13

PART A

The Respiratory System

PowerPoint® Lecture Slide Presentation by Jerry L. Cook, Sam Houston University

ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY

EIGHTH EDITION

ELAINE N. MARIEB

Organs of the Respiratory system

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

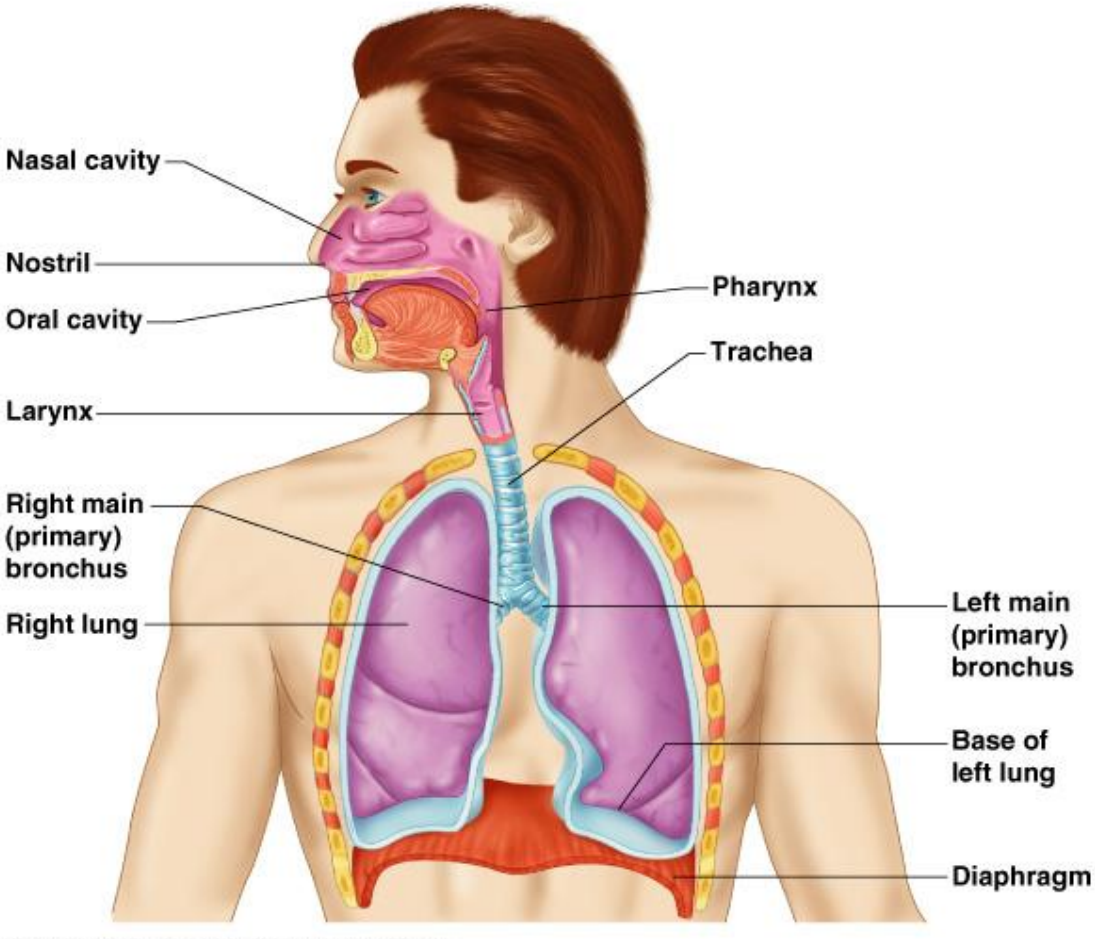


Figure 13.1

Function of the Respiratory System

- Oversees gas exchanges between the blood and external environment
- Exchange of gasses takes place within the lungs in the alveoli
- Passageways to the lungs purify, warm, and humidify the incoming air

