
| Boulder, Colorado | 5000 | 632 | 133 |
| Aspen, Colorado | 8000 | 565 | 118 |
| Pike’s Peak, Colorado | 14,000 | 447 | 94 |
| Denali (Mt. McKinley), Alaska | 20,000 | 350 | 73 |
| Mt. Everest, Tibet | 29,000 | 260 | 54 |

Embryonic Development



**Figure 1. Development of the Lower Respiratory System.**

Respiratory Illnesses