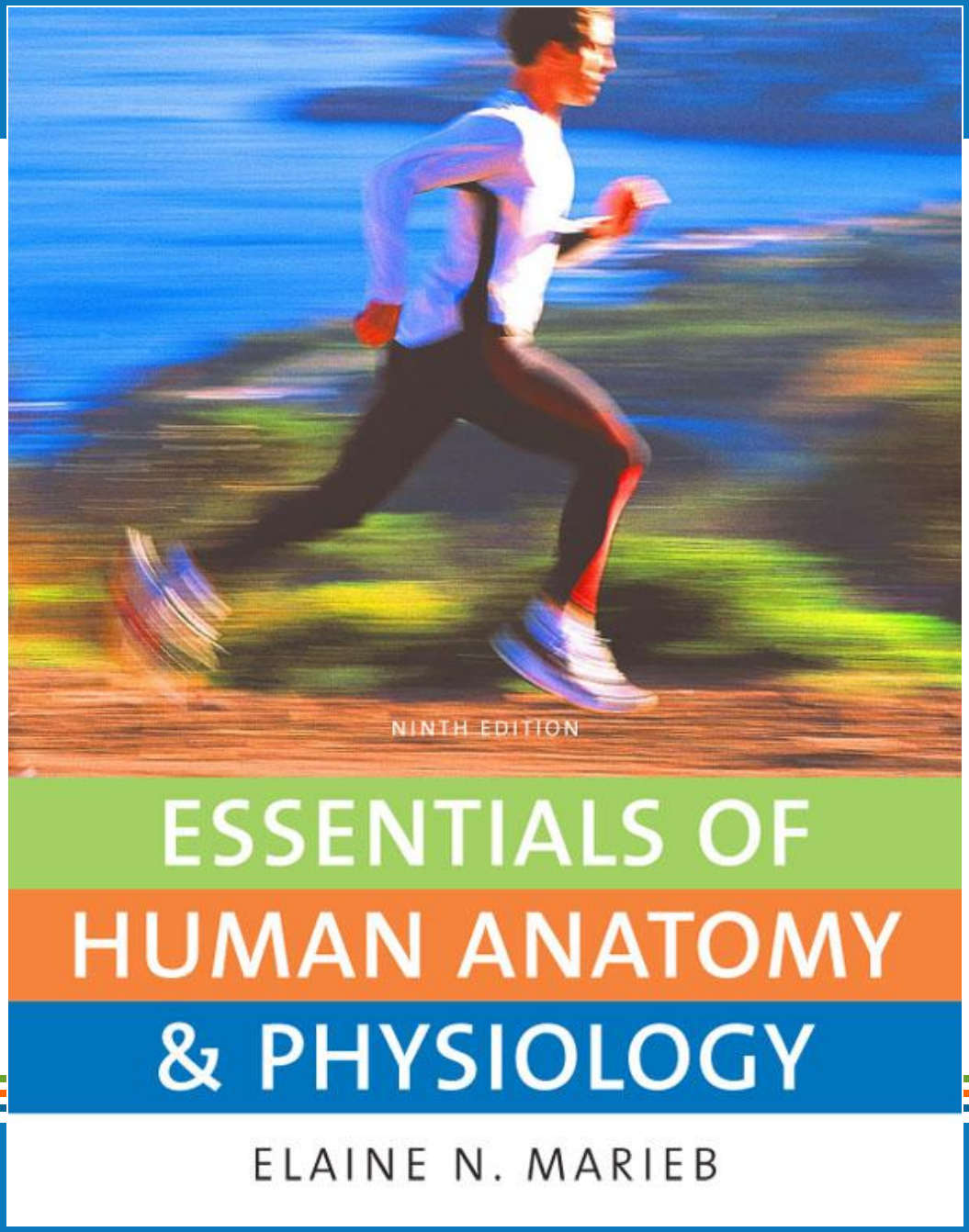


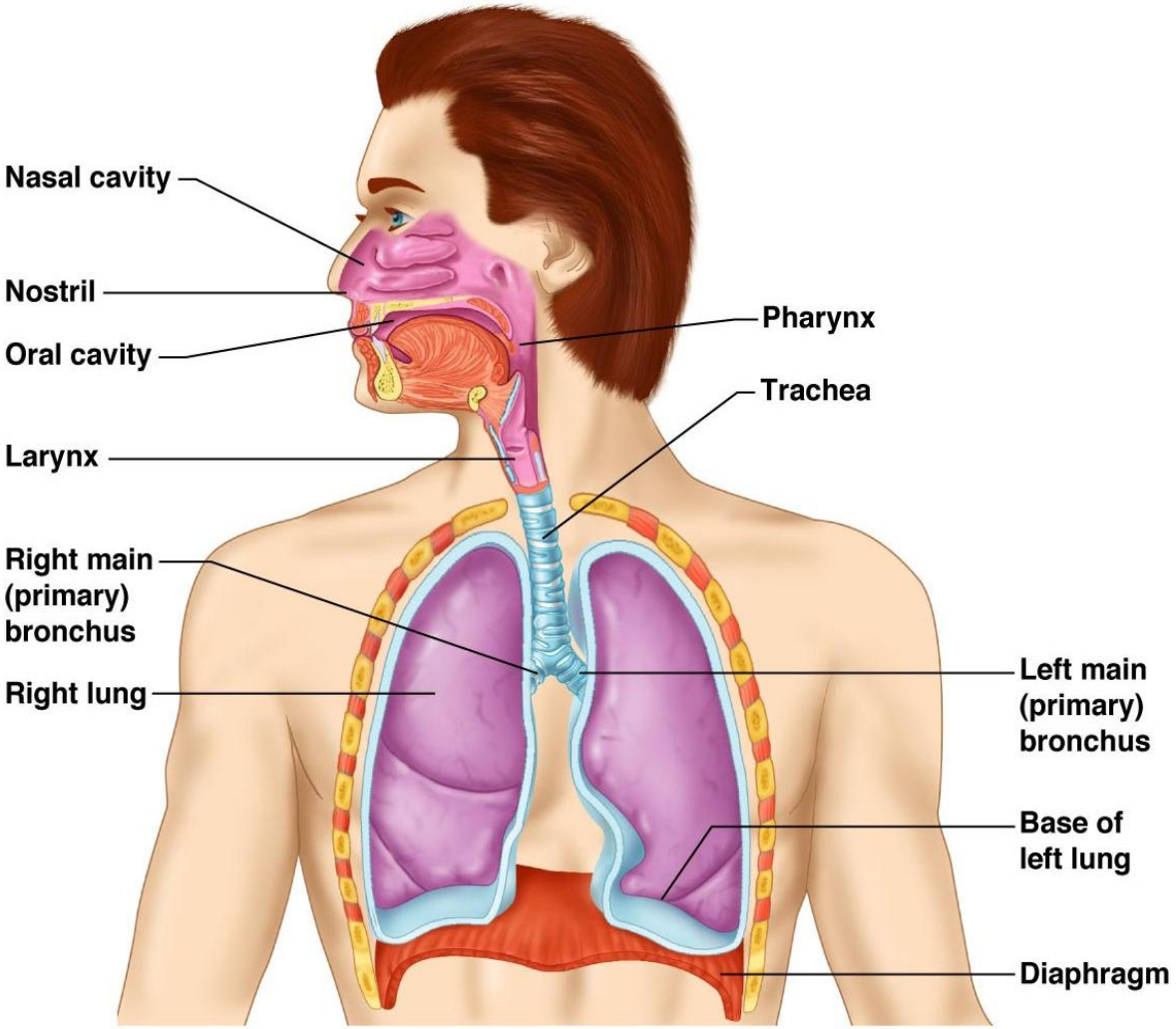
PowerPoint® Lecture Slide Presentation
by Patty Bostwick-Taylor,
Florence-Darlington Technical College

The Respiratory System

13 PART A

Organs of the Respiratory System

- Nose
- Pharynx
- Larynx
- Trachea
- Bronchi
- Lungs—alveoli



Functions of the Respiratory System

- Gas exchanges between the blood and external environment
  - Occurs in the alveoli of the lungs
- Passageways to the lungs purify, humidify, and warm the incoming air

The Nose

- Only externally visible part of the respiratory system
- Air enters the nose through the external nostrils (nares)
- Interior of the nose consists of a nasal cavity divided by a nasal septum

Upper Respiratory Tract

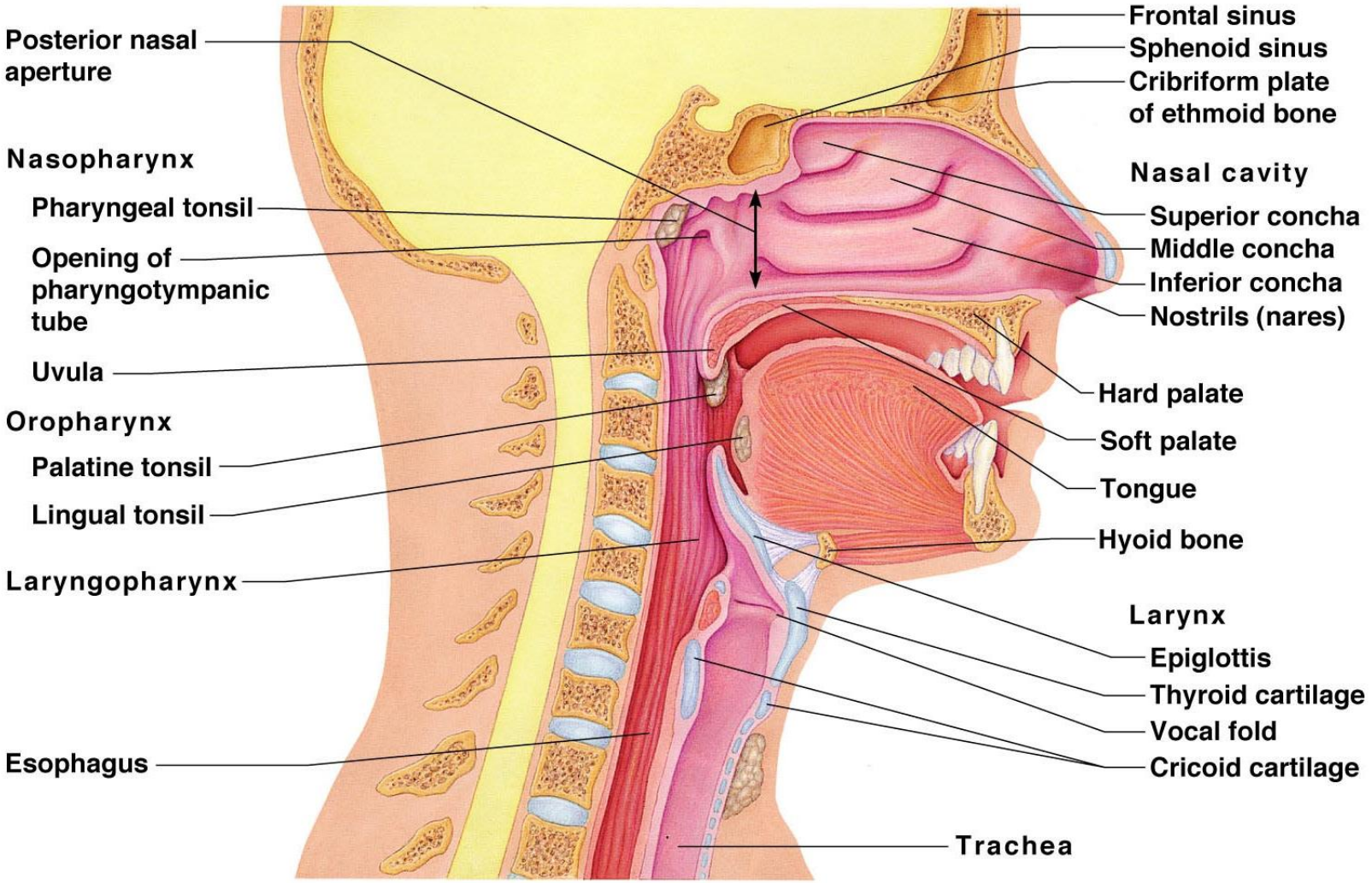


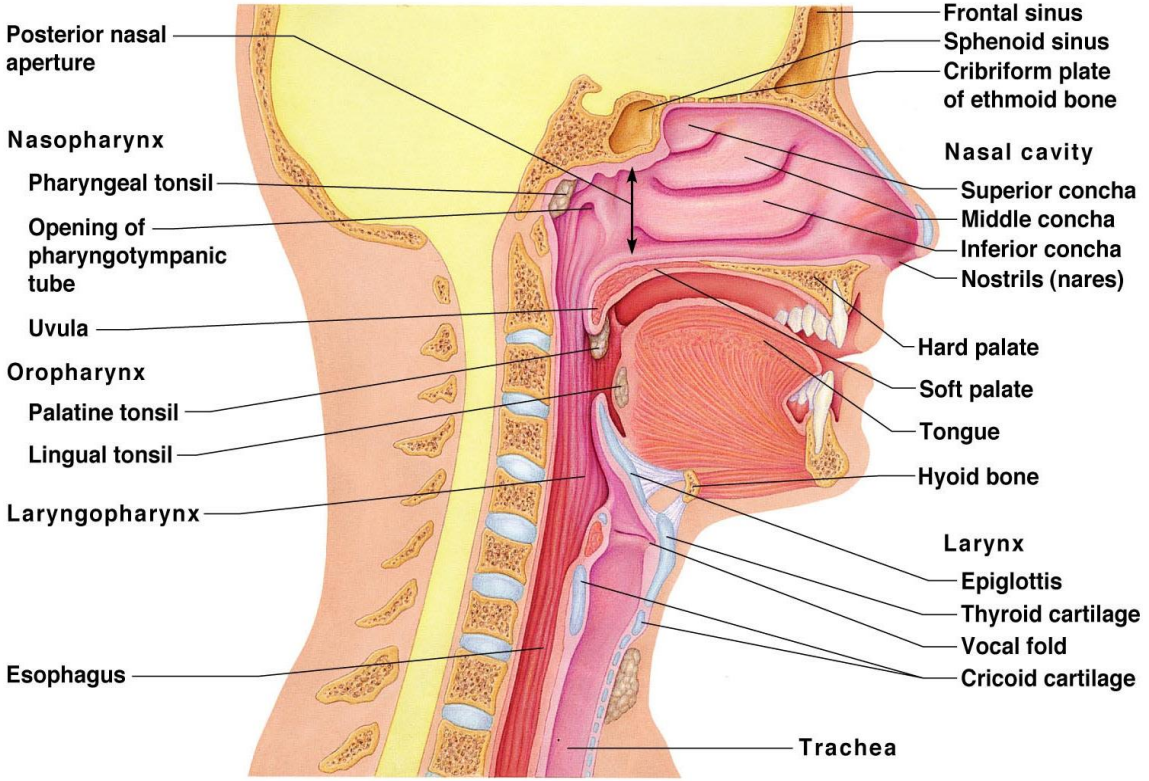
Figure 13.2

Anatomy of the Nasal Cavity

- Olfactory receptors are located in the mucosa on the superior surface
- The rest of the cavity is lined with respiratory mucosa that
  - Moisten air
  - Heat air
  - Trap incoming foreign particles