The Nose

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

Upper Respiratory Tract

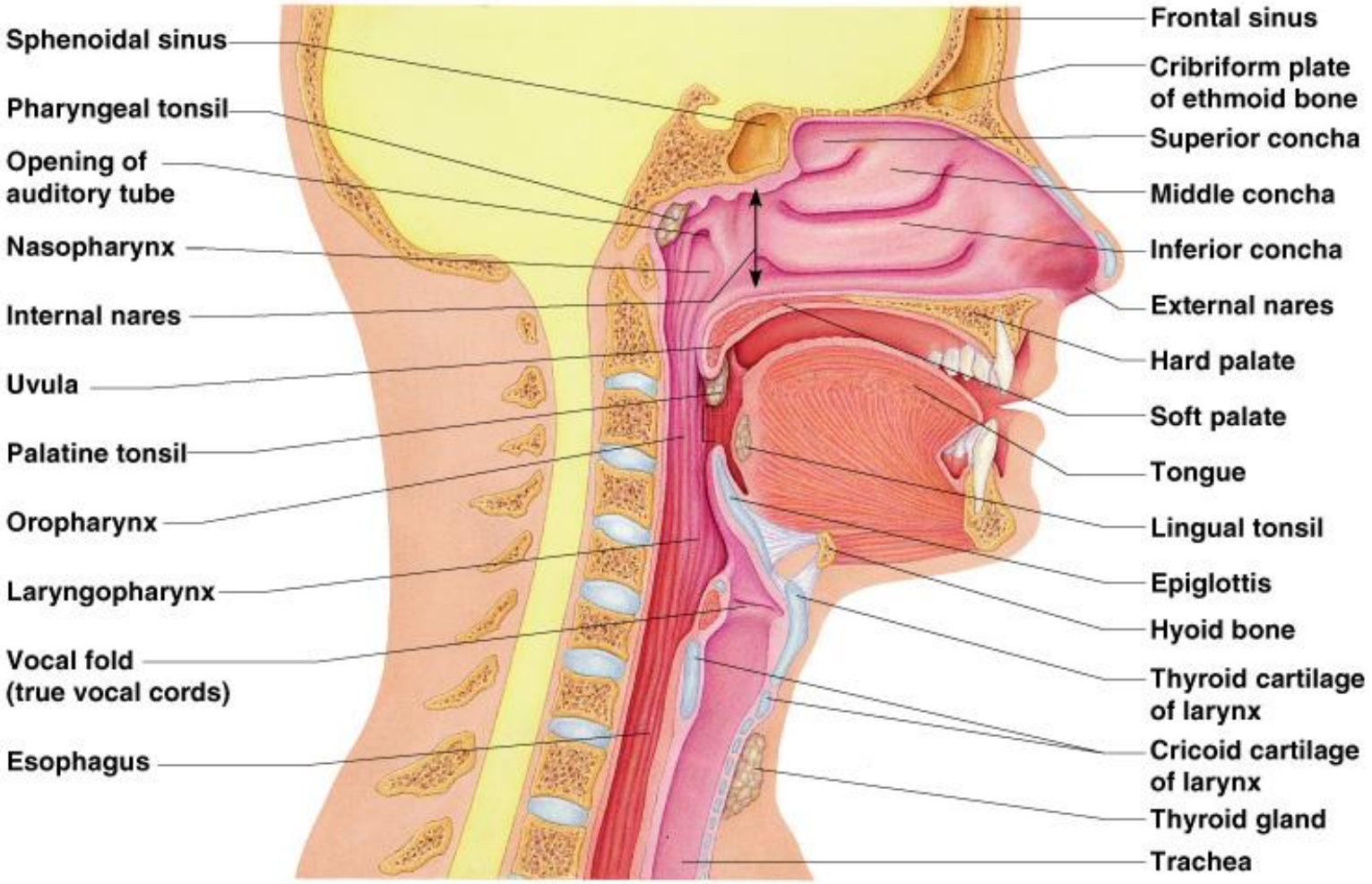


Figure 13.2

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
  - Moistens air
  - Traps incoming foreign particles

Anatomy of the Nasal Cavity

- Lateral walls have projections called conchae
  - Increases surface area
  - Increases 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)

Paranasal Sinuses

- Cavities within bones surrounding the nasal cavity
  - Frontal bone
  - Sphenoid bone
  - Ethmoid bone
  - Maxillary bone

Paranasal Sinuses

- Function of the sinuses
  - Lighten the skull
  - Act as resonance chambers for speech
  - Produce mucus that drains into the nasal cavity

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 attached to larynx
- The oropharynx and laryngopharynx are common passageways for air and food

Structures of the Pharynx

- Auditory tubes enter the nasopharynx
- Tonsils of the pharynx
  - Pharyngeal tonsil (adenoids) in the nasopharynx
  - Palatine tonsils in the oropharynx
  - Lingual tonsils at the base of the tongue

Larynx (Voice Box)

- Routes air and food into proper channels
- Plays a role in speech
- Made of eight rigid hyaline cartilages and a spoon-shaped flap of elastic cartilage (epiglottis)

Structures of the Larynx

- Thyroid cartilage
  - Largest hyaline cartilage
  - Protrudes anteriorly (Adam's apple)
- Epiglottis
  - Superior opening of the larynx
  - Routes food to the larynx and air toward the trachea

Structures of the Larynx

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

Trachea (Windpipe)

- Connects larynx with bronchi
- Lined with ciliated mucosa
  - Beat continuously in the opposite direction of incoming air
  - Expel mucus loaded with dust and other debris away from lungs
- Walls are reinforced with C-shaped hyaline cartilage

Primary Bronchi

- Formed by division of the trachea
- Enters the lung at the hilus (medial depression)
- Right bronchus is wider, shorter, and straighter than left
- Bronchi subdivide into smaller and smaller branches

Lungs

- Occupy most of the thoracic cavity
  - 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

