Respiratory System
Functions

- Gas Exchange
- Speech
- Smell
- pH regulation
Nose and Nasal Cavity

Frontal sinus
Nasal concha:
  Superior
  Middle
  Inferior
Meatuses:
Hard palate
Tongue
Larynx:
  Epiglottis
  Vestibular fold
  Vocal cord
Trachea:

Criciform plate
Auditory tube
Sites of respiratory control nuclei:
  Pars
  Noduli oblongata
Nasopharynx
Uvula
Oropharynx
Laryngopharynx

Vertebral column
Esophagus

Frontal sinus
Nasal concha:
  Superior
  Middle
  Inferior
Meatuses:
  Superior
  Middle
  Inferior
Sphenoid sinus
Prediuret nasal aperture
Pharyngeal tonsil
Auditory tube
Soft palate
Uvula
Palatine tonsil
Lingual tonsil
Epiglottis

Trachea
Esophagus

Nasal septum:
  Perpendicular plate
  Septal cartilage
  Vomer
Pharynx:
  Nasopharynx
  Oropharynx
  Laryngopharynx
Pharynx

• Function

• Structure
  - Nasopharynx
  - Oropharynx
  - Laryngopharynx
Larynx

- "Voice Box"
- Functions
- Anatomy
  - Glottis
  - Epiglottis
  - Vocal Chord
- Sound Production
Vocal Cords

Adduction of vocal cords

Abduction of vocal cords

- Thyroid cartilage
- Cricoid cartilage
- Vocal cord
- Lateral cricoarytenoid muscle
- Arytenoid cartilage
- Corniculate cartilage
- Posterior cricoarytenoid muscle

Anterior
Posterior

Base of tongue
Epiglottis
Vestibular fold
Vocal cord
Glottis
Corniculate cartilage
Trachea

- “Windpipe”
- C-shaped cartilage rings
- Pseudostratified Columnar Epithelial
- Connection between Larynx and Bronchial Tree
Bronchial Tree

- Network of highly branched air tubes
- Lots of elastic cartilage
- Structures
  - Main Bronchi
  - Lobar Bronchi
  - Segmental Bronchi
Bronchial Tree cont’d

- Terminal Bronchioles
- Respiratory Bronchioles
- Alveolar Ducts
- Alveoli
Lower Respiratory Tract

Figure 22.7 a–c

(a) Larynx
- Thyroid cartilage
- Cricoid cartilage

(b) Trachea
- Carina
- Lobar bronchi
- Segmental bronchi
- Main bronchi

(c) Trachealis muscle
- Hyaline cartilage ring
- Mucosa
- Mucous gland
- Perichondrium

Epithelium:
- Goblet cell
- Ciliated cell

Mucus
- Mucociliary escalator
- Particles of debris

Cartilage
- Chondrocytes

Lumen
- Mucous gland

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Lungs

• Lobes
  – Right lung: 3
  – Left Lung: 2
Lungs Continued

- Alveoli
  - Type I Cells
  - Type II Cells (Great Cells)
Pleurae

• Visceral Pleura

• Parietal Pleura

• Pleural Cavity
G. Site Gas Exchange

- Respiratory Membrane
  - Structural Barrier between Air and Blood

- Alveolar Wall
  - Type II Cells
  - Type I Cells
  - Macrophages

- Capillary Wall

- Shared Basement membrane
Respiration

Respiration has three meanings:

1. Pulmonary ventilation (breathing)

2. Gas exchange – the exchange of gases between the air in the alveoli and the blood

3. Gas transport in blood
Inhalation

• Inspiration (Inhaling)
  – Active Process
  – 2 major muscle groups: diaphragm and external intercostals
  – ↑ Space ↓ Pressure allows for more diffusion and air to come in
Exhalation

• Expiration
  – Passive Process
  – ↓ Space ↑ Pressure pushes air out

• Quiet vs. Forced Respiration
Sites of respiration

• Sites of pressure change
  – Alveolar (intrapulmonary) Pressure
  – Intrapleural
Types of Pressure

• Composition of air

• Atmospheric Pressure

• Partial Pressure
In inspiration, the thoracic cavity expands laterally, vertically, and anteriorly; intrapulmonary pressure drops 1 cm H₂O below atmospheric pressure, and air flows into the lungs.

In expiration, the thoracic cavity contracts in all three directions; intrapulmonary pressure rises 1 cm H₂O above atmospheric pressure, and air flows out of the lungs.
Gas Exchange

• Recall the respiratory membrane

• Partial pressure of oxygen and carbon dioxide facilitates exchange.
Figure 22.12 b-c

(b) Great alveolar cell
(c) Alveolar macrophage

- Respiratory membrane
- Capillary endothelial cell
- Fluid with surfactant
- Squamous alveolar cell
- Lymphocyte

Air

CO₂

O₂

Blood

- Respiratory membrane:
  - Squamous alveolar cell
  - Shared basement membrane
  - Capillary endothelial cell
Exchange

IV. Transportation of Gases

• Oxygen
  - Oxyhemoglobin
  - Dissolved in plasma

• Carbon Dioxide
  - Bicarbonate ion (HCO$_3^-$)
    • $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{HCO}_3^- + \text{H}^+$
  - Hemoglobin – Carbaminohemoglobin
  - Dissolved in plasma
Gas Exchange and Transportation

- **Respiring tissue**
  - CO₂: 7%
  - CO₂: 23%
  - CO₂: 70%
  - O₂: 98.5%
  - O₂: 1.5%

- **Capillary blood**
  - CO₂ + plasma protein → Carbaminio compounds
  - CO₂ + Hb → HbCO₂
  - CO₂ + H₂O → H₂CO₃ → HCO₃⁻ + H⁺
  - O₂ + HHb → HbO₂ + H⁺

**Key**
- Hb: Hemoglobin
- HbCO₂: Carbaminohemoglobin
- HbO₂: Oxyhemoglobin
- HHb: Deoxyhemoglobin
- CAH: Carbonic anhydrase
V. Neural Control of Breathing

• exact mechanism for setting the rhythm of respiration remains unknown

• breathing depends on repetitive stimulation of skeletal muscles from brain

• neurons in medulla oblongata and pons control unconscious breathing

• voluntary control provided by motor cortex
Brainstem Respiratory Centers

• Automatic, unconscious cycle of breathing is controlled by three pairs of respiratory centers in the reticular formation of the medulla oblongata and the pons

• Respiratory center in medulla
  – ventral respiratory group (VRG)
  – dorsal respiratory group (DRG)

• Respiratory center in pons
  – Pneumotaxic Center