Anatomy of the Nasal Cavity

- Lateral walls have projections called conchae
  - Increase surface area
  - Increase air turbulence within the nasal cavity
- The nasal cavity is separated from the oral cavity by the palate
  - Anterior hard palate (bone)
  - Posterior soft palate (muscle)



Pharynx (Throat)

- Muscular passage from nasal cavity to larynx
- Three regions of the pharynx
  - Nasopharynx—superior region behind nasal cavity
  - Oropharynx—middle region behind mouth
  - Laryngopharynx—inferior region posterior to larynx
- The oropharynx and laryngopharynx are common passageways for air and food

Upper Respiratory Tract

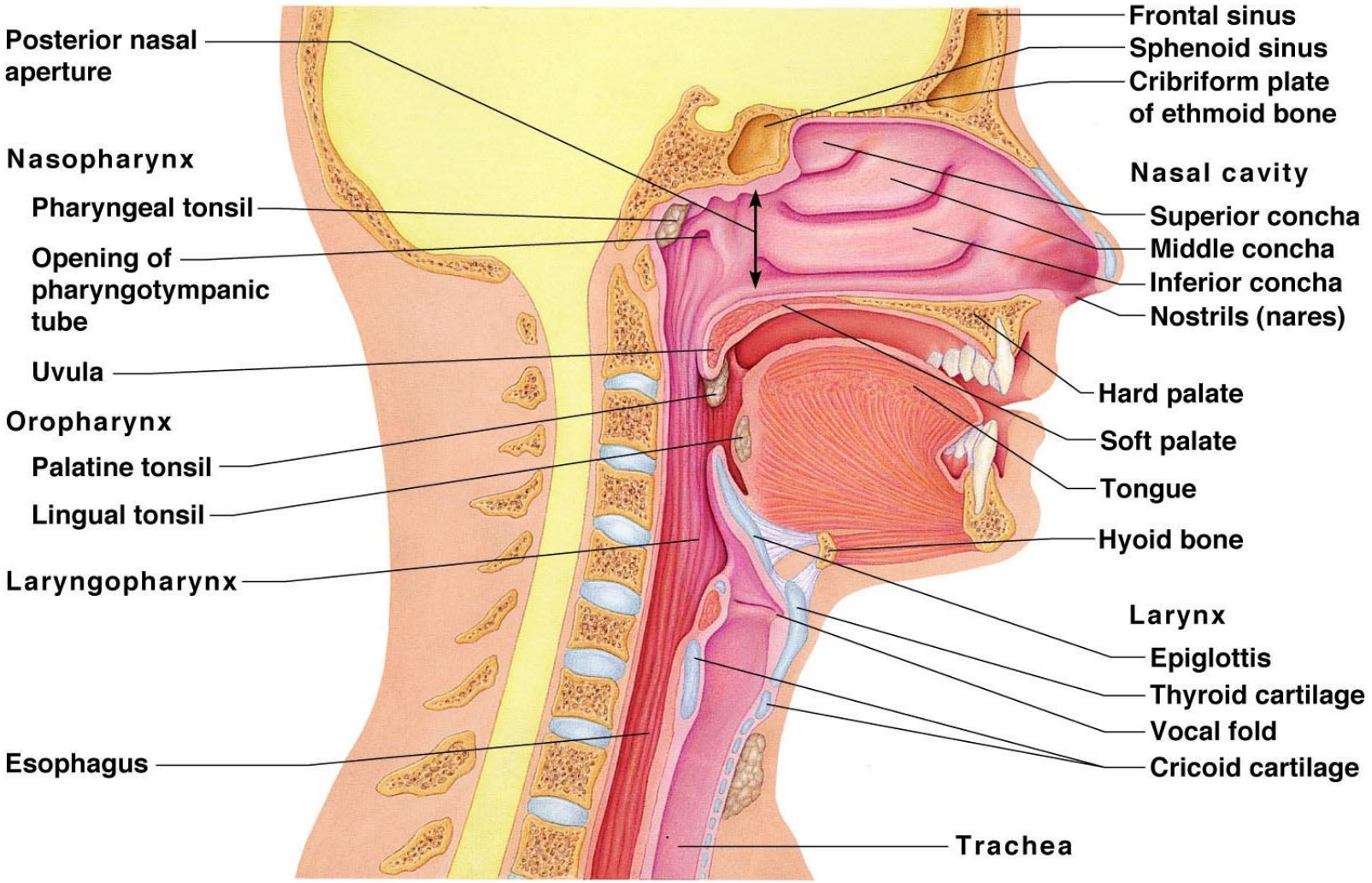


Figure 13.2

Structures of the Pharynx

- Pharyngotympanic tubes (auditory tubes) open into the nasopharynx
- Tonsils of the pharynx
  - Pharyngeal tonsil (adenoids) are located in the nasopharynx
  - Palatine tonsils are located in the oropharynx
  - Lingual tonsils are found at the base of the tongue

Upper Respiratory Tract: Pharynx

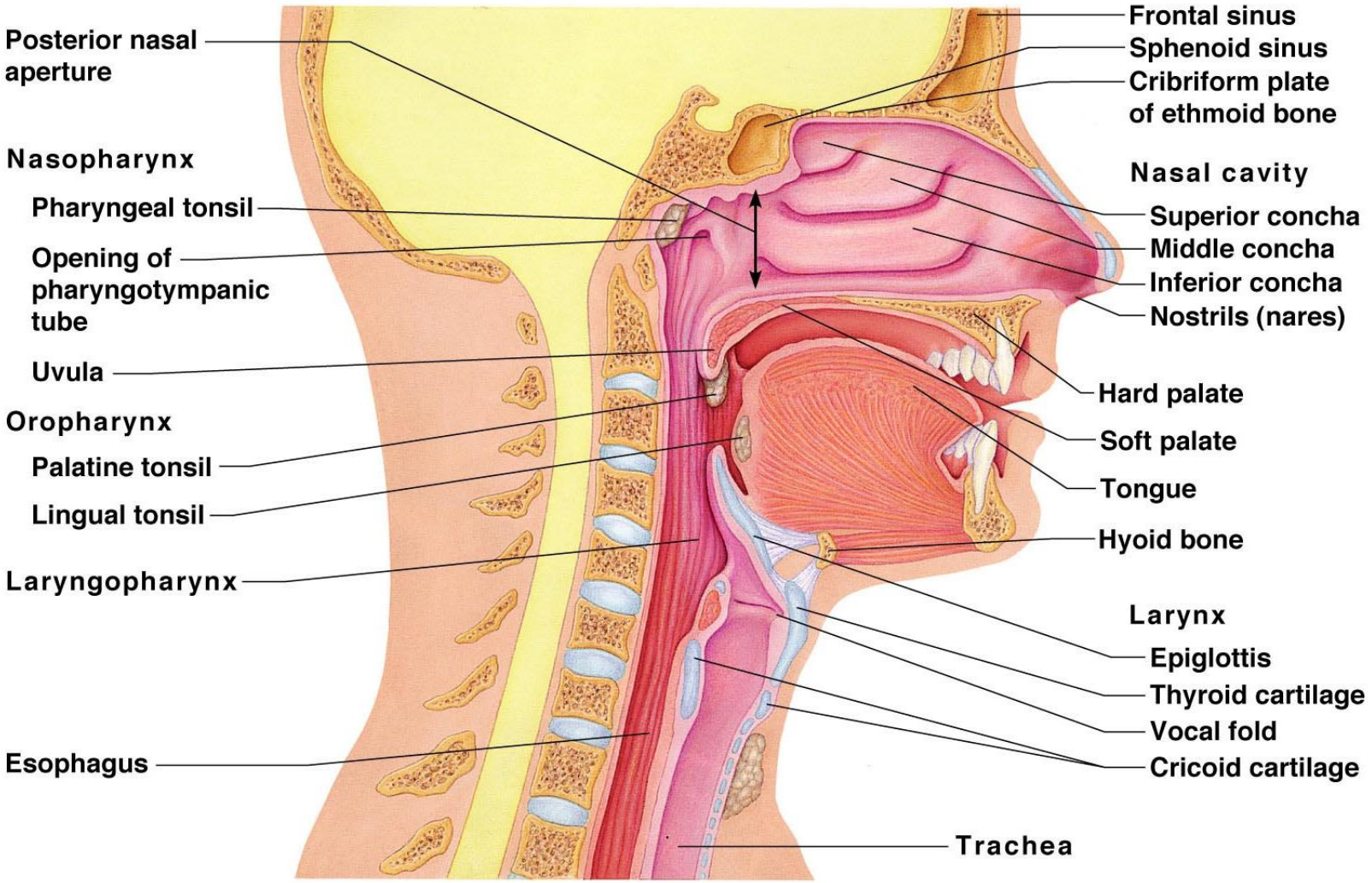
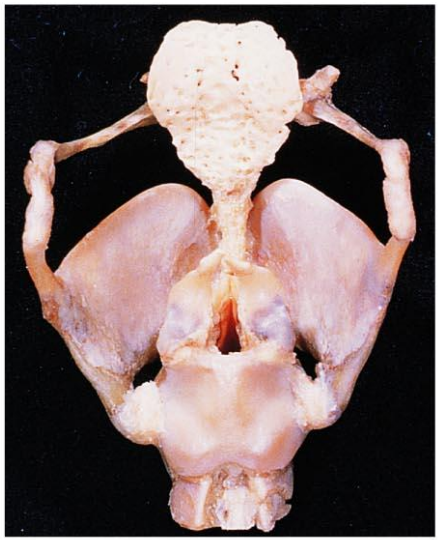
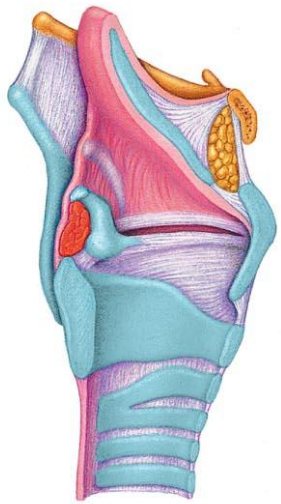


Figure 13.2

Larynx (Voice Box)

- Site of speech production
- Made of several rigid hyaline cartilages and a spoon-shaped flap of elastic cartilage (epiglottis)



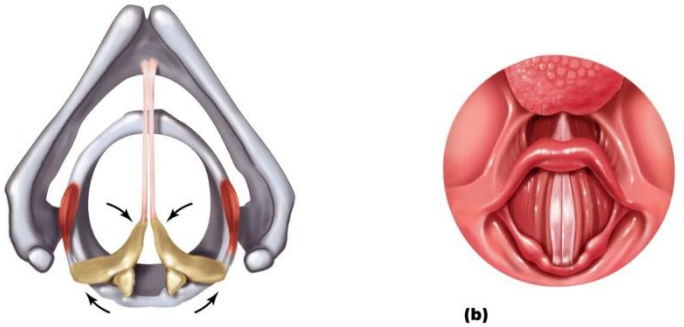


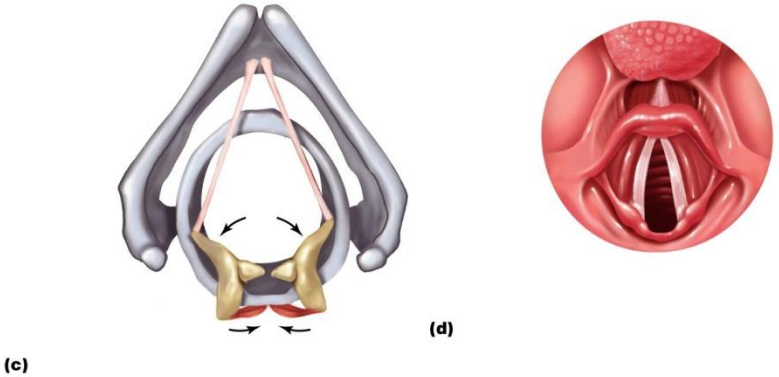
Structures of the Larynx

- Thyroid cartilage
  - Largest of the hyaline cartilages
  - Protrudes anteriorly (Adam's apple)
- Arytenoid cartilages
  - Sit on top of cricoid cart.
  - Vocal cords connect them to inside of thyroid cart.
- Cricoid cartilage
  - Below thyroid cart.
  - Complete ring of cartilage
  - Muscles run from it to thyroid cart. and to arytenoid carts.
- Epiglottis
  - Protects the superior opening of the larynx
  - Routes food to the esophagus and air toward the trachea
  - When swallowing, the epiglottis rises and forms a lid over the opening of the larynx

Structures of the Larynx

- Vocal folds (true vocal cords)
  - Vibrate with expelled air to create sound (speech)
- Glottis—opening between vocal cords