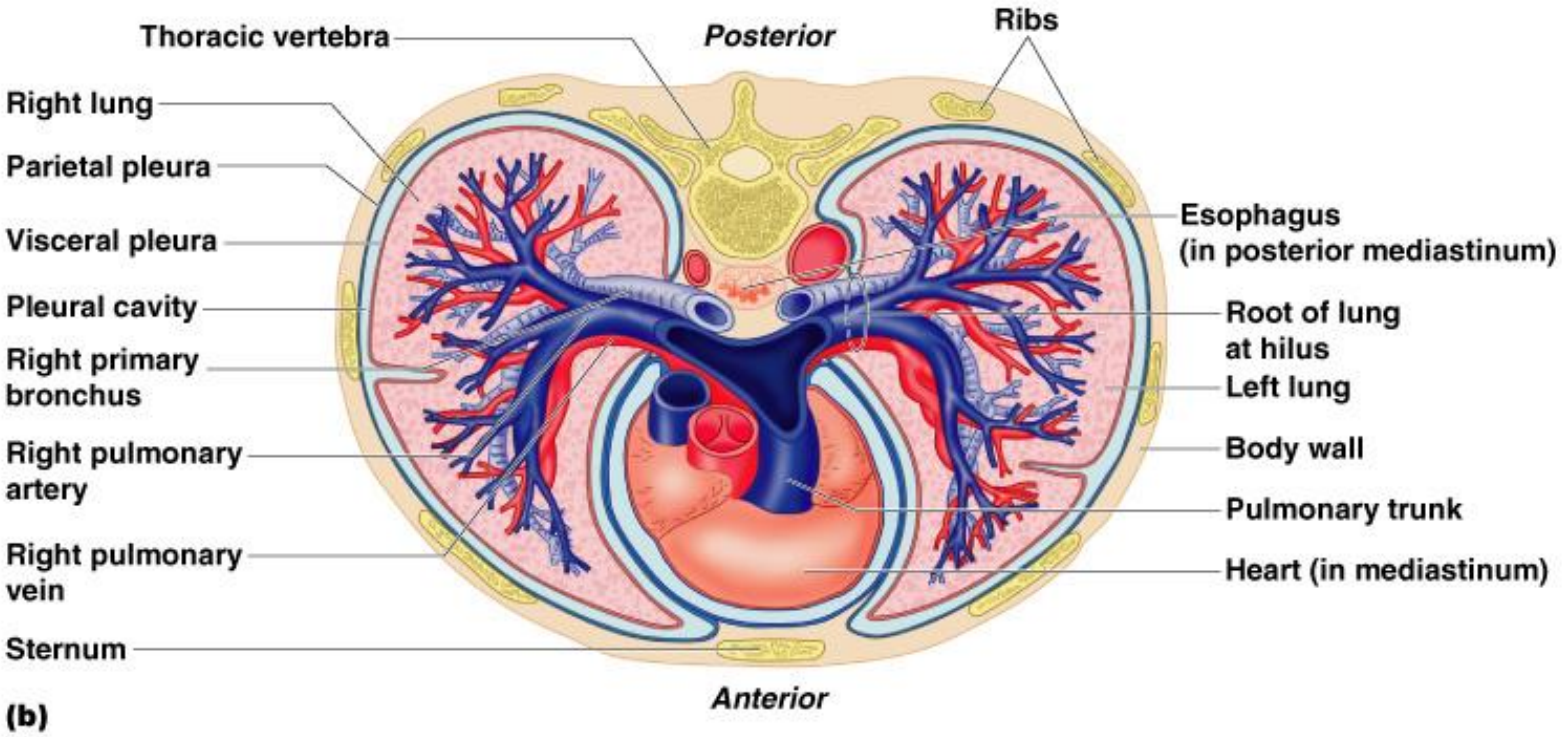


Figure 13.4b

Coverings of the Lungs

- Pulmonary (visceral) 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

Respiratory Tree Divisions

- Primary bronchi
- Secondary bronchi
- Tertiary bronchi
- Bronchioli
- Terminal bronchioli

