The Respiratory System

• Supplies body with oxygen
• Disposes of carbon dioxide
• Four processes in respiration
  • Pulmonary ventilation
  • External respiration
  • Transport of respiratory gases
  • Internal respiration

Functional Anatomy of the Respiratory System

• Respiratory organs
  • Nose, nasal cavity, and paranasal sinuses
  • Pharynx, larynx, and trachea
  • Bronchi and smaller branches
  • Lungs and alveoli
• Divided into:
  • Conducting zone
  • Respiratory zone
Organs of the Respiratory System

The Nose

- Provides an airway for respiration
- Moistens and warms air
- Filters inhaled air
- Resonating chamber for speech
- Houses olfactory receptors
- Size variation due to differences in nasal cartilages
- Skin is thin – contains many sebaceous glands

The Nasal Cavity

- **External nares** – nostrils
  - Divided by – nasal septum
  - Continuous with nasopharynx
    - Posterior nasal apertures – choanae

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**Figure 22.2**

- Frontal bone
- Nasal bone
- Septal cartilage
- Maxillary bone (frontal process)
- Lateral process of septal cartilage
- Minor alar cartilages
- Dense fibrous connective tissue
- Major alar cartilages

(b) External skeletal framework
Nasal Cavity

- Two types of mucous membrane
  - **Olfactory mucosa**
    - Near roof of nasal cavity
    - Houses olfactory (smell) receptors
  - **Respiratory mucosa**
    - Lines nasal cavity
    - Epithelium is pseudostratified ciliated columnar

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The Upper Respiratory Tract

![Diagram of the Upper Respiratory Tract](image)

- Nasal cavity
- Nasal conchae (superior, middle, and inferior)
- Nasal meatuses (superior, middle, and inferior)
- Nasopharynx
- Oropharynx
- Laryngopharynx
- Uvula
- Palatine tonsil
- Pharyngeal tonsil
- Hard palate
- Soft palate
- Hypopharynx
- Tongue
- Larynx
- Epiglottis
- Thyroid cartilage
- Cricoid cartilage
- Thyroid gland
- Esophagus

Respiratory Mucosa

- **Consists of:**
  - Pseudostratified ciliated columnar epithelium
  - Goblet cells within epithelium
  - Underlying layer of lamina propria
  - **Cilia** move contaminated mucus posteriorly
**Nasal Conchae**

- Superior and middle – part of the ethmoid bone
- **Inferior – a separate bone**
- Project medially from the lateral wall of the nasal cavity
- Particulate matter – deflected to mucus-coated surfaces

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**The Upper Respiratory Tract**

![Illustration of the Upper Respiratory Tract](Image)

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**The Paranasal Sinuses**

![Illustration of the Paranasal Sinuses](Image)
The Pharynx
- Funnel-shaped passageway
- Connects nasal cavity and mouth
- Divided into three locations
  - Nasopharynx, oropharynx, and laryngopharynx
- Type of mucosal lining varies along its length

The Nasopharynx
- Superior to the point where food enters
- Only an air passageway
- Closed off during swallowing
- Pharyngeal tonsil (adenoids)
  - Located on posterior wall
  - Destroys entering pathogens
- Contains the opening to the pharyngotympanic (auditory) tube
- Epithelium is ciliated pseudostratified columnar

The Oropharynx
- Arch-like entranceway – fauces
- Extends from soft palate to the epiglottis
- Epithelium is stratified squamous epithelium
- Two types of tonsils in the oropharynx
  - Palatine tonsils – in the lateral walls of the fauces
  - Lingual tonsils – covers the posterior surface of the tongue
The Laryngopharynx

- Passageway for both food and air
- Lined with stratified squamous epithelium
- Continuous with the esophagus and larynx

The Larynx

- Three functions
  - Voice production
  - Provides an open airway
  - Routes air and food into the proper channels
Anatomy of the Larynx