Upper Respiratory Tract: Larynx

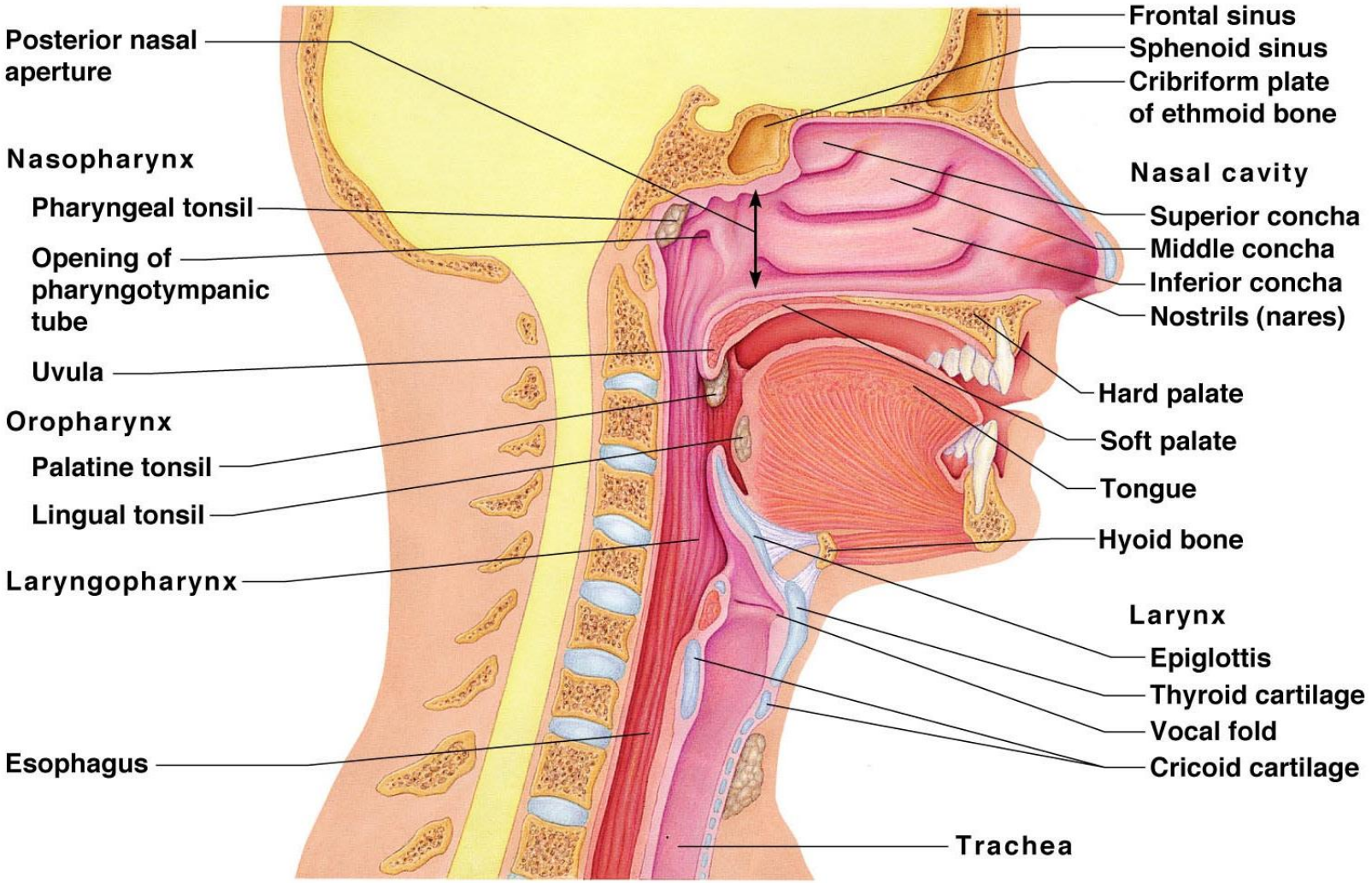


Figure 13.2

Trachea (Windpipe)

- Four-inch-long tube that connects larynx with bronchi
- Walls are reinforced with C-shaped hyaline cartilage
- Lined with ciliated mucosa (pseudostratified columnar ciliated epithelium)
  - Beat continuously in the opposite direction of incoming air towards laryngopharynx
  - Remove mucus loaded with dust and other debris away from lungs

Trachea (Windpipe)

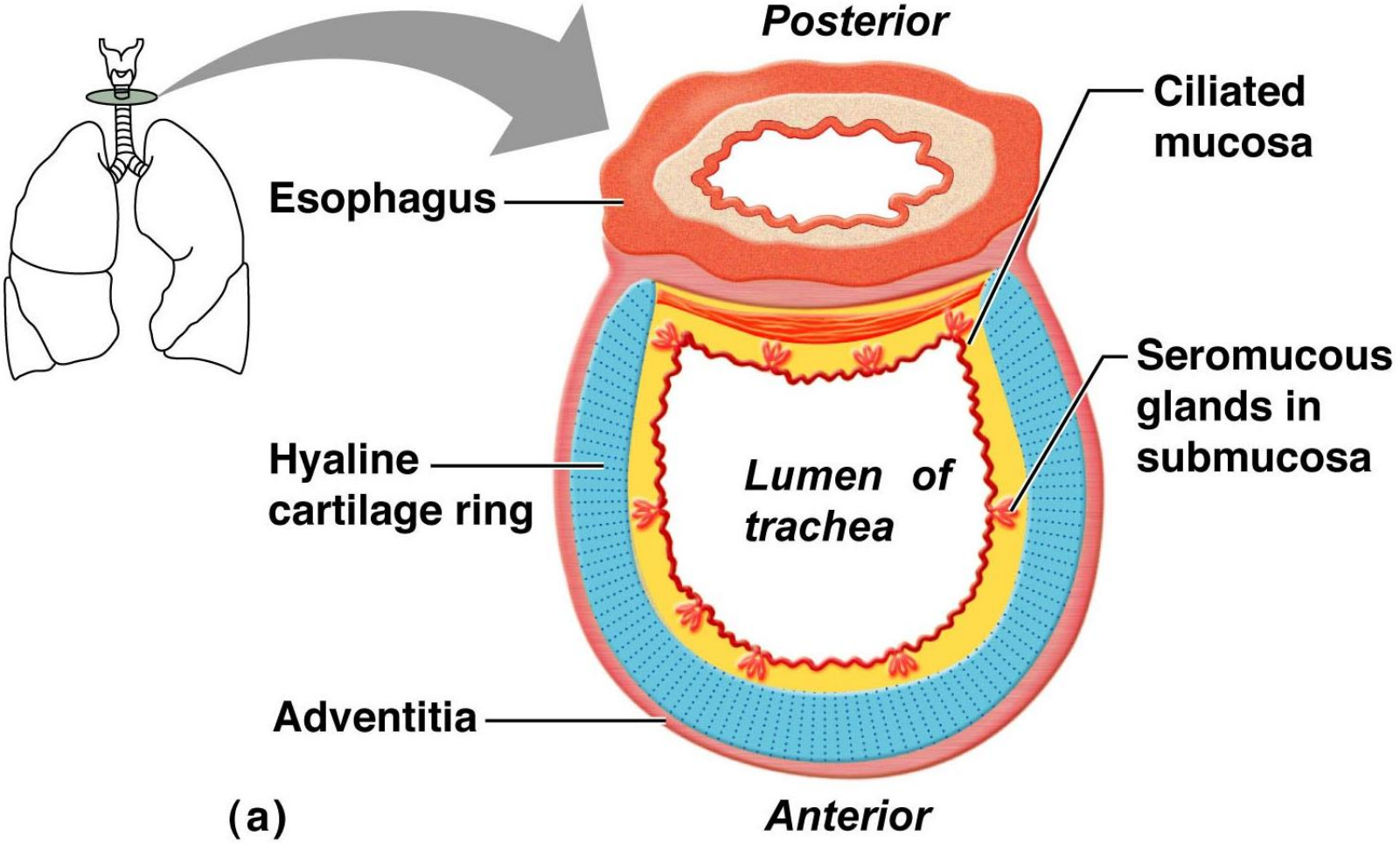


Figure 13.3a

Trachea (Windpipe)

(b)

Figure 13.3b

Main (Primary) Bronchi

- Formed by division of the trachea
- Enters the lung at the hilum (medial depression) along with blood vessels
- Right bronchus is wider, shorter, and straighter than left; inhaled solid substances tend to fall into right lung
- Bronchi subdivide into smaller and smaller branches

Main Bronchi

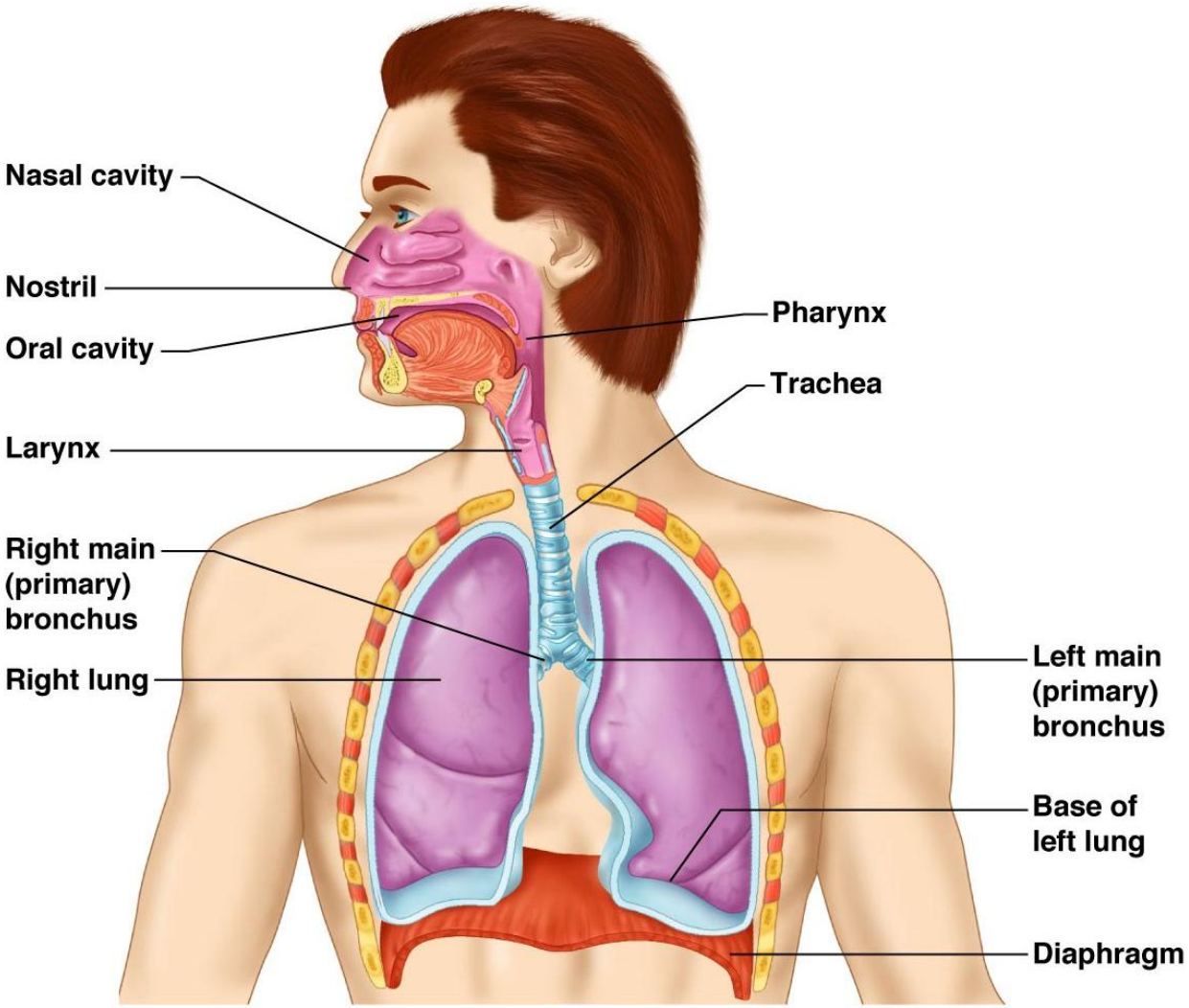
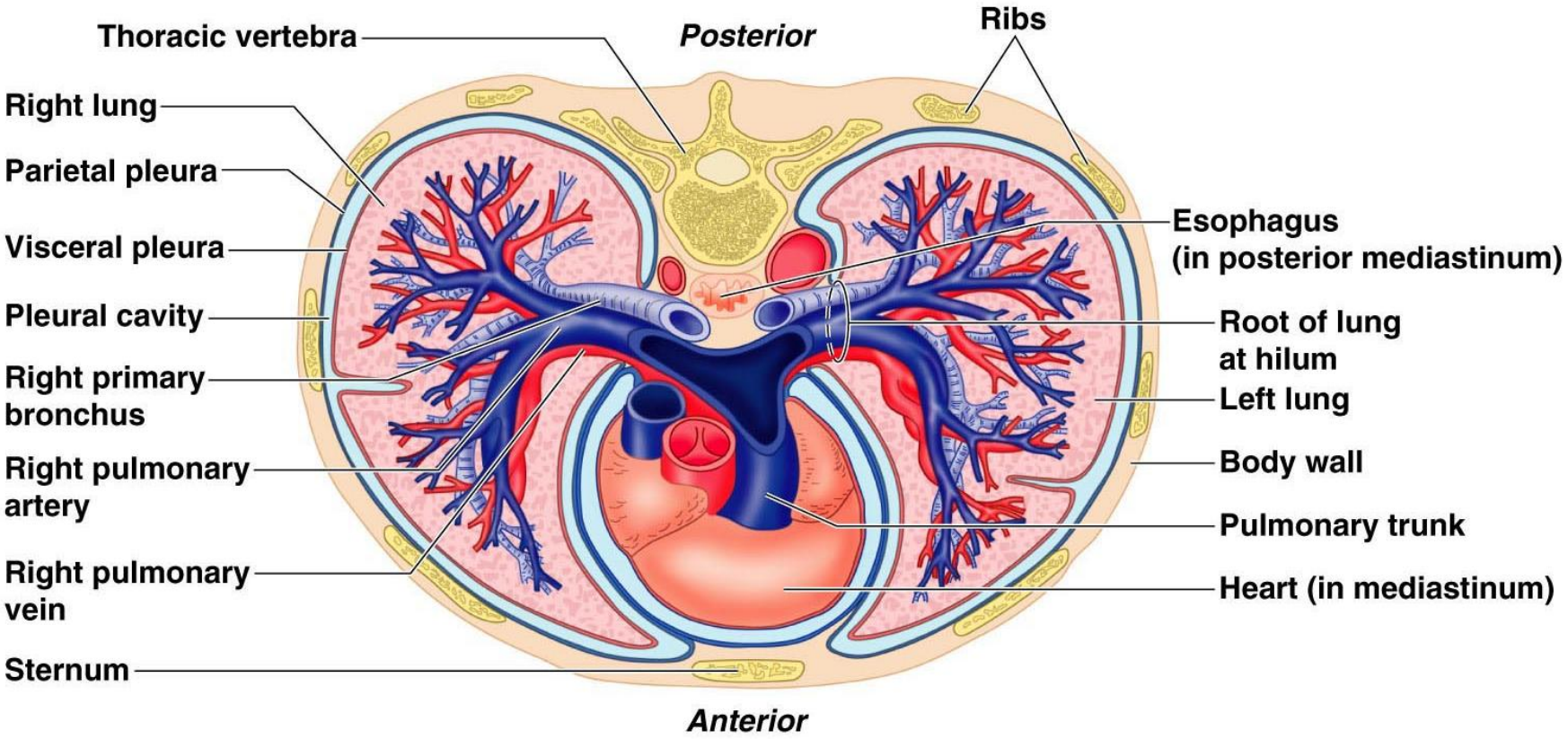