Bronchioles

- Smallest branches of the bronchi

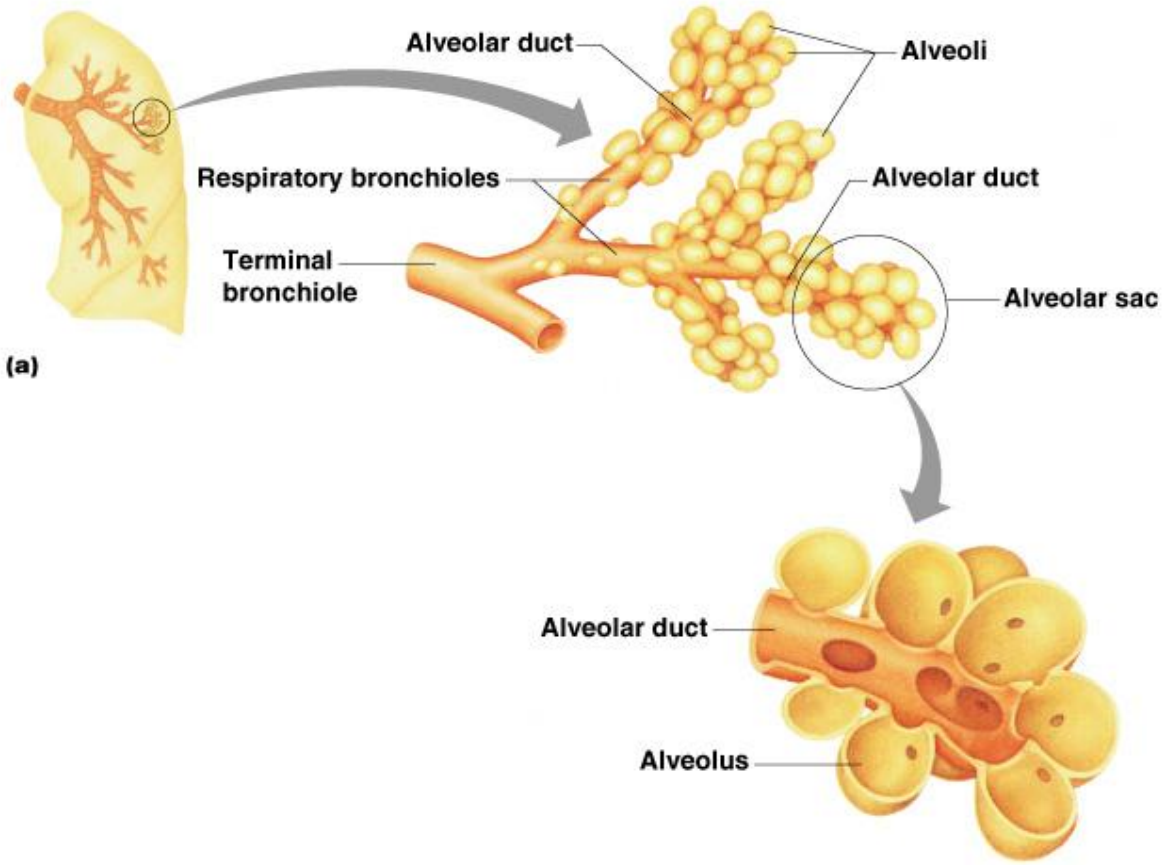


Figure 13.5a

Bronchioles

- All but the smallest branches have reinforcing cartilage

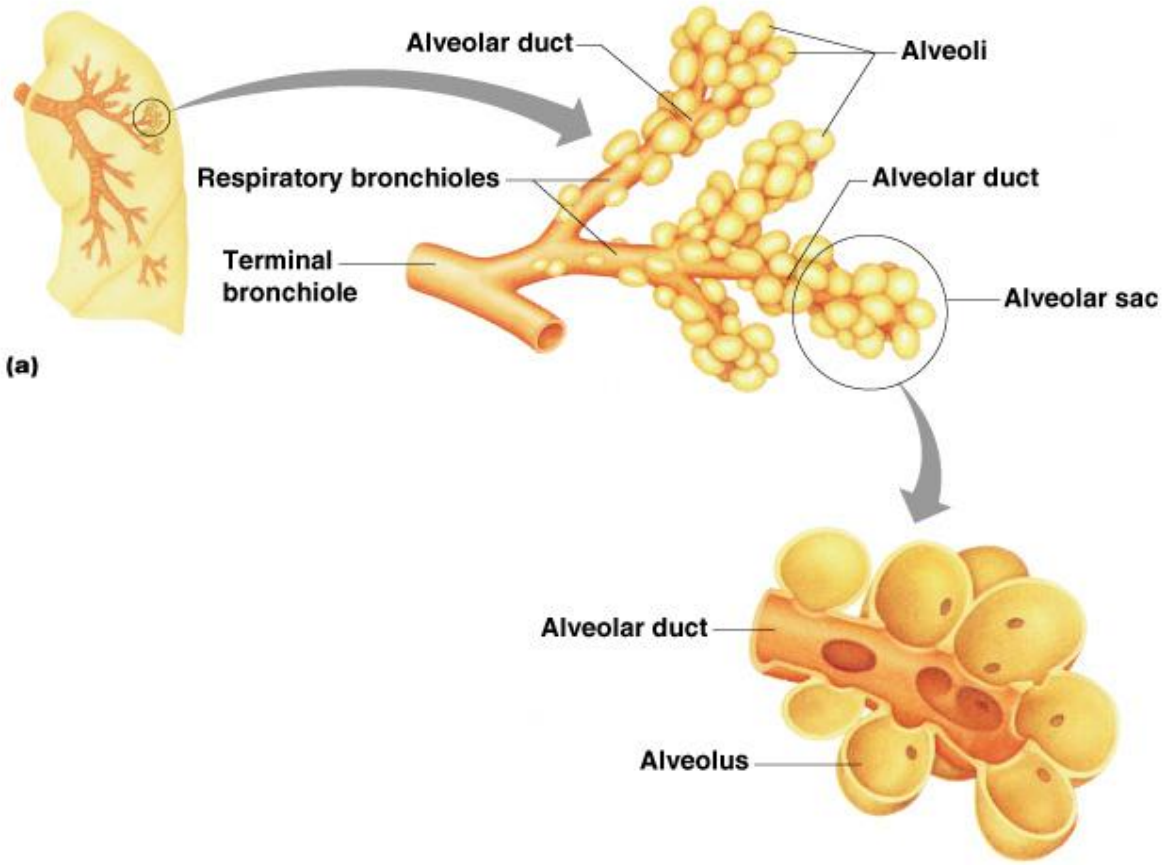


Figure 13.5a

Bronchioles

- Terminal bronchioles end in alveoli

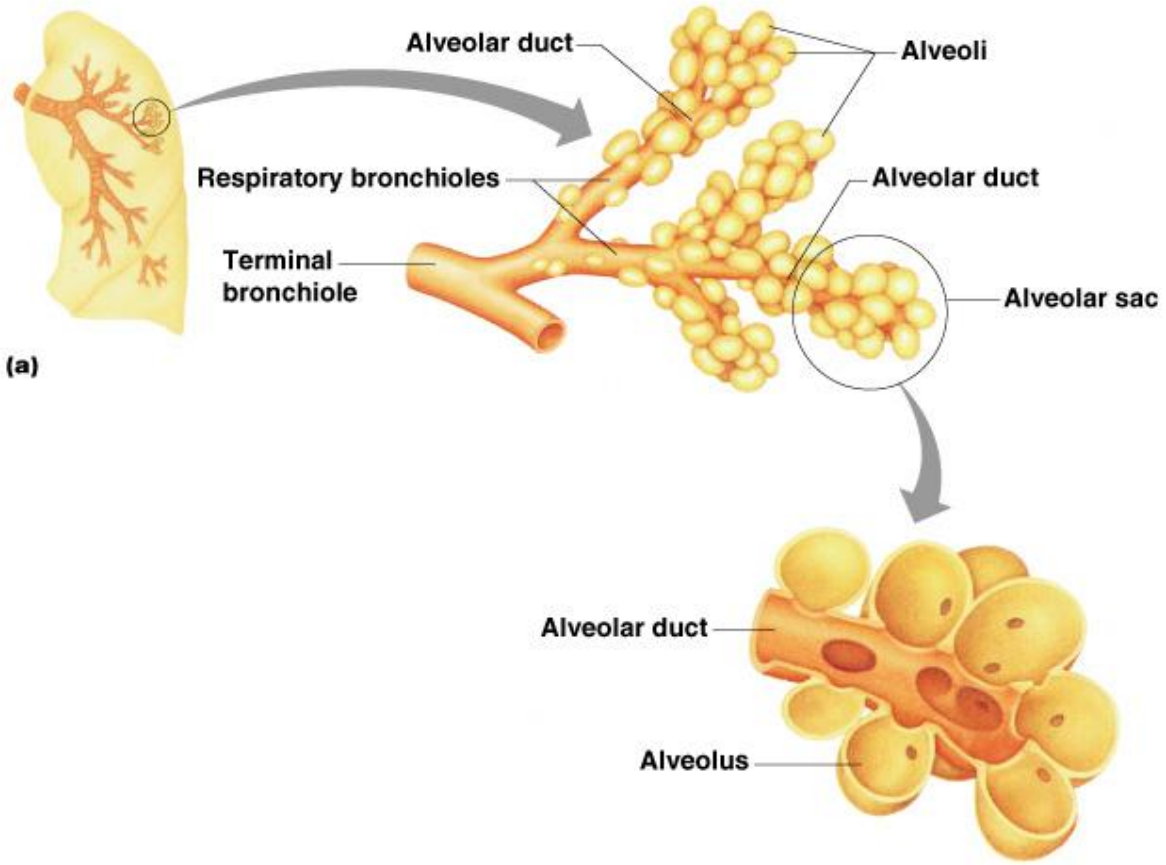


Figure 13.5a

Respiratory Zone

- Structures
  - Respiratory bronchioli
  - Alveolar duct
  - Alveoli
- Site of gas exchange

Alveoli

- Structure of alveoli
  - Alveolar duct
  - Alveolar sac
  - Alveolus
- Gas exchange takes place within the alveoli in the respiratory membrane

Respiratory Membrane (Air-Blood Barrier)

- Thin squamous epithelial layer lining alveolar walls
- Pulmonary capillaries cover external surfaces of alveoli

Respiratory Membrane (Air-Blood Barrier)

