

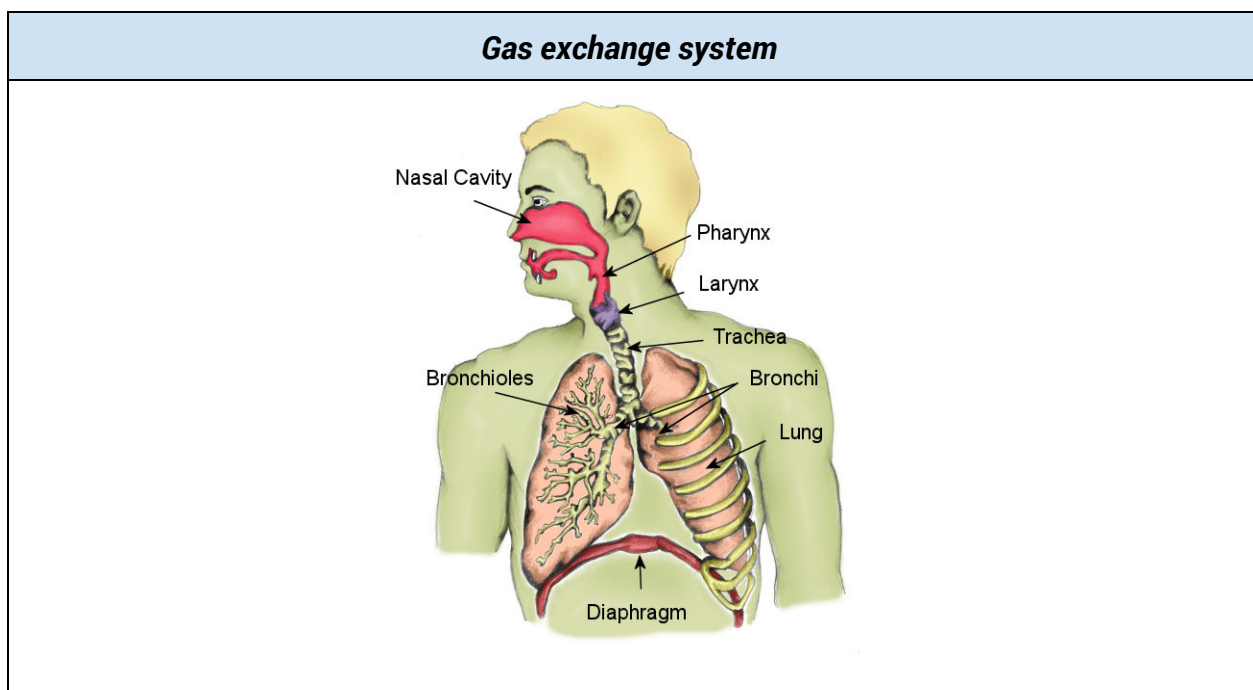
# Gas exchange

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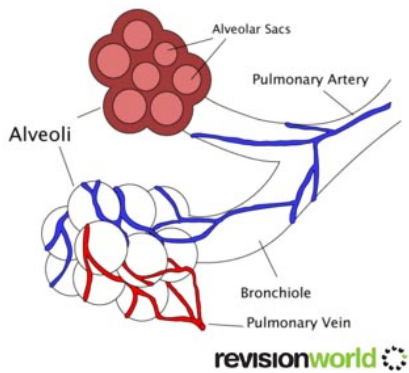
## Gas exchange in humans

Humans use up a great deal of energy so they must have a very efficient gas exchange system. They are made up of:

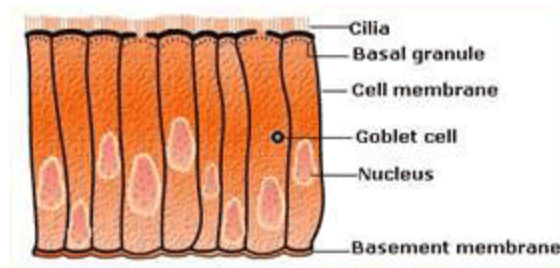
- a **respiratory surface** - membranes lining the alveoli (air sacs) in the lungs.
- a **set of tubes** to allow air from the outside to reach the respiratory surface.  
This set of tubes has many branches and is sometimes called the 'bronchial tree'.
- a **blood supply** (carried by the pulmonary artery and pulmonary vein) to carry dissolved gases to and from the respiratory surface.
- a **ventilation system** (the intercostal muscles and the diaphragm) to keep a good flow of air over the respiratory surface.



- **Larynx (voice box)** - air passes through here during breathing. When breathing out, the vocal cords can be made to vibrate. The sounds produced make up our speech.
- **Trachea (windpipe)** - tube that carries air towards the lngs. C-shaped rings of cartilage prevent the trachea collapsing during inhalation.
- **Bronchus** - first branch from the trachea. There is one bronchus to each lung.
- **Bronchiole** - final, very fine branch leading into the alveolus.
- **Alveolus (air sac)** - these are lined by the membranes where gas exchange takes place. The surface is moist, thin and has an enormous area.



- **Branch of pulmonary artery** - delivers deoxygenated blood at high pressure from the right ventricle of the heart.
- **Branch of pulmonary vein** - returns oxygenated blood to the heart for pumping out to the tissues.



- **Cilia** - fine 'hairs' on surface of cell. These can be beat in a coordinated way to carry mucus (with trapped microbes and dust) away from lung surfaces.
- **Goblet cell** - produces sticky mucus and releases it onto the surface of the cells.
- **Basement membrane** - holds the cells in place.

Breathing is the set of muscular movements that gives the respiratory surface a constant supply of fresh air. This means there is always a concentration gradient between the blood and the air in the alveoli for both oxygen and carbon dioxide. As shown below, breathing is brought about by:

- the action of two groups of muscles - the **intercostal muscles** and the **diaphragm**
- the properties of the **pleural membranes** that surround the lungs.

During exercise the muscles work hard, and need to release more energy by respiration. Greater volumes of air must therefore be breathed in and out, by:

- increasing the **breathing rate** - more breaths per minute
- increasing the **tidal volume** - more air per breath.

These two changes can increase the volume of air passing in and out of the lungs from the typical 8 dm<sup>3</sup> per minute at rest to 50-60 dm<sup>3</sup> per minute during strenuous exercise.

As well as exercise some other factors affect breathing rate:

<b><i>Factor</i></b>	<b><i>Effect</i></b>
Smoking	<ul style="list-style-type: none"> <li>● Increase, due to the effect of carbon monoxide</li> </ul>
Anxiety	<ul style="list-style-type: none"> <li>● Increase, due to the effect of adrenaline</li> </ul>
Drugs	<ul style="list-style-type: none"> <li>● Some cause an increase eg. amphetamines</li> </ul>
	<ul style="list-style-type: none"> <li>● Some cause a decrease eg. alcohol</li> </ul>
Environmental factors	<ul style="list-style-type: none"> <li>● Increased by high CO<sub>2</sub> concentration</li> <li>● Sometimes increased by high temperature or humidity</li> </ul>
Altitude	<ul style="list-style-type: none"> <li>● Increased by low O<sub>2</sub> concentration</li> </ul>
Weight	<ul style="list-style-type: none"> <li>● Can increase because fat makes lung ventilation harder</li> <li>● Can decrease if excess body weight is a symptom of low activity of the thyroid gland</li> </ul>