Figure 13.1

Main Bronchi



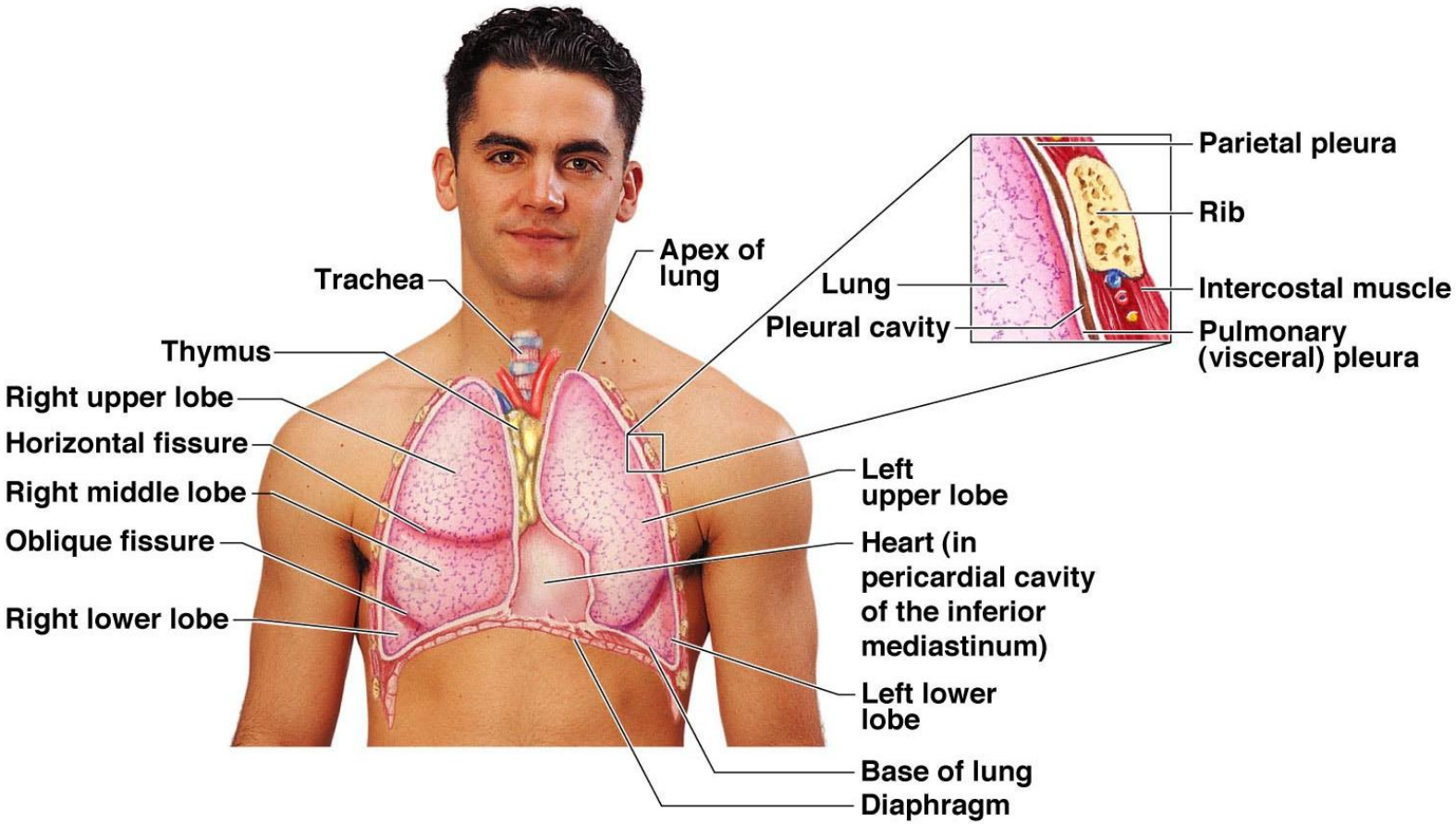
(b) Transverse section through the thorax, showing the relationship of the major organs present in the thorax

Figure 13.4b

Lungs

- Occupy most of the thoracic cavity
  - Heart occupies central portion called mediastinum
- Apex is near the clavicle (superior portion)
- Base rests on the diaphragm (inferior portion)
- Each lung is divided into lobes by fissures
  - Left lung—two lobes
  - Right lung—three lobes

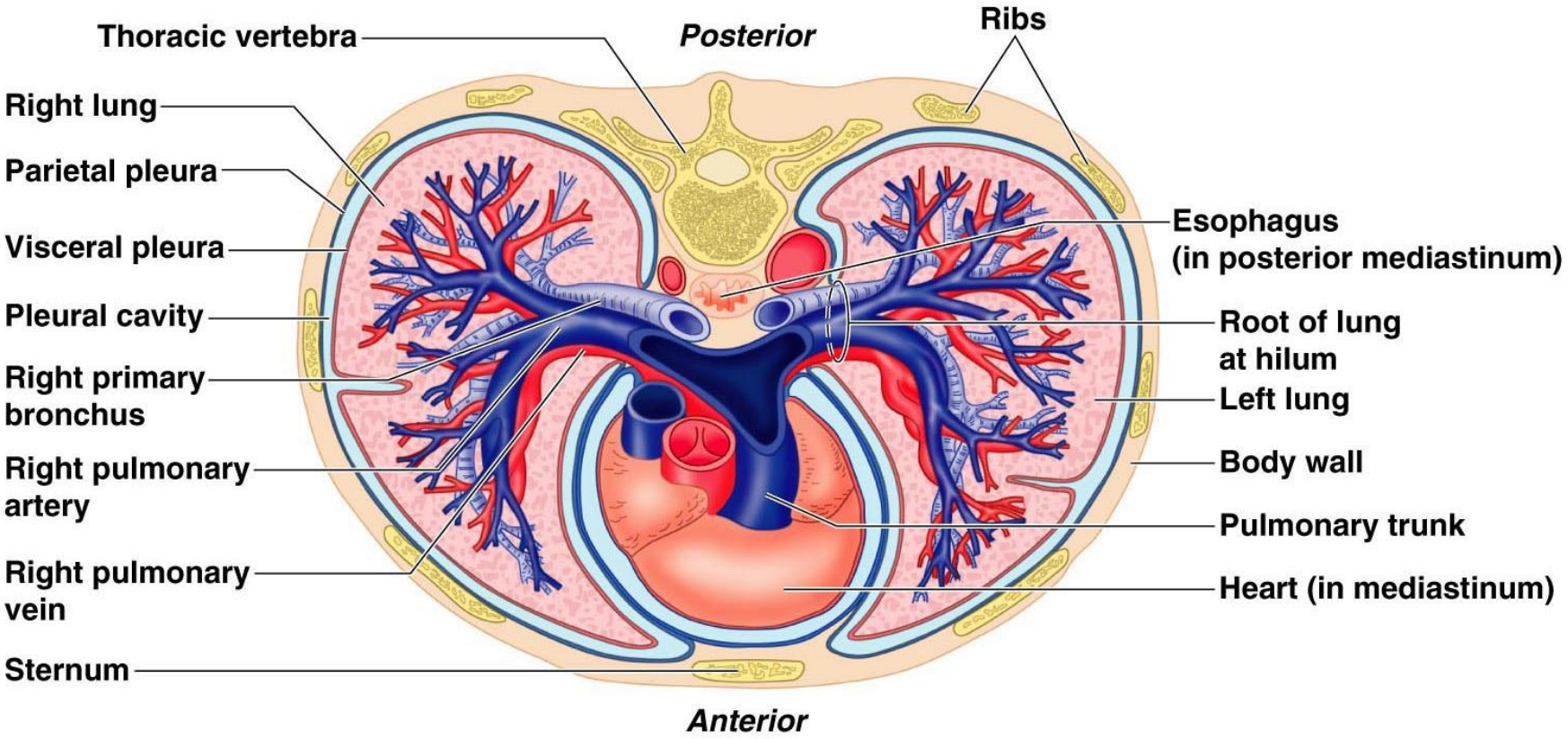
Lungs



(a) Anterior view of the thoracic cavity organs, showing the position of the lungs, which flank the heart laterally

Figure 13.4a

Lungs

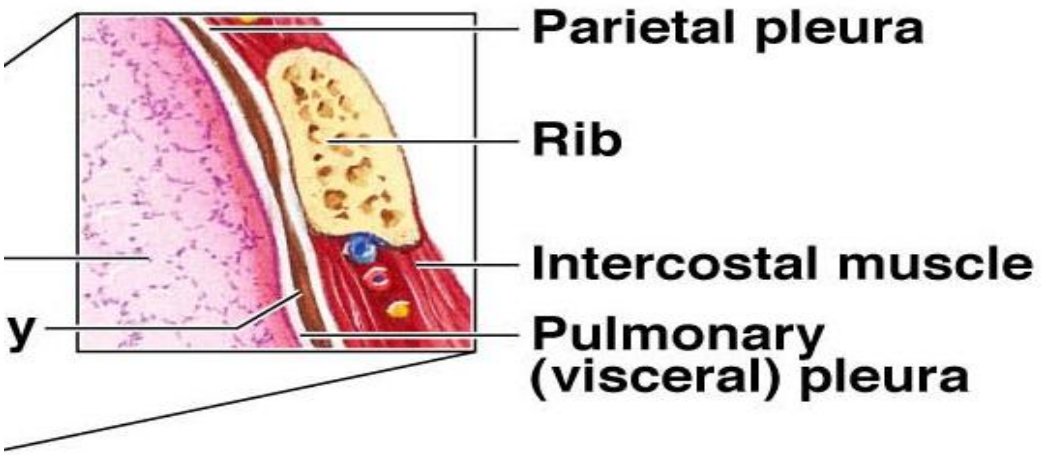


(b) Transverse section through the thorax, showing the relationship of the major organs present in the thorax

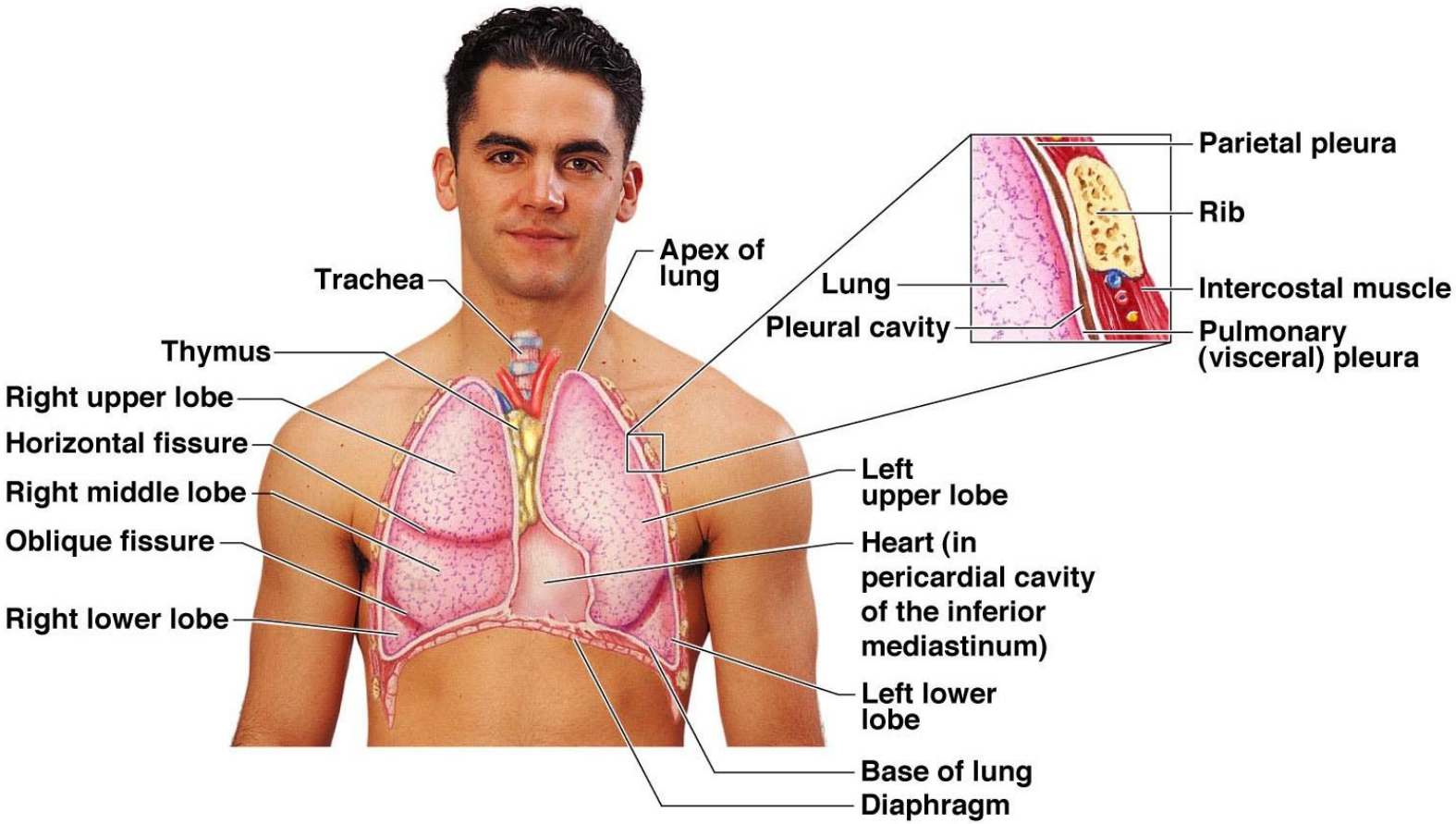
Figure 13.4b

Coverings of the Lungs

- Serosa covers the outer surface of the lungs
  - Visceral (pulmonary) pleura covers the lung surface
  - Parietal pleura lines the walls of the thoracic cavity
- Pleural fluid fills the area between layers of pleura to allow gliding
- These two pleural layers resist being pulled apart; there is a vacuum (negative pressure) between them