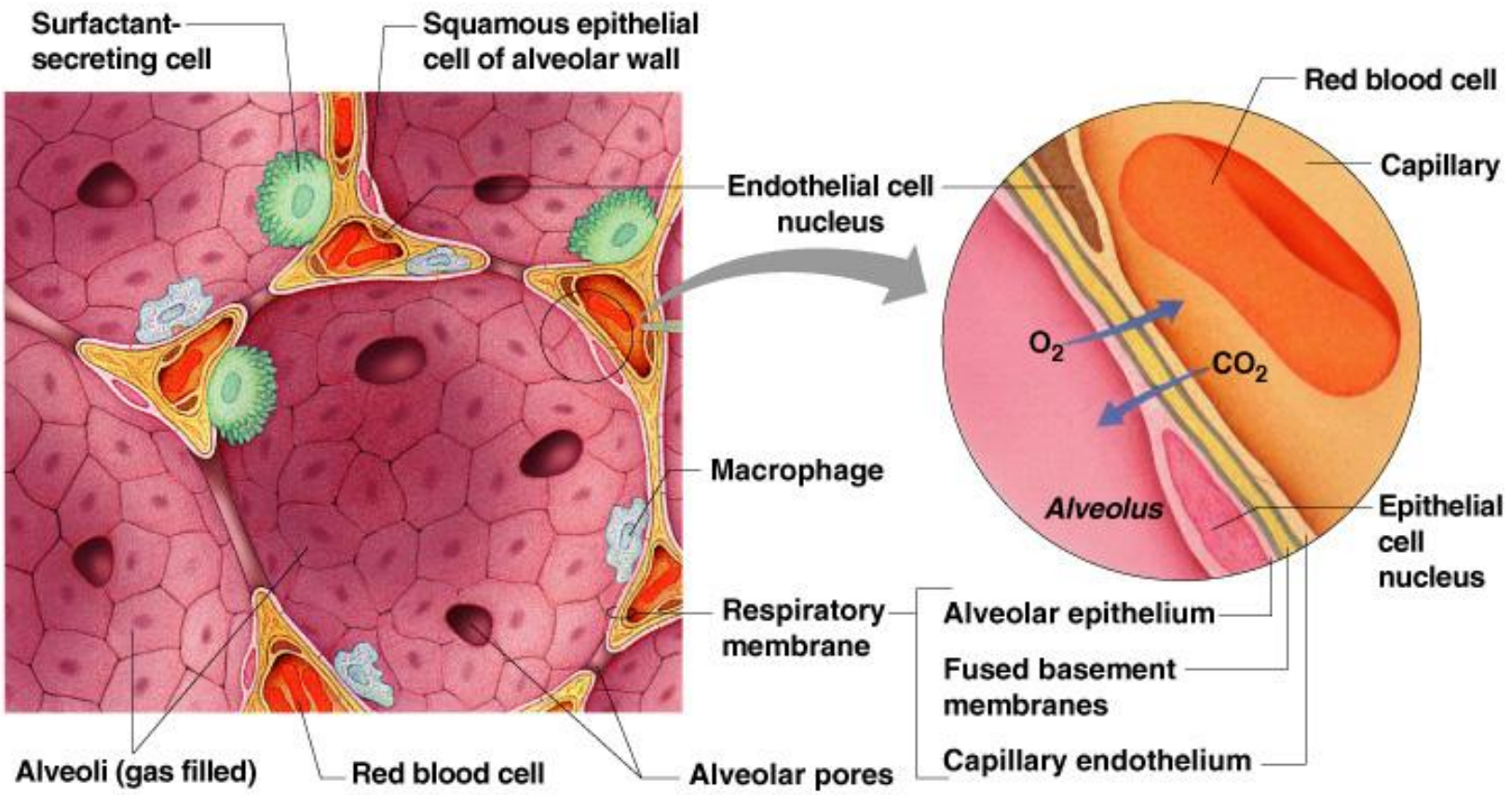


Figure 13.6

Gas Exchange

- Gas crosses the respiratory membrane by diffusion
  - Oxygen enters the blood
  - Carbon dioxide enters the alveoli
- Macrophages add protection
- Surfactant coats gas-exposed alveolar surfaces

Events of Respiration

- Pulmonary ventilation – moving air in and out of the lungs
- External respiration – gas exchange between pulmonary blood and alveoli

Events of Respiration

- Respiratory gas transport – transport of oxygen and carbon dioxide via the bloodstream
- Internal respiration – gas exchange between blood and tissue cells in systemic capillaries

Mechanics of Breathing (Pulmonary Ventilation)

- Completely mechanical process
- Depends on volume changes in the thoracic cavity
- Volume changes lead to pressure changes, which lead to the flow of gases to equalize pressure

Mechanics of Breathing (Pulmonary Ventilation)

- Two phases
  - Inspiration – flow of air into lung
  - Expiration – air leaving lung

Inspiration

- Diaphragm and intercostal muscles contract
- The size of the thoracic cavity increases
- External air is pulled into the lungs due to an increase in intrapulmonary volume

