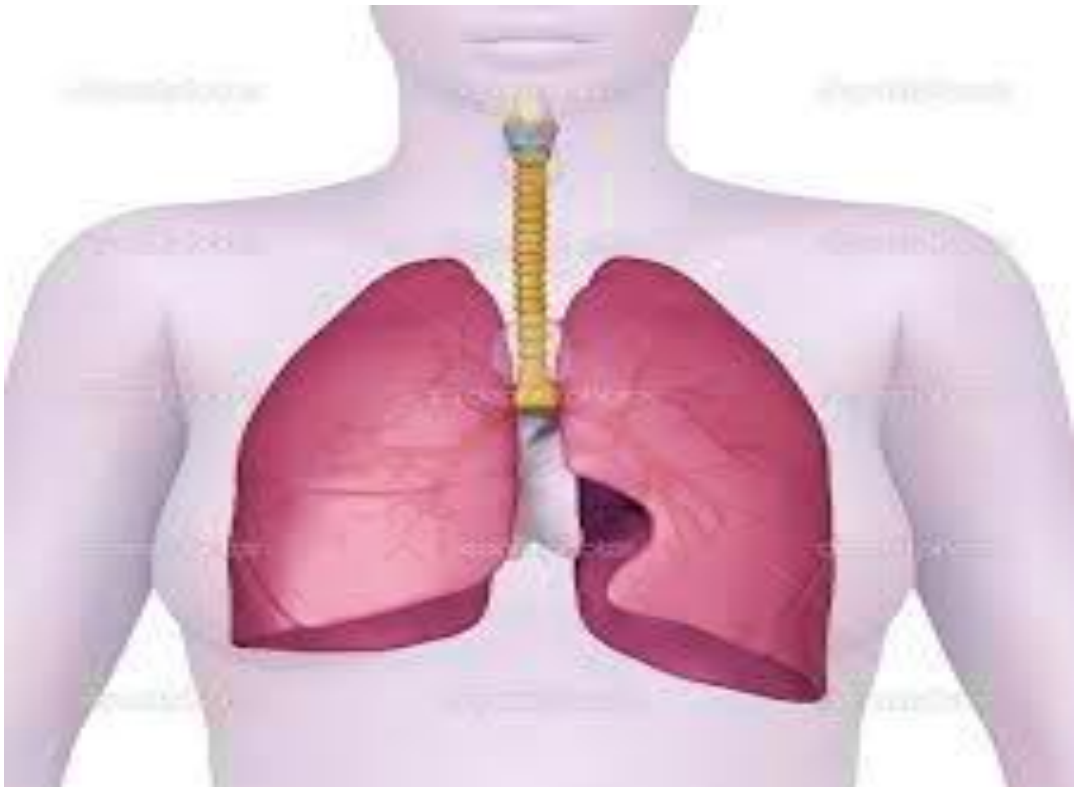
UNIT - 05

Respiration



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Respiration is the process of obtaining energy.

Glucose + Oxygen ⟶ Carbon Dioxide + Water + Energy

Every day we breathe without even knowing.

The stored energy is usually released in cells through a process known as respiration. Did you know that breathing is exercise?

But really, exercising hard makes we breathe faster, which helps us to be healthier. That's why you have to exercise to get healthy; it makes you breathe faster which helps your body. Respiration is NOT breathing. It's a complicated process which requires you to eat healthy foods.

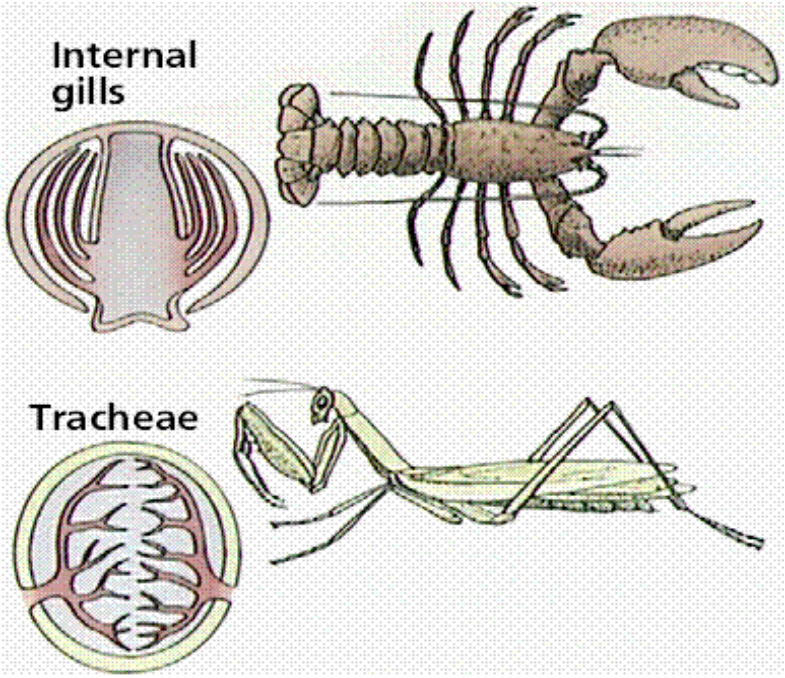
Primary function is to obtain oxygen for use by body's cells & eliminate carbon dioxide that cells produce. It includes respiratory airways leading into & out of respiratory surfaces.

Respiratory Surfaces

Large animals cannot maintain gas exchange by diffusion across their outer surface. They developed a variety of respiratory surfaces that all increase the surface area for exchange, thus allowing for larger bodies. A respiratory surface is covered with thin, moist epithelial cells that allow oxygen and carbon dioxide to exchange. Those gases can only cross cell membranes when they are dissolved in water or an aqueous solution, thus respiratory surfaces must be moist.

Methods of Respiration

Sponges and jellyfish lack specialized organs for gas exchange and take in gases directly from the surrounding water. Flatworms and annelids use their outer surfaces as gas exchange surfaces. Arthropods, annelids, and fish use gills; terrestrial vertebrates utilize internal lungs.



The Body Surface

Flatworms and annelids use their outer surfaces as gas exchange surfaces. Earthworms have a series of thin-walled blood vessels known as capillaries. Gas exchange occurs at capillaries located throughout the body as well as those in the respiratory surface.