Lungs



(a) Anterior view of the thoracic cavity organs, showing the position of the lungs, which flank the heart laterally

Figure 13.4a

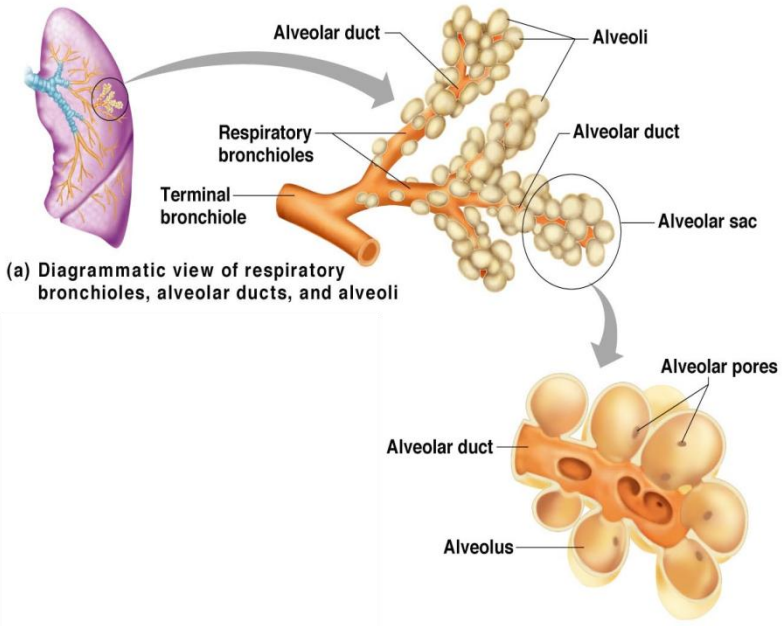
Bronchial (Respiratory) Tree Divisions

- The larger passageways have reinforcing cartilage in their walls; the smaller lack cartilage
  - Cartilage
    - Primary bronchi
    - Secondary bronchi
    - Tertiary bronchi
  - No Cartilage
    - Bronchioles
    - Terminal bronchioles

Division of Airways

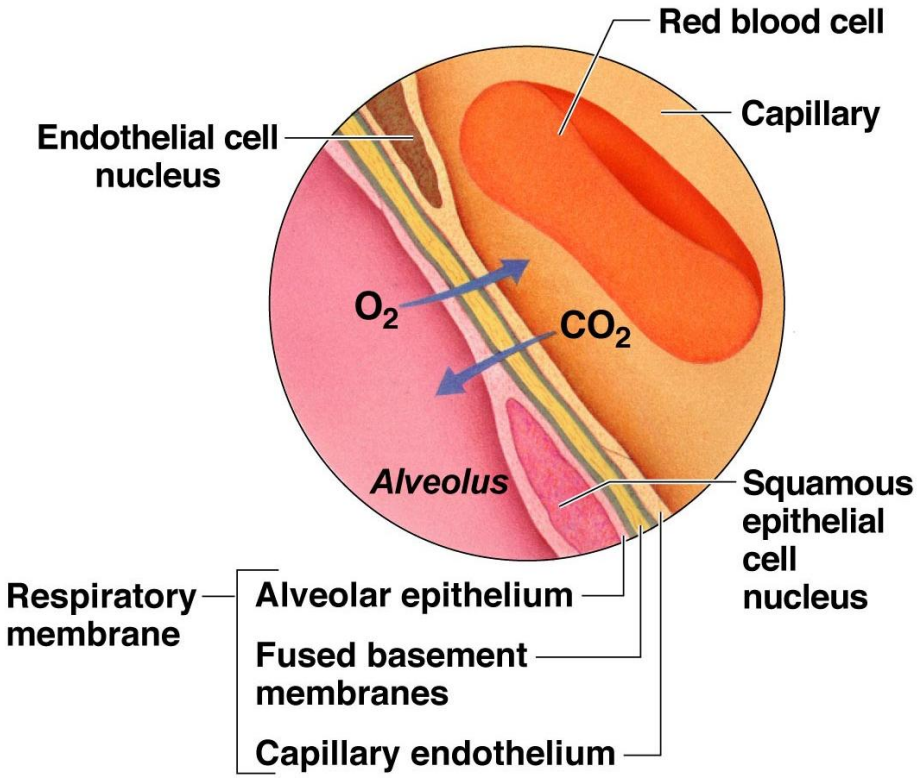
- Conducting Zone
  - The larger airways that are too thick to allow gas exchange: nasal cavity to terminal bronchioles
- Respiratory Zone
  - The smaller airways where the wall is thin enough to allow for gas exchange
    - Respiratory bronchioles
    - Alveolar ducts
    - Alveolar sacs
    - Alveoli (air sacs)

Site of gas exchange = alveoli only



Respiratory Membrane (Air-Blood Barrier)

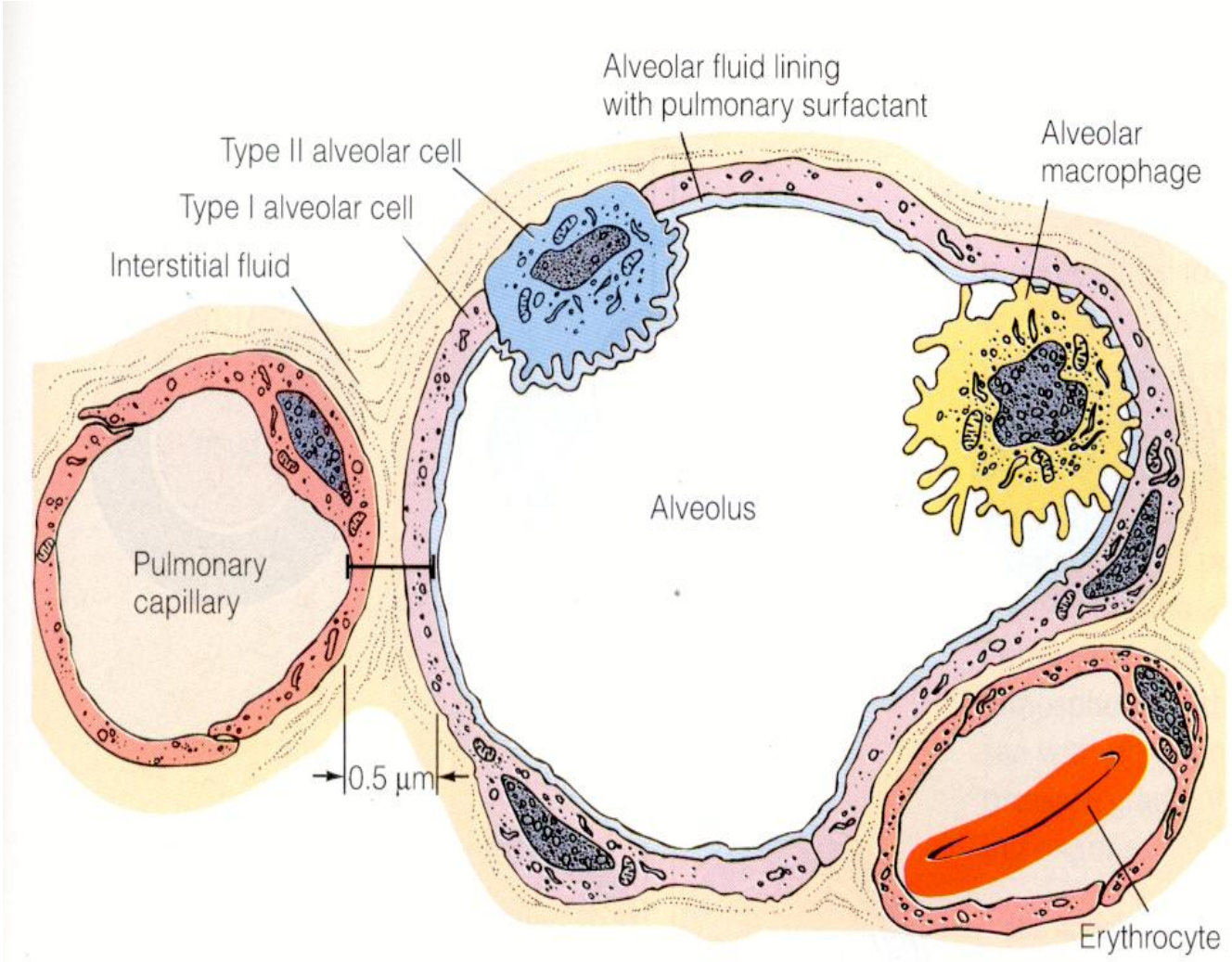
- Thin squamous epithelial layer lines alveolar walls
- Alveolar pores connect neighboring air sacs
- Pulmonary capillaries cover external surfaces of alveoli
- On one side of the membrane is air and on the other side is blood flowing past



Gas Exchange

- Gas crosses the respiratory membrane by diffusion
  - Oxygen enters the blood
  - Carbon dioxide enters the alveoli
- Alveolar macrophages ("dust cells") add protection by picking up bacteria, carbon particles, and other debris
- Surfactant, a lipid molecule produced by septal cells, coats gas-exposed alveolar surfaces

Gas Exchange: Alveolar Wall Structure



Four Events of Respiration

- **Pulmonary ventilation —moving air in and out of the lungs (commonly called *breathing*)**
- **External respiration —gas exchange between pulmonary blood and alveoli**
  - **Oxygen is loaded into the blood**
  - **Carbon dioxide is unloaded from the blood**
- **Respiratory gas transport —transport of oxygen and carbon dioxide via the bloodstream**
- **Internal respiration —gas exchange between blood and tissue cells in systemic capillaries**

External Respiration

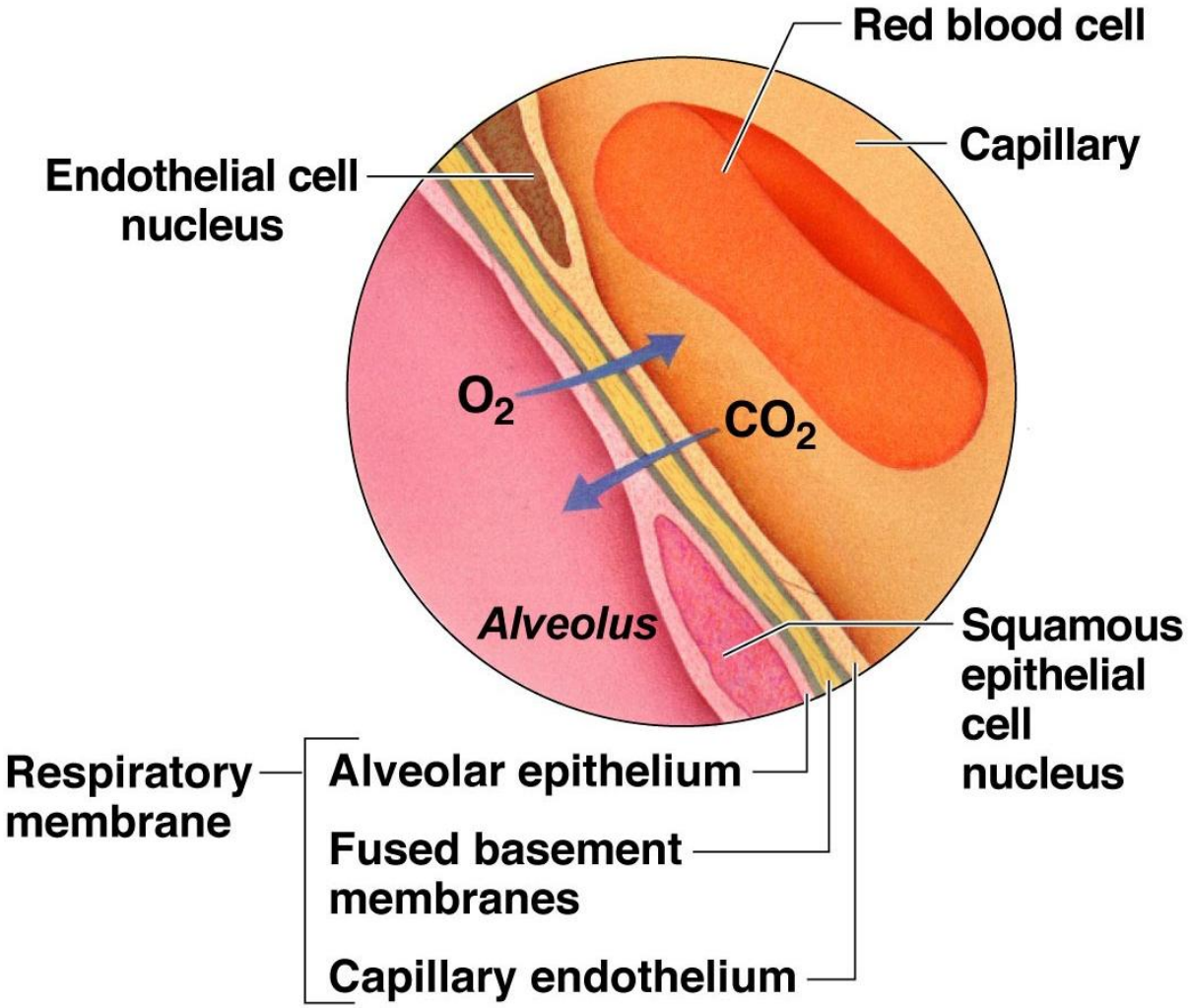


Figure 13.6 (2 of 2)