Inspiration

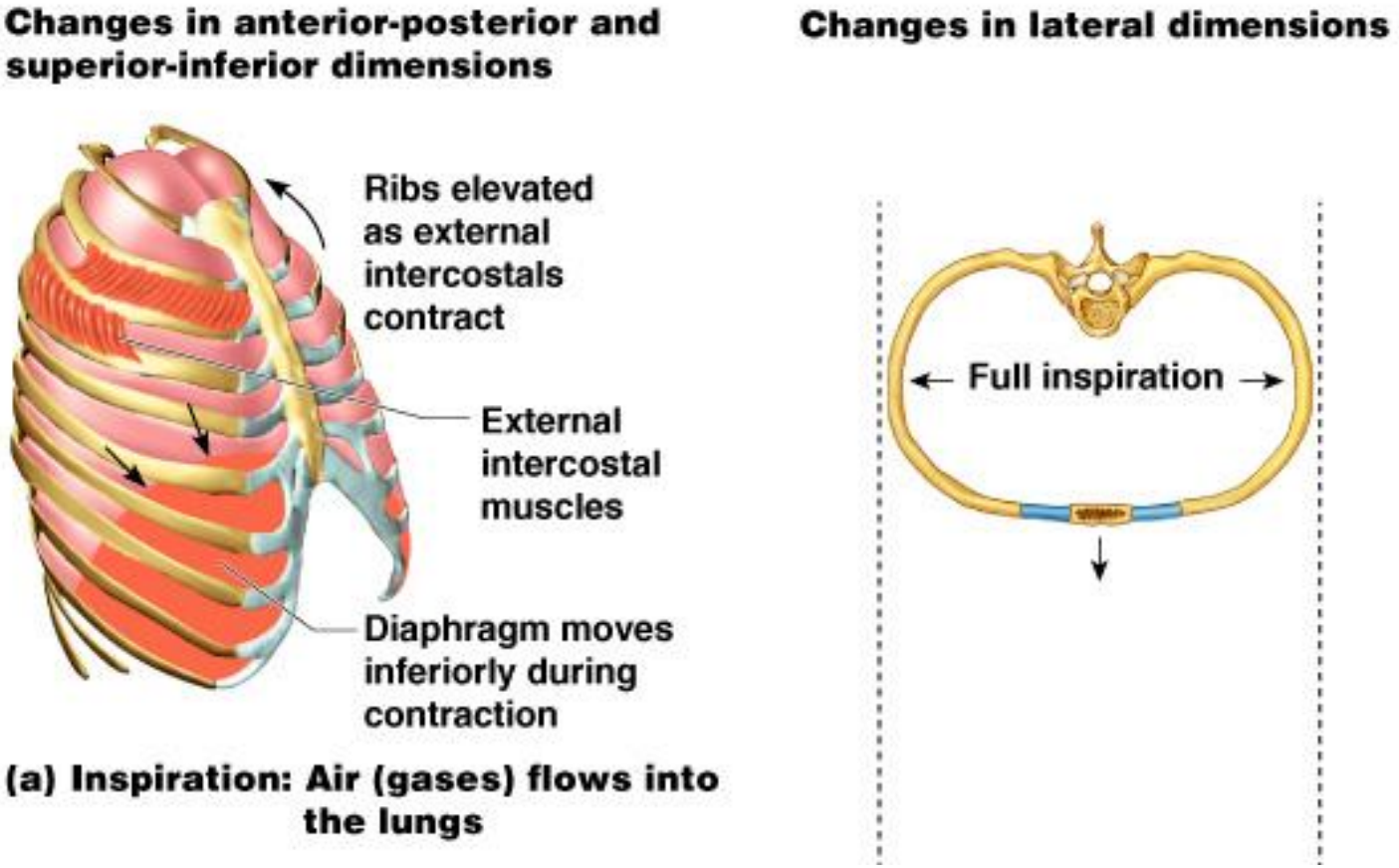
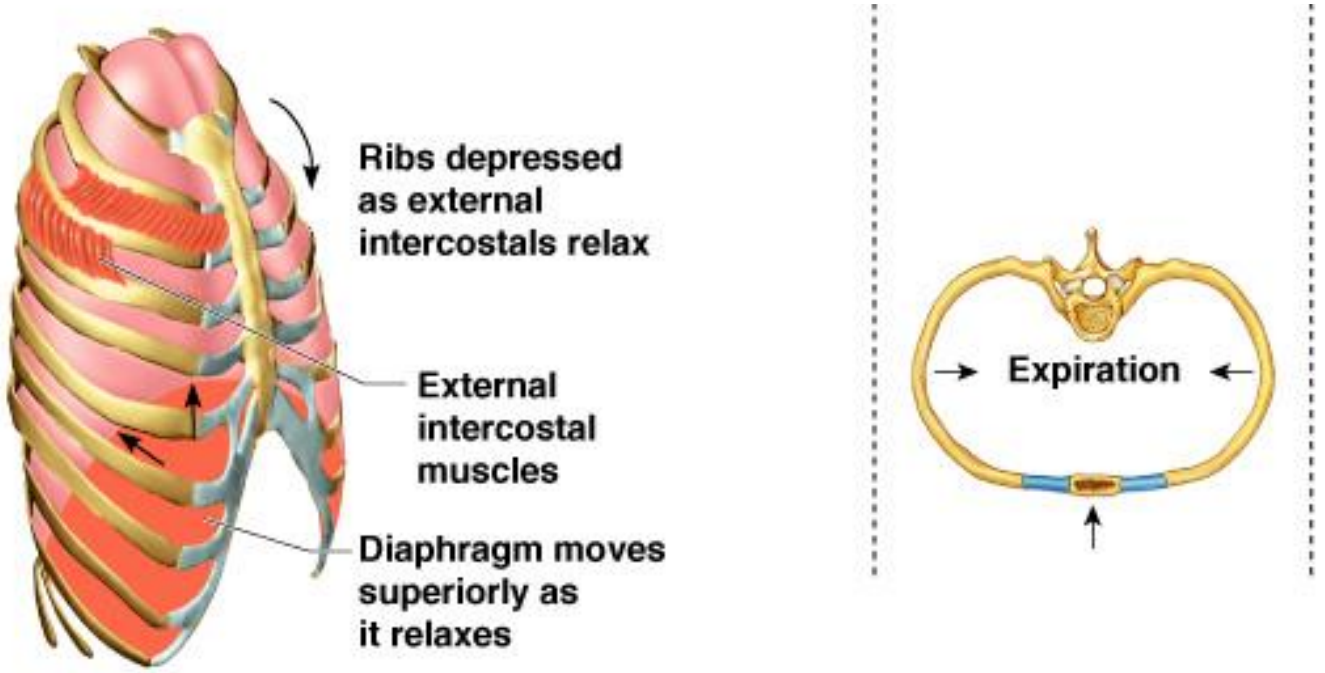


