THE RESPIRATORY SYSTEM
Functions of the Respiratory System

- Provides extensive gas exchange surface area between air and circulating blood
- Moves air to and from exchange surfaces of lungs
- Protects respiratory surfaces from outside environment
- Produces sounds
- Participates in olfactory sense
Components of the Respiratory System

The Respiratory Tract

- Passageways that carries air two and from the gas exchange surfaces

1. Conducting portion (superior)
   - From nasal cavity to terminal bronchioles
     - filters, warms, and humidifies the air
     - Lined by the mucous membrane: respiratory mucosa

2. Respiratory portion (inferior)
   - The respiratory bronchioles and alveoli
Components of the Respiratory System

3. Alveoli - air-filled pockets within the lungs
   - all gas exchange takes place here
Components of the Respiratory System

- **Respiratory Defense System**
  - Mucous cells and mucous glands
    - Produce mucus that bathes exposed surfaces
  - Cilia:
    - Sweep debris trapped in mucus toward the pharynx (*mucus escalator*)
  - Filtration in nasal cavity removes large particles
  - Alveolar macrophages engulf small particles that reach lungs
Components of the Respiratory System

- Alveolar Epithelium
  - Is a very delicate, simple squamous epithelium
  - Contains scattered and specialized cells
  - Lines exchange surfaces of alveoli
The Respiratory Mucosa

Figure 15-2

Movement of mucus to pharynx

(a) Ciliated columnar epithelial cell
Mucous cell
Stem cell
Mucus layer
Lamina propria

(b) SEM x 1647
The Nose

- Air enters the respiratory system
  - Through nostrils or external nares
  - Into nasal vestibule

- Nasal hairs
  - Are in nasal vestibule
  - Are the first particle filtration system
Structures of the Upper Respiratory System

Figure 15-3

Nasal cavity
Internal nares
Nasopharynx
Pharyngeal tonsil
Entrance to auditory tube
Soft palate
Palatine tonsil
Oropharynx
Epiglottis
Laryngopharynx
Glottis
Vocal fold
Esophagus

Frontal sinus
Nasal conchae
Nasal vestibule
External nares
Hard palate
Oral cavity
Tongue
Mandible
Hyoid bone
Thyroid cartilage
Cricoid cartilage
Trachea
The Nose

- **The Nasal Cavity**
  - The *nasal septum*:
    - Divides nasal cavity into left and right
  - Mucous secretions from paranasal sinus and tears:
    - Clean and moisten the nasal cavity
  - Superior portion of nasal cavity is the olfactory region:
    - Provides sense of smell
The Pharynx

* A chamber shared by digestive and respiratory systems
- Extends from internal nares to entrances to larynx and esophagus
- Divided into
  - nasopharynx
  - oropharynx
  - laryngopharynx
The Larynx

- Cartilages of the Larynx

  - Three large, unpaired cartilages form the larynx:
    - Thyroid cartilage
    - Cricoid cartilage
    - Epiglottis
The Larynx

- The Thyroid Cartilage
  - Also called the Adam’s apple
  - Is hyaline cartilage
  - Forms anterior and lateral walls of larynx
  - Ligaments attach to hyoid bone, epiglottis, and laryngeal cartilages
The Larynx

- The Cricoid Cartilage
  - Is hyaline cartilage
  - Forms posterior portion of larynx
  - Ligaments attach to first tracheal cartilage
The Larynx

- The Epiglottis
  - Composed of elastic cartilage
  - Ligaments attach to thyroid cartilage and hyoid bone
  - Folds back over glottis when swallowing occurs
Figure 15-4 c,d,e
The Larynx

- Sound is varied by
  - Tension on vocal folds:
    - Vocal folds involved with sound are known as vocal cords
  - Voluntary muscles (position arytenoid cartilage relative to thyroid cartilage)

- Speech is produced by
  - Phonation: Sound production at the larynx
  - Articulation: Modification of sound by other structures

http://www.youtube.com/watch?v=z9LKwISwb_c
The Trachea

- The Trachea
  - Also called the windpipe
  - Extends from the cricoid cartilage into mediastinum:
    - Where it branches into right and left pulmonary bronchi

- The Submucosa
  - Beneath mucosa of trachea
  - Contains mucous glands
The Trachea

- The Tracheal Cartilages
  - 15–20 tracheal cartilages:
    - Strengthen and protect airway
    - Discontinuous where trachea contacts esophagus
  - Ends of each tracheal cartilage are connected by:
    - An elastic ligament
    - trachealis muscle
The Bronchi

- **The Primary Bronchi**
  - **Right and left primary bronchi:**
    - Separated by an internal ridge (the carina)

- **The Right Primary Bronchus**
  - Is larger in diameter than the left
  - Descends at a steeper angle
The Bronchi

- Structure of Primary Bronchi
  - Each primary bronchus:
    - Travels to a groove (hilum) along the medial surface of the lung
The Bronchi

- A Primary Bronchus
  - Branches to form **secondary bronchi** (lobar bronchi)
  - One secondary bronchus goes to each lobe

- Secondary Bronchi
  - Branch to form **tertiary bronchi**, also called the segmental bronchi
  - Each segmental bronchus:
    - Supplies air to a single **bronchopulmonary segment**
Respiratory Portion: The Bronchioles

- Each tertiary bronchus branches into multiple **bronchioles**
  - Bronchioles branch into **terminal bronchioles**:  
    - One tertiary bronchus forms about 6500 terminal bronchioles

- **Bronchiole Structure**
  - Bronchioles: (1mm diameter)
    - Have no cartilage
    - Are dominated by smooth muscle

[YouTube Video Link](http://www.youtube.com/watch?v=S04dci7NTPk)  
Bronchoconstriction
The Bronchial Tree and Lobules of the Lung

Figure 15-6a
The Bronchial Tree and Lobules of the Lung

Figure 15-6b
The Alveolar Ducts and Alveoli

- **An Alveolus (150 million in each lung)**
  - Respiratory bronchioles are connected to alveoli along **alveolar ducts**
  - Alveolar ducts end at **alveolar sacs:**
    - Common chambers connected to many individual alveoli
  - Has an extensive network of capillaries
  - Is surrounded by elastic fibers
Alveolar Organization

Figure 15-7a

(a) Alveolar organization
Figure 15-7b

(b) Alveolar ducts and alveoli

SEM × 270

Alveoli
Alveolar sac
Alveolar duct

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Alveolar Organization

Figure 15-7c

(c) Alveolar structure

- Septal cell (secretes surfactant)
- Elastic fibers
- Alveolar epithelial cell
- Alveolar macrophage
- Capillary
- Alveolar macrophage
- Endothelial cell of capillary
The Alveolar Ducts and Alveoli

- **Alveolar Epithelium**
  - Consists of simple squamous epithelium
  - Consists of thin, delicate *pneumocytes type I*
  - Patrolled by *alveolar macrophages*
  - Contains *pneumocytes type II* (septal cells) that produce *surfactant*—oil secretion that reduces surface tension
The Respiratory Membrane

- Three Layers of the Respiratory Membrane
  - Squamous epithelial lining of alveolus
  - Endothelial cells lining an adjacent capillary
  - Fused basal laminae between alveolar and endothelial cells
The Respiratory Membrane

Figure 15-7d

(d) The respiratory membrane
The Lungs

- Left and right lungs:
  - Are in left and right pleural cavities

- The base:
  - Inferior portion of each lung rests on superior surface of diaphragm

- Lobes of the lungs:
  - Lungs have lobes separated by deep fissures
The Lungs

- The right lung has three lobes
  - Superior, middle, and inferior
  - Separated by horizontal and oblique fissures

- The left lung has two lobes
  - Superior and inferior
  - Separated by an oblique fissure
The Lungs

Figure 15-8
The Lungs

Figure 15-9

- Parietal pleura
- Right pleural cavity
- Visceral pleura
- Mediastinum
- Right Lung
- Left Lung
- Heart
- Pericardial cavity
The Pleural Cavities

- Two *pleural cavities*
  - Are separated by the mediastinum

- Each pleural cavity
  - Holds a lung
  - Is lined with a serous membrane (the *pleura*)
The Pleural Cavities

- The Pleura
  - Consists of two layers:
    - Parietal pleura
    - Visceral pleura
  - Pleural fluid:
    - Lubricates space between two layers