Mechanics of Breathing (Pulmonary Ventilation)

- Completely mechanical process that depends on volume changes in the thoracic cavity
- Volume changes lead to pressure changes, which lead to the flow of gases to equalize pressure
- Two phases
  - Inspiration = inhalation
    - flow of air into lungs
  - Expiration = exhalation
    - air leaving lungs

Inspiration

- Diaphragm and external intercostal muscles contract
- The size of the thoracic cavity increases
- External air is pulled into the lungs due to
  - Increase in intrapulmonary volume
  - Decrease in gas pressure within alveoli

Inspiration

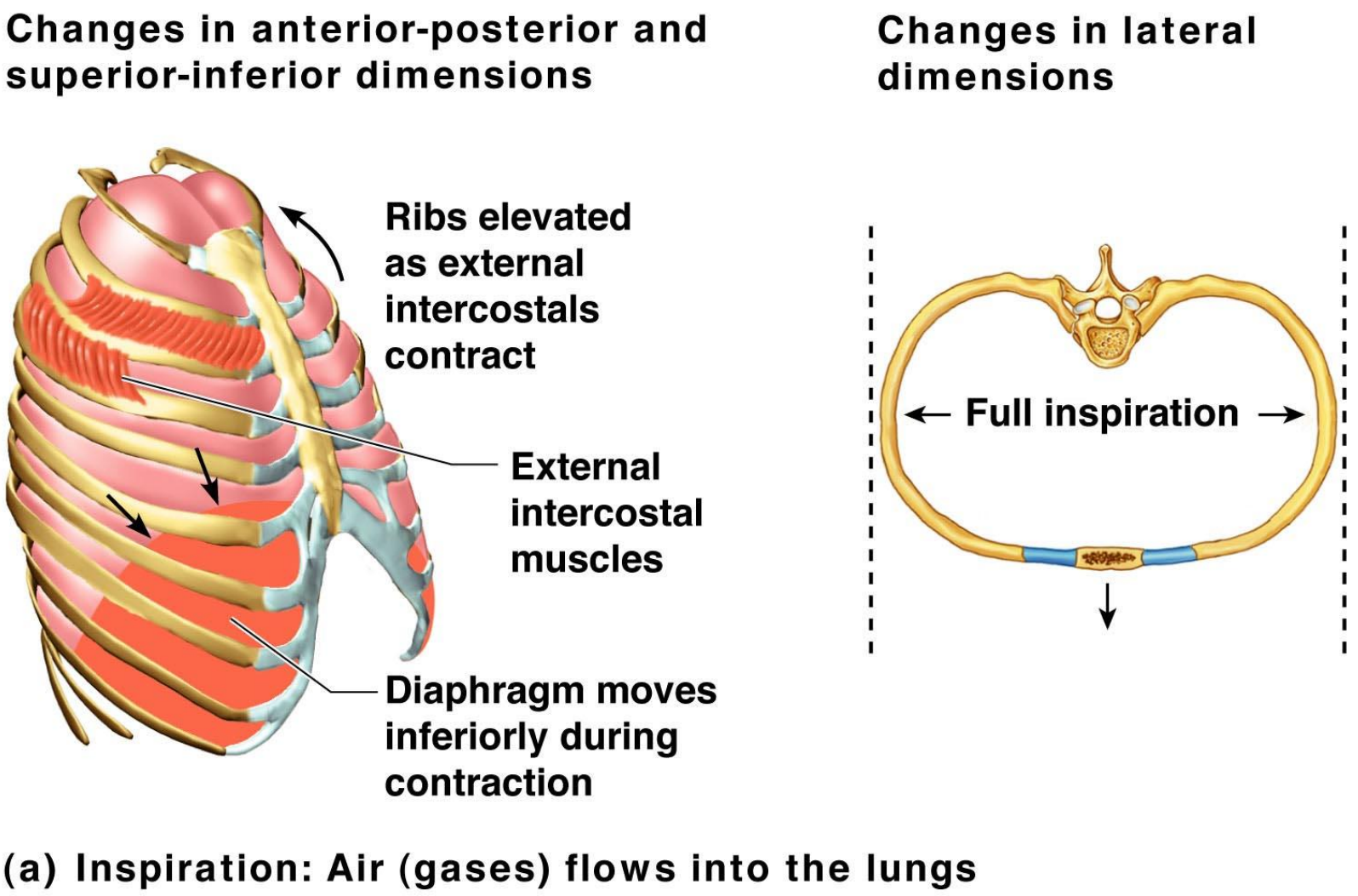


Figure 13.7a

Inspiration

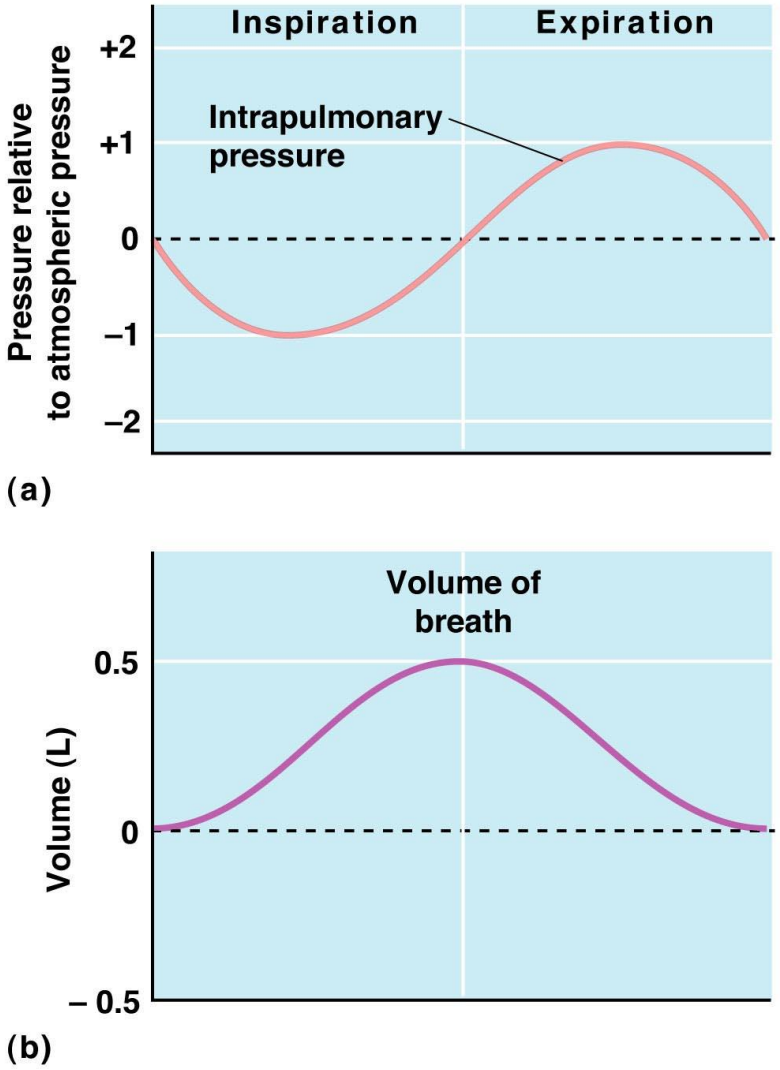
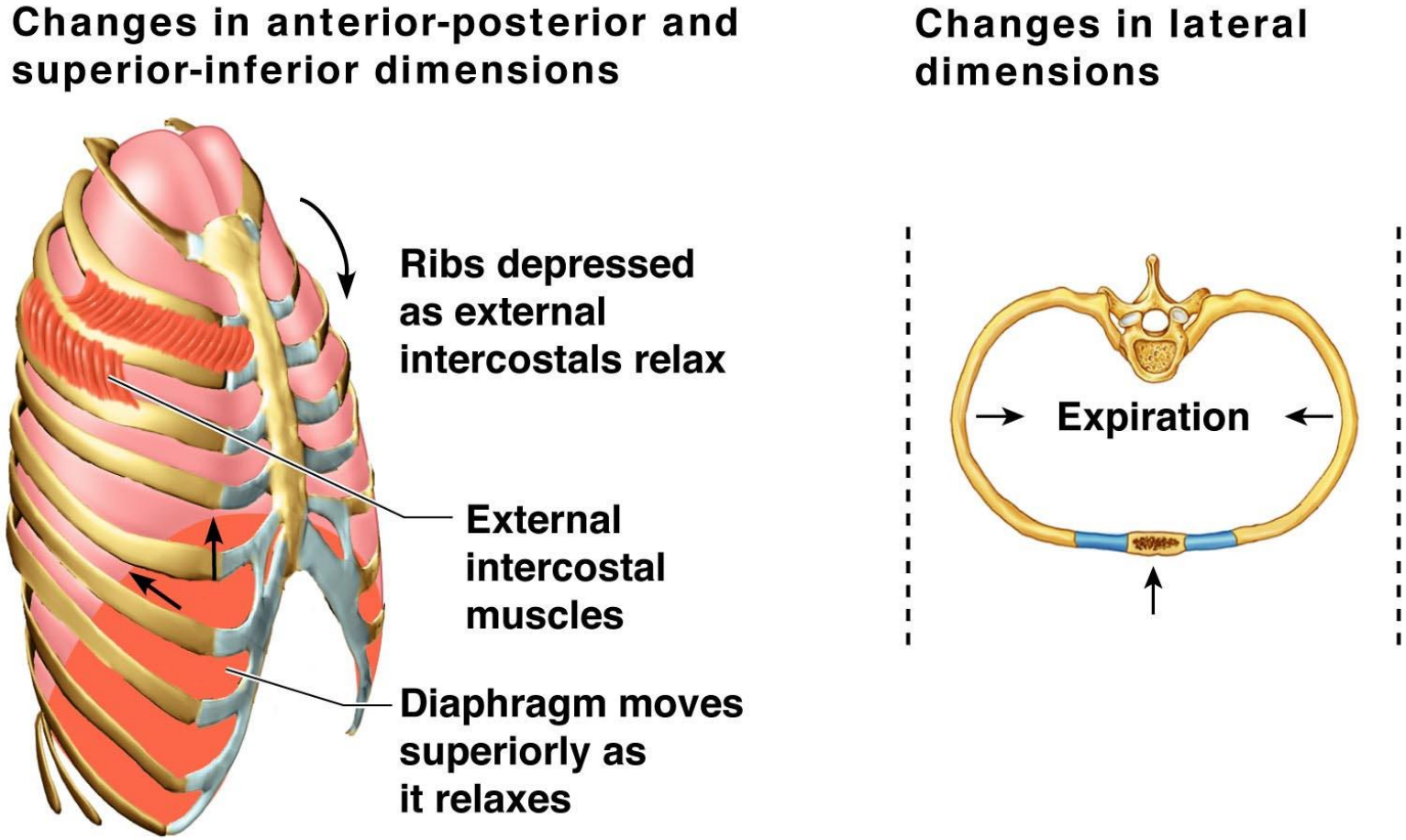


Figure 13.8

Expiration

- Largely a passive process which depends on natural lung elasticity
- As muscles relax, air is pushed out of the lungs due to
  - Decrease in intrapulmonary volume
  - Increase in gas pressure in alveoli
- Forced expiration can occur mostly by contracting internal intercostal muscles to depress the rib cage

