Respiratory System

Nose
Nasal cavity
Oral cavity
Larynx
Trachea
Pharynx
Right primary bronchus
Lungs

(a) Anterior view showing organs of respiration

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(a) Anterior view showing organs of respiration
(b) Anterior view of the lungs after removal of the anterolateral thoracic wall and parietal pleura.
(a) Anterolateral view of external portion of nose showing cartilaginous and bony framework
(b) Sagittal section of the left side of the head and neck showing the location of respiratory structures.
Anterior view

1. **Root**: Superior attachment of the nose to the frontal bone
2. **Apex**: Tip of nose
3. **Bridge**: Bony framework of nose formed by nasal bones
4. **External naris**: Nostril; external opening into nasal cavity
Sagittal section showing the regions of the pharynx

- Superior nasal concha
- Hard palate
- Oral cavity
- Tongue
- Mandible
- Hyoid bone
- Thyroid cartilage (Adam's apple)
- Cricoid cartilage
- Trachea
- Nasopharynx
- Oropharynx
- Laryngopharynx (hypopharynx)
- Pharyngeal tonsil
- Opening of auditory (Eustachian) tube
- NASOPHARYNX
- Soft palate
- Palatine tonsil
- Fauces
- OROPHARYNX
- Lingual tonsil
- Epiglottis
- LARYNGOPHARYNX (hypopharynx)
- Esophagus

Regions of the pharynx
(a) Movement of vocal folds apart (abduction)

(b) Movement of vocal folds together (adduction)
Interior view of a transverse section through the thoracic cavity showing the pleural cavity and pleural membranes.
Volume = 1 liter  
Pressure = 1 atm

Volume = 1/2 liter  
Pressure = 2 atm
MUSCLES OF INHALATION

Sternocleidomastoid
Scaless
External intercostals
Diaphragm

MUSCLES OF EXHALATION

Internal intercostals
External oblique
Internal oblique
Transversus abdominis
Rectus abdominis

(a) Muscles of inhalation and their actions (left); muscles of exhalation and their actions (right)

(b) Changes in size of thoracic cavity during inhalation and exhalation

(c) During inhalation, the ribs move upward and outward like the handle on a bucket
1. At rest (diaphragm relaxed)

Atmospheric pressure = 760 mm Hg

Alveolar pressure = 760 mm Hg

Intrapleural pressure = 756 mm Hg

2. During inhalation (diaphragm contracting)

Atmospheric pressure = 760 mm Hg

Alveolar pressure = 758 mm Hg

Intrapleural pressure = 754 mm Hg

3. During exhalation (diaphragm relaxing)

Alveolar pressure = 762 mm Hg

Intrapleural pressure = 756 mm Hg
During normal quiet inhalation, the diaphragm and external intercostals contract. During labored inhalation, sternocleidomastoid, scalenes, and pectoralis minor also contract.

Alveolar pressure increases to 762 mm Hg

Atmospheric pressure is about 760 mm Hg at sea level

Thoracic cavity increases in size and volume of lungs expands

Alveolar pressure decreases to 758 mm Hg

During normal quiet exhalation, diaphragm and external intercostals relax. During forceful exhalation, abdominal and internal intercostal muscles contract.

Thoracic cavity decreases in size and lungs recoil

(a) Inhalation

(b) Exhalation
(a) Effect of pH on affinity of hemoglobin for oxygen

(b) Effect of $P_{O_2}$ on affinity of hemoglobin for oxygen
BPG

2,3 Biphosphoglycerate
(a) Exchange of $O_2$ and $CO_2$ in pulmonary capillaries (external respiration)

(b) Exchange of $O_2$ and $CO_2$ in systemic capillaries (internal respiration)
RESPIRATORY CENTER:

- Pneumotaxic area
- Apneustic area
- Medullary rhythmicity area:
  - Inspiratory area
  - Expiratory area

- Midbrain
- Pons
- Medulla oblongata
- Spinal cord

Sagittal section of brain stem
(a) During normal quiet breathing

INSPIRATORY AREA
ACTIVE

2 seconds

Diaphragm and external intercostals actively contract

Normal quiet inhalation

(b) During forceful breathing

INSPIRATORY AREA
ACTIVE

Activates

EXPIRATORY AREA

INTERNAL intercostal and abdominal muscles contract

Forceful exhalation

FORCEFUL inhalation

INSPIRATORY AREA
INACTIVE

3 seconds

Diaphragm and external intercostals relax, followed by elastic recoil of chest wall and lungs

Normal quiet exhalation
Some stimulus disrupts homeostasis by increasing arterial blood $P_{O_2}$ (or decreasing pH or $P_{CO_2}$).

**Receptors**
- Central chemoreceptors in medulla
- Peripheral chemoreceptors in aortic and carotid bodies

**Control center**
- Inspiratory area in medulla oblongata

**Effectors**
- Muscles of inhalation and exhalation contract more forcefully and more frequently (hyperventilation)
- Decrease in arterial blood $P_{O_2}$, increase in pH, and increase in $P_{CO_2}$

Return to homeostasis when response brings arterial blood $P_{O_2}$, pH, and $P_{CO_2}$ back to normal.
Types of Hypoxia

- Anemic
- Hypoxic
- Ischemic
- Histotoxic
- Hypoxemic
Lung Diseases

- COPD = Chronic Obstructive Pulmonary Disease (Asthma, Bronchitis and Emphysema)
- Tuberculosis
- Lung Cancer
- Pneumonia
- Pulmonary edema
Words to Learn

- Apnea, Dyspnea, Hyperpnea, Orthopnea, Hypercapnea, Tachypnea, eupnea
- Haldane Effect
- Aspiration
- Bronchoscopy
- Cheyne-Stokes breathing
- Pulmonary embolism
- SIDS
- Asphyxia
- Rales
- Compliance