

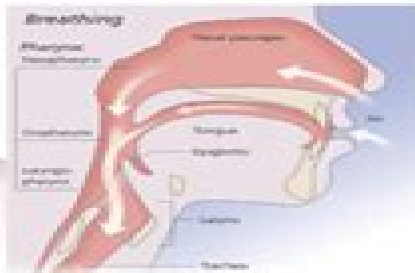
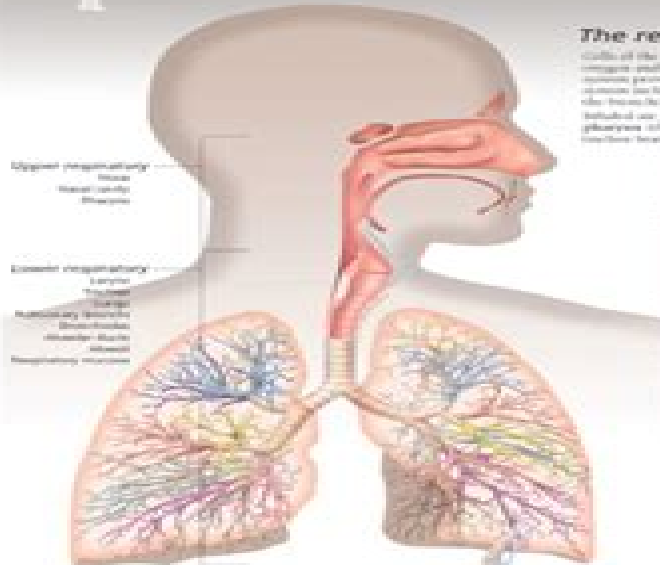


# Respiration & Gas Exchange

## The respiratory system

Cells of the body get oxygen through aerobic metabolism, a process that uses oxygen and produces carbon dioxide as a waste product. The respiratory system provides the means to exchange these gases at the cellular level. The system includes the nose and mouth passages, the pharynx, larynx and trachea, the bronchi and the lungs.

Inhaled air entering through the nasal cavity or mouth, flows through the pharynx (throat) and the larynx (voice box) to the trachea (windpipe). The trachea branches into two bronchi, which carry air into each of the lungs.



Through breathing, our respiratory system provides the needed oxygen and expels the carbon dioxide we need to eliminate. It completely breathes in (inhaling or inspiration) and then expelling or (expiration).

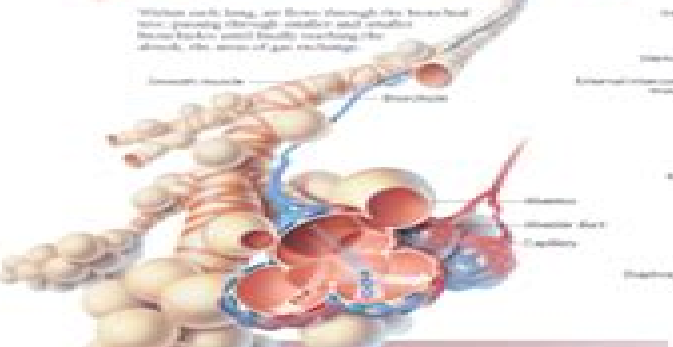
A normal adult inhales about 16 pints of air per minute while resting and about five to eight pints per minute while asleep. During exercise or under unusual situations, the body's demand for oxygen increases and the rate of breathing increases.