Expiration



(b) Expiration: Air (gases) flows out of the lungs

Figure 13.7b

Expiration

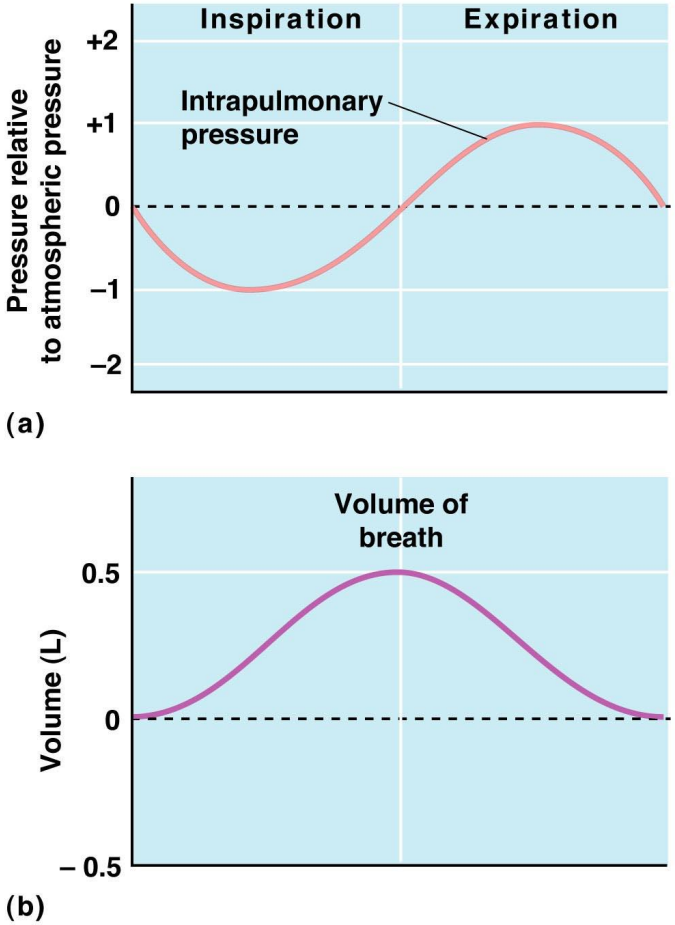


Figure 13.8

Pressure Differences in the Thoracic Cavity

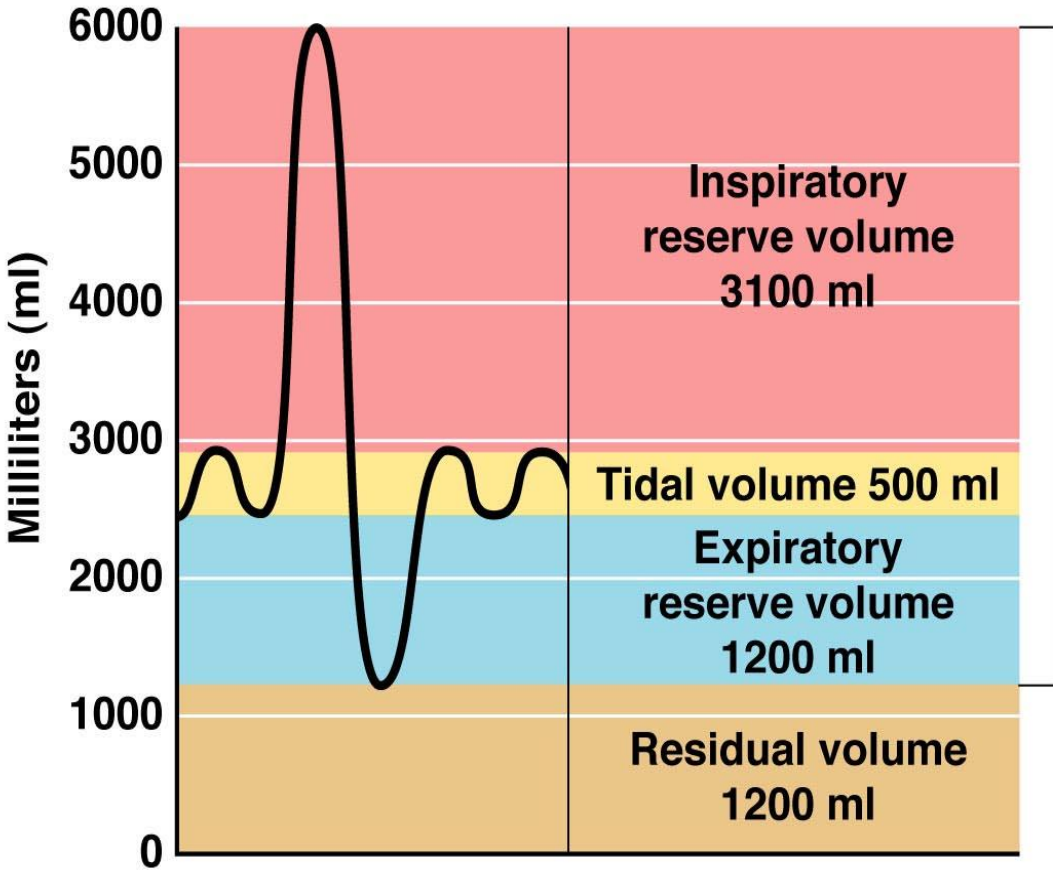
- Normal pressure within the pleural space is always negative (intrapleural pressure)
- Differences in lung and pleural space pressures keep lungs from collapsing
- Pneumothorax: loss of negative pressure in pleual cavity; lung collapses

Respiratory Volumes and Capacities

- Normal breathing moves about 500 mL of air with each breath
  - This respiratory volume is tidal volume (TV)
- Many factors that affect respiratory capacity
  - A person's size
  - Gender
  - Age
  - Physical condition

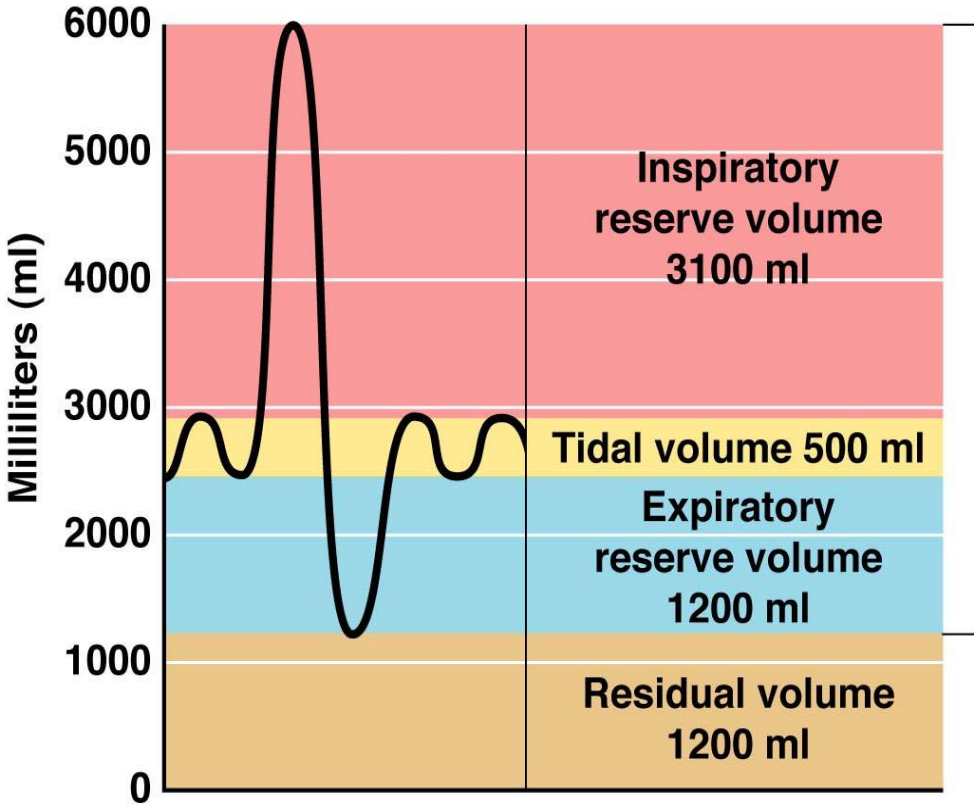
Respiratory Volumes and Capacities

- Inspiratory reserve volume (IRV)
  - Amount of air that can be taken in forcibly over the tidal volume
  - Usually between 2100 and 3200 mL
- Expiratory reserve volume (ERV)
  - Amount of air that can be forcibly exhaled
  - Approximately 1200 mL



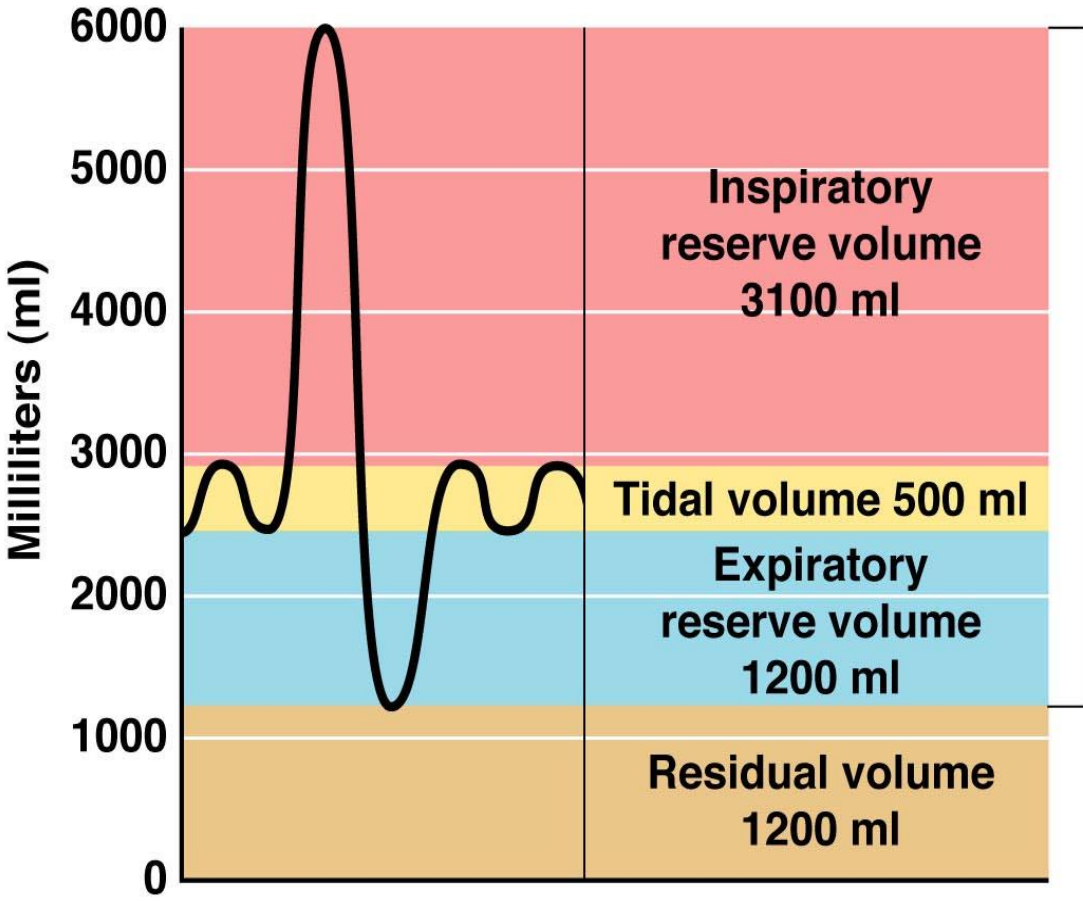
Respiratory Volumes and Capacities

- Residual volume
  - Air remaining in lung after expiration
  - About 1200 ml
- Inspiratory Capacity
  - IRV+TV
  - About 3600 ml



Respiratory Volumes and Capacities

- Vital capacity
  - The total amount of exchangeable air
  - Vital capacity = TV + IRV + ERV
- Total Lung Capacity
  - Residual Volume
  - Vital Capacity



Respiratory Volumes

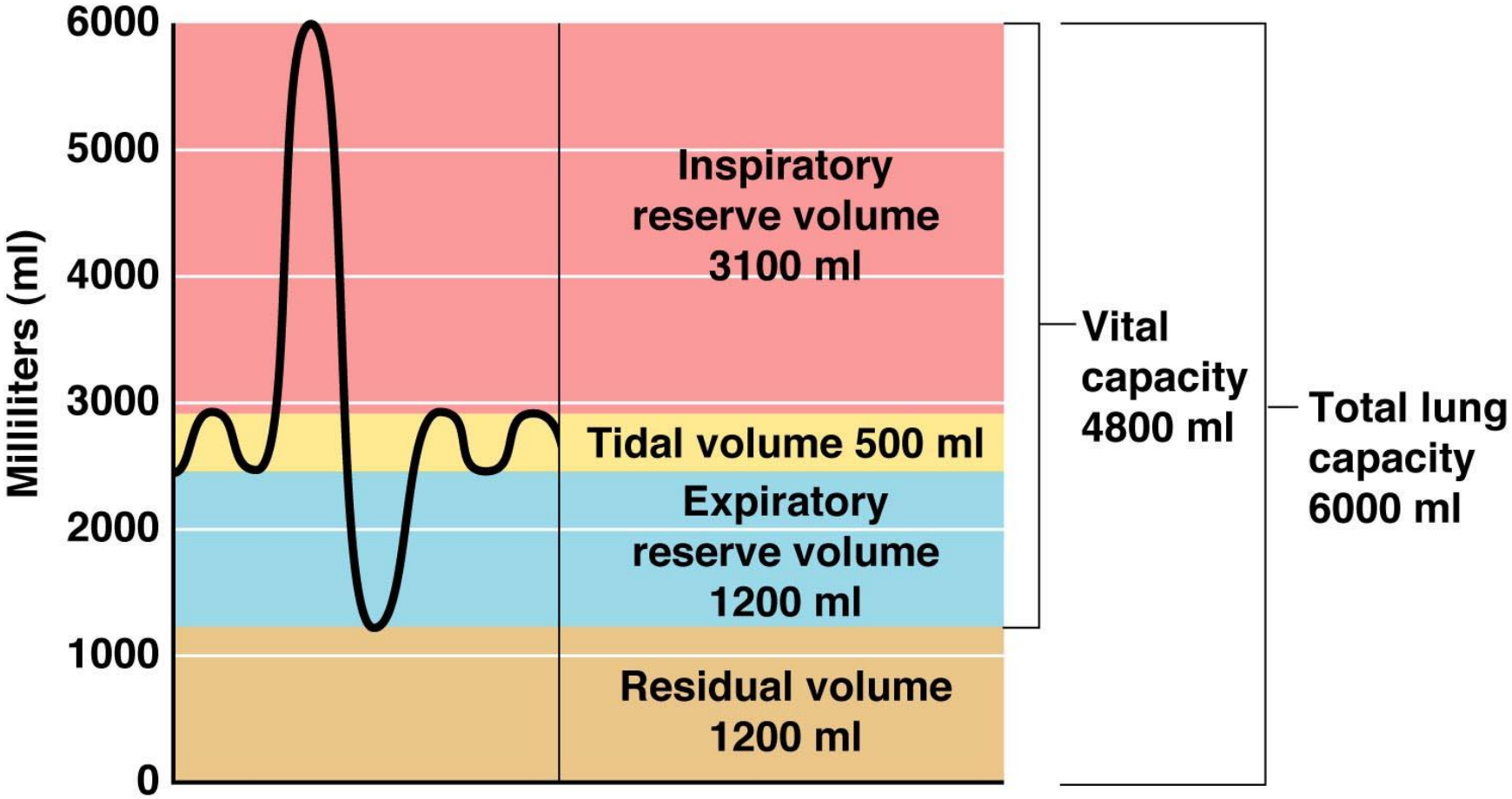


Figure 13.9

Respiratory Volumes and Capacities

- Functional volume
  - Air that actually reaches the respiratory zone
  - Usually about 350 mL
- Dead space volume
  - Air that remains in conducting zone and never reaches alveoli
  - About 150 mL
- Respiratory capacities are measured with a spirometer

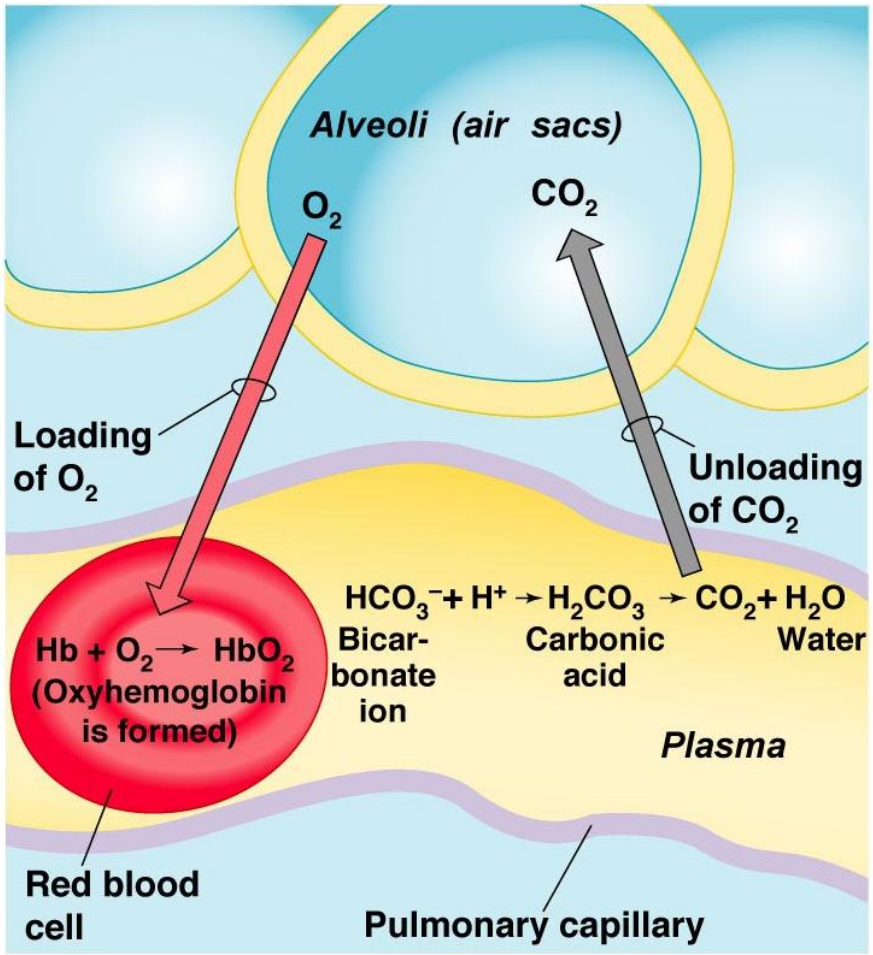
External Respiration

- Oxygen loaded into the blood
  - Under almost all circumstances, the alveoli always have more oxygen than the blood
  - Oxygen moves by diffusion towards the area of lower concentration
  - Pulmonary capillary blood gains oxygen

External Respiration

- Carbon dioxide unloaded out of the blood
  - Blood returning from tissues has higher concentrations of carbon dioxide than air in the alveoli
  - Pulmonary capillary blood gives up carbon dioxide to be exhaled
- Blood leaving the lungs is oxygen-rich and carbon dioxide-poor

External Respiration



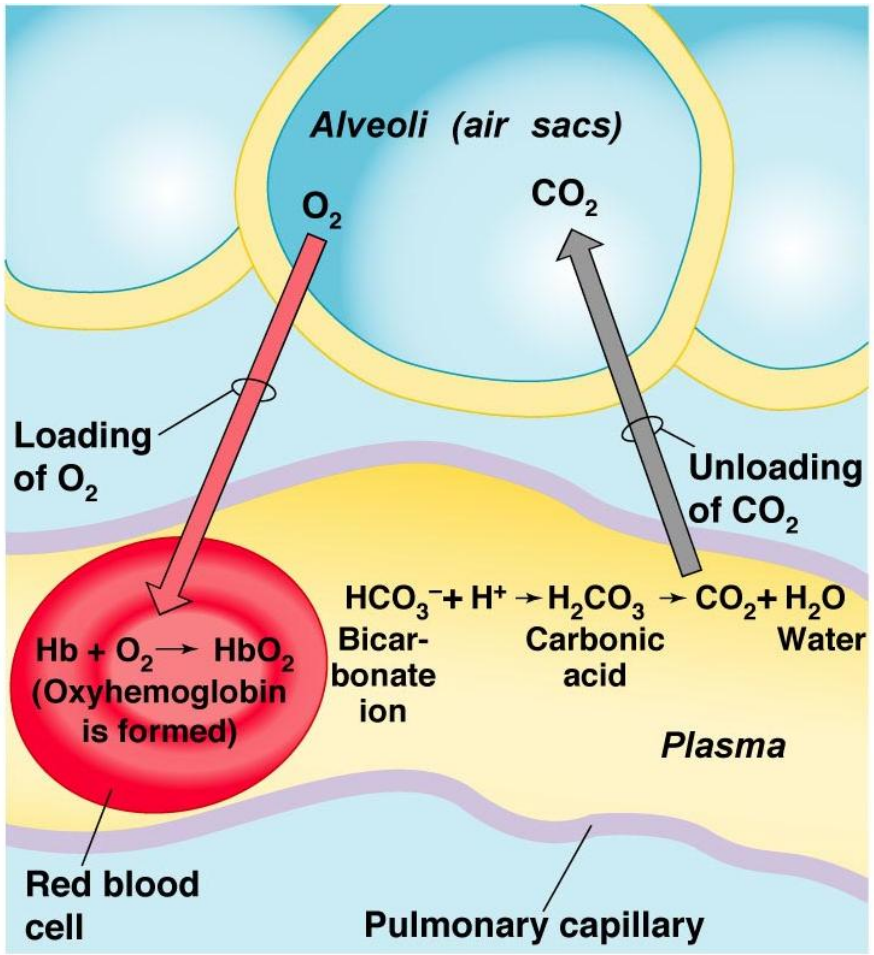
(a) External respiration in the lungs (pulmonary gas exchange): Oxygen is loaded and carbon dioxide is unloaded.

Figure 13.11a

Gas Transport in the Blood

- Oxygen transport in the blood
  - Most oxygen attached to hemoglobin to form oxyhemoglobin (HbO_2)
  - A small dissolved amount is carried in the plasma

Gas Transport in the Blood



(a) External respiration in the lungs (pulmonary gas exchange): Oxygen is loaded and carbon dioxide is unloaded.

Figure 13.11a

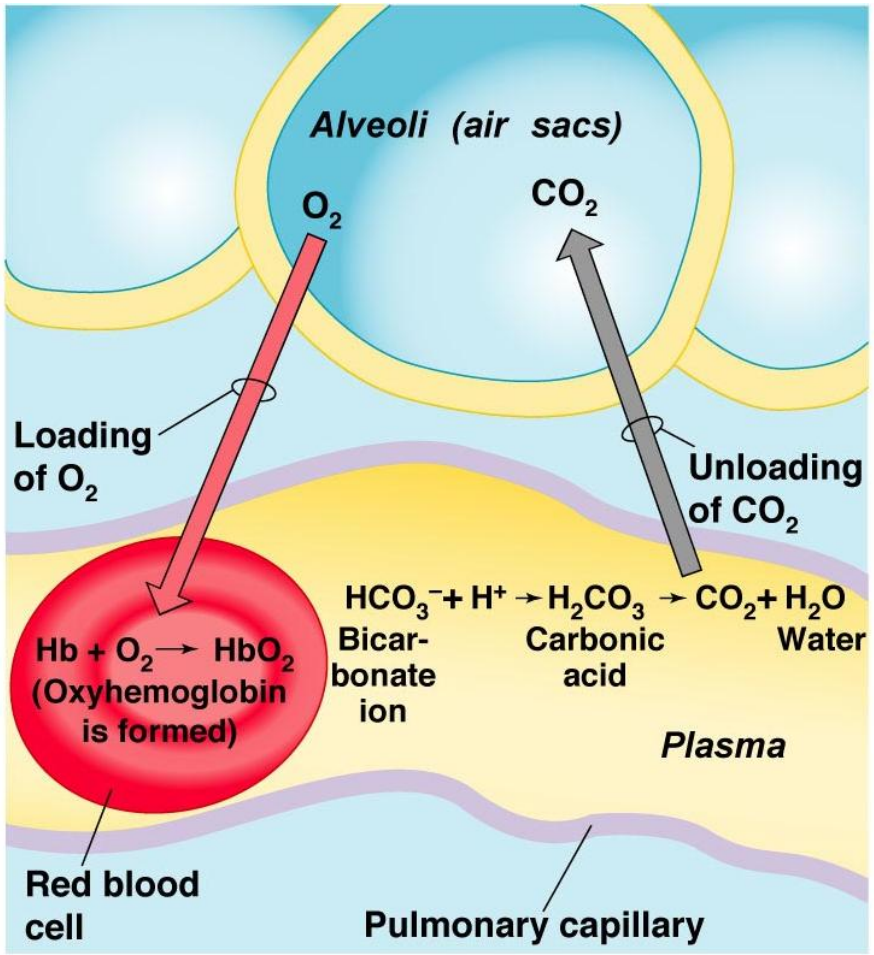
Gas Transport in the Blood

- Carbon dioxide transport in the blood
  - Most is transported in the plasma as bicarbonate ion (HCO_3^-) (about 70%)
  - A small amount is carried inside red blood cells on hemoglobin (about 20%), but at different binding sites than those of oxygen
  - The remaining 10% or so is CO_2 dissolved in plasma

Gas Transport in the Blood

- For carbon dioxide to diffuse out of blood into the alveoli, it must be released from its bicarbonate form:
  - Bicarbonate ions enter RBC
  - Combine with hydrogen ions
  - Form carbonic acid (H_2CO_3)
  - Carbonic acid splits to form water + CO_2
  - Carbon dioxide diffuses from blood into alveoli

Gas Transport in Blood



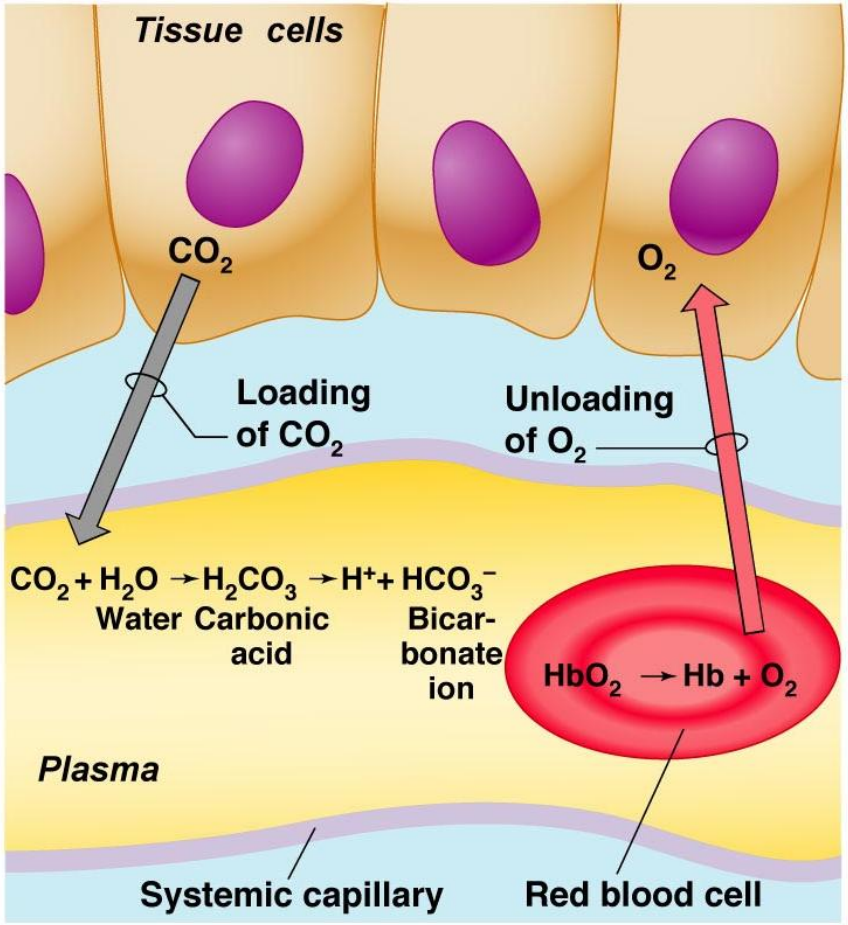
(a) External respiration in the lungs (pulmonary gas exchange): Oxygen is loaded and carbon dioxide is unloaded.

Figure 13.11a

Internal Respiration

- Exchange of gases between blood and body cells
- An opposite reaction to what occurs in the lungs
  - Carbon dioxide diffuses out of tissue to blood (called *loading*)
  - Oxygen diffuses from blood into tissue (called *unloading*)

Internal Respiration



(b) Internal respiration in the body tissues (systemic capillary gas exchange): Oxygen is unloaded and carbon dioxide is loaded into the blood.

Figure 13.11b

Factors Influencing Respiratory Rate and Depth

- Physical factors
  - Increased body temperature
  - Exercise
  - Talking
  - Coughing
- Volition (conscious control)
- Emotional factors

Factors Influencing Respiratory Rate and Depth

- Chemical factors: CO_2 levels
  - The body's need to rid itself of CO_2 is the most important stimulus
  - Increased levels of carbon dioxide (and thus, a decreased or acidic pH) in the blood increase the rate and depth of breathing
  - Changes in carbon dioxide act directly on the medulla oblongata
- Chemical factors: oxygen levels
  - Changes in oxygen concentration in the blood are detected by chemoreceptors in the aorta and common carotid artery
  - Information is sent to the medulla

Hyperventilation and Hypoventilation

- Hyperventilation, the response to acidosis
  - Results from increased CO_2 in the blood (acidosis)
  - Breathing becomes deeper and more rapid
  - Blows off more CO_2 to restore normal blood pH
- Hyperventilation, voluntary
  - Lowers blood CO_2 levels and reduces need to breathe

Hyperventilation and Hypoventilation

- **Hypoventilation, the response to alkalosis**
  - **Results when blood becomes alkaline (alkalosis)**
  - **Extremely slow or shallow breathing**
  - **Allows CO_2 to accumulate in the blood, leading to a decrease in pH in blood**