Figure 13.7a

Expiration

- Largely a passive process which depends on natural lung elasticity
- As muscles relax, air is pushed out of the lungs
- 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

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

Nonrespiratory Air Movements

- Can be caused by reflexes or voluntary actions
- Examples
  - Cough and sneeze – clears lungs of debris
  - Laughing
  - Crying
  - Yawn
  - Hiccup

Respiratory Volumes and Capacities

- Normal breathing moves about 500 ml of air with each breath (tidal volume [TV])
- Many factors that affect respiratory capacity
  - A person's size
  - Sex
  - Age
  - Physical condition
- Residual volume of air – after exhalation, about 1200 ml of air remains in the lungs

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

Respiratory Volumes and Capacities

- Vital capacity
  - The total amount of exchangeable air
  - Vital capacity = TV + IRV + ERV
  - Dead space volume
    - Air that remains in conducting zone and never reaches alveoli
    - About 150 ml

Respiratory Volumes and Capacities

- Functional volume
  - Air that actually reaches the respiratory zone
  - Usually about 350 ml
- Respiratory capacities are measured with a spirometer

Respiratory Capacities

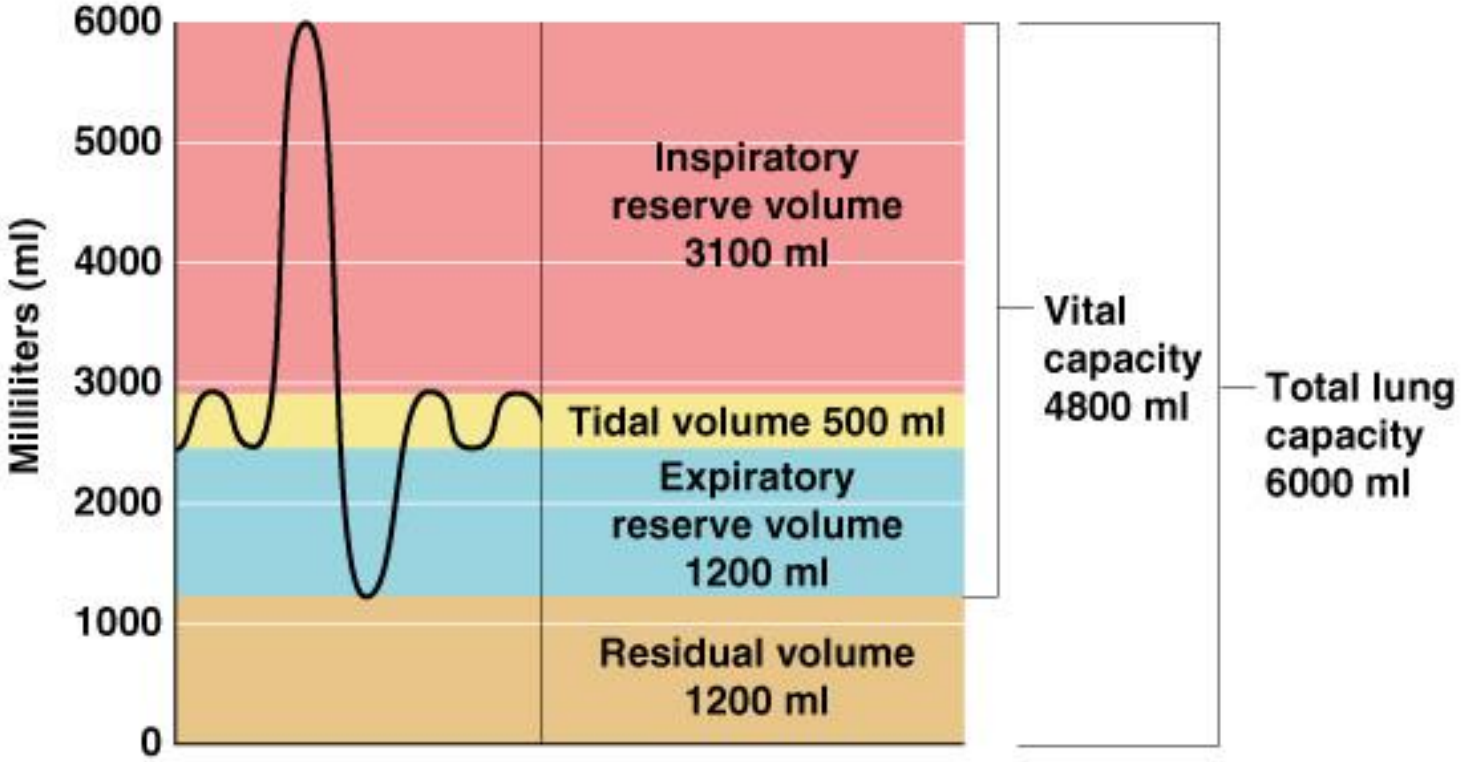


Figure 13.9