## Total lung capacity

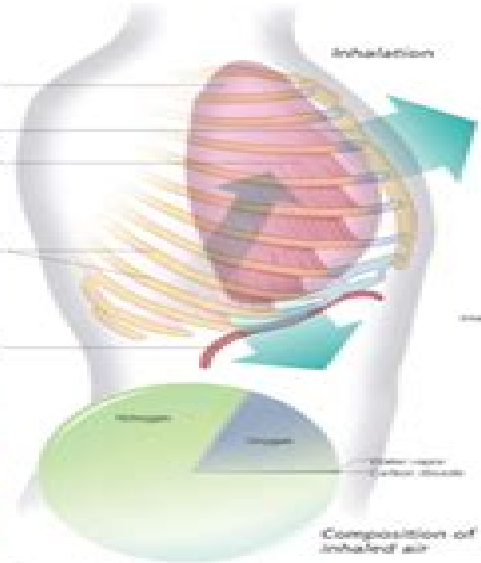
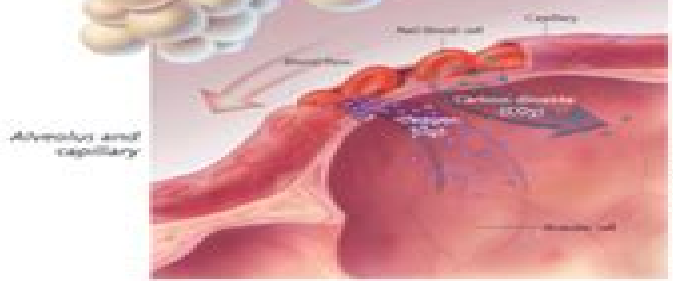


## Lung volumes

During normal respiration, the amount of air breathed in and out is called tidal volume. The additional amount of air that can be forcibly inhaled (just a normal volume) is the inspiratory reserve volume. The additional amount of air that can be forcibly exhaled (just a normal volume) is the expiratory reserve volume. Together the normal volume and the inspiratory reserve volume make up the total capacity. Exhaling all the air in the lungs would create a vacuum, so when air re-enters in the lungs, this air is called residual volume. Adding the residual volume to the total capacity gives us the total lung capacity (volume) of both of our lungs.

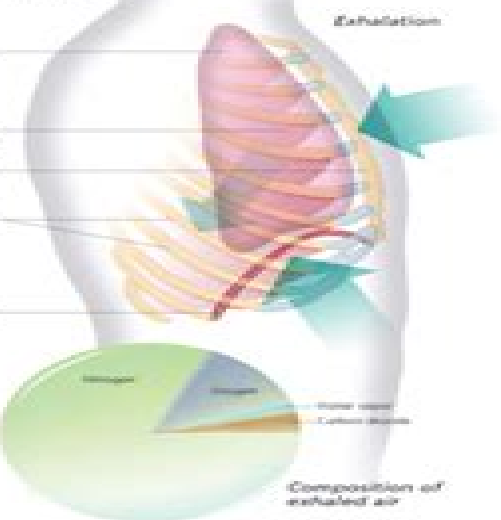


Within each lung, air flows through the bronchial tree, passing through smaller and smaller bronchi until finally reaching the alveoli, the sites of gas exchange.



## The mechanics of breathing

During inhalation, the diaphragm contracts down in a vacuum, and the external intercostal ribs do not pull the ribs outward. This action decreases the volume of the chest cavity. A partial vacuum is created by the additional space, and air is drawn in to equalize the pressure. During exhalation, the external intercostal muscle contracts, the chest cavity. The lungs passively expand and air is pushed out of the lungs.



## Gas exchange

Over a billion alveoli in the lungs have more than 100 million tiny blood vessels (capillaries) nearby. These alveoli work along the respiratory membrane, alveolar ducts and alveolar sacs, exposed to air carried through the trachea to these alveoli. Blood is carried from the capillaries that wrap around all the alveoli. These capillaries are so narrow that blood cells must pass through at a single file. Oxygen (O<sub>2</sub>) diffuses across the alveolar wall into the blood cells to replace hemoglobin (Hb) diffused from the blood into the alveoli. The CO<sub>2</sub> is inhaled. The newly oxygenated blood flows from the lungs to the heart to be pumped throughout the body.



# Respiratory Physiology Understanding Gas Exchange From Basic Principles To Applications

**RJ Shavelson**



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