Movements of the Vocal Folds

The Larynx

- **Voice production**
  - Length of the vocal folds changes with pitch
  - Loudness depends on the force of air across the vocal folds

- **Sphincter function of the larynx**
  - Valsalva’s maneuver

- **Innervation of the larynx** – recurrent laryngeal nerves
The Trachea

- Descends into the mediastinum
- Divides into two main bronchi
- C-shaped cartilage rings keep airway open

Bronchi in the Conducting Zone

- Bronchial tree – extensively branching respiratory passageways
- Primary bronchi (main bronchi) – largest bronchi
- Right main bronchi – wider and shorter than the left
Bronchi in the Conducting Zone

- **Secondary** (lobar) bronchi
  - Three on the right
  - Two on the left
- **Tertiary** (segmental) bronchi
  - Branch into each lung segment
- **Bronchioles** – little bronchi, less than 1 mm in diameter
- **Terminal bronchioles** – less than 0.5 mm in diameter

Changes in Tissue Composition along Conducting Pathways

- Supportive connective tissues change
  - C-shaped rings replaced by cartilage plates
- Epithelium changes
  - First, pseudostratified ciliated columnar
  - Replaced by simple columnar, then simple cuboidal epithelium
- Smooth muscle becomes important

The Respiratory Zone

- Consists of air-exchanging structures
- **Respiratory bronchioles** – branch from terminal bronchioles
  - Lead to alveolar ducts
  - Lead to alveolar sacs
Structures of the Respiratory Zone

The Respiratory Zone

- Alveoli consist of type I cells and basal laminae
- Scattered among type I cells
  - Cuboidal epithelial cells – type II cells
  - Secrete surfactant

Anatomy of Alveoli and the Respiratory Membrane
The Respiratory Zone

- Features of alveoli
  - Surrounded by elastic fibers
  - Interconnect by way of alveolar pores
  - Internal surfaces
    - A site for free movement of alveolar macrophages

The Mechanisms of Ventilation

- Two phases of pulmonary ventilation
  - Inspiration – inhalation
  - Expiration – exhalation
  - Air enters and exits the lungs based on air pressure.
  - Air flows from high pressure into an area of low pressure, passively.
**Inspiration**

- Volume of thoracic cavity increases
- Decreases internal gas pressure
- Action of the diaphragm – diaphragm flattens
- Action of intercostal muscles – contraction raises the ribs
- Deep inspiration requires
  - Scalenes, sternocleidomastoid, and pectoralis minor
  - Erector spinae – extends the back

**Expiration**

- Quiet expiration – chiefly a passive process
- Inspiratory muscles relax
- Diaphragm moves superiorly
- Volume of thoracic cavity decreases
- Forced expiration – an active process
  - Produced by contraction of:
    - The oblique and transversus abdominis muscles

**Location of Lungs in Thoracic Cavity**

![Image of lungs in thoracic cavity with labels for rib numbers, lung regions, and other anatomical landmarks.](image)
Changes in Thoracic Volume

**Figure 22.14**
- **(a) Inspiration**
  - Ribs are elevated and sternum flares as external intercostals contract.
  - Diaphragm moves inferiorly during contraction.
  - Thoracic cavity volume increases.

- **(b)Expiration**
  - Ribs and sternum are depressed as external intercostals relax.
  - Diaphragm moves superiorly as it relaxes.

Changes in Thoracic Volume

**Figure 22.15**
- **Inspiration**
  - Inspiratory muscles contract and increase the volume of the thoracic and pleural cavities. Pleural fluid in the pleural cavity holds the parietal and visceral pleura close together, causing the lungs to expand. As volume increases, pressure decreases and air flows into the lungs.

- **Expiration**
  - Inspiratory muscles relax, reducing thoracic volume, and the lungs recoil. Simultaneously, volumes of the pleural cavity and the lungs decrease, causing pressure to increase in the lungs, and air flows out. Resting state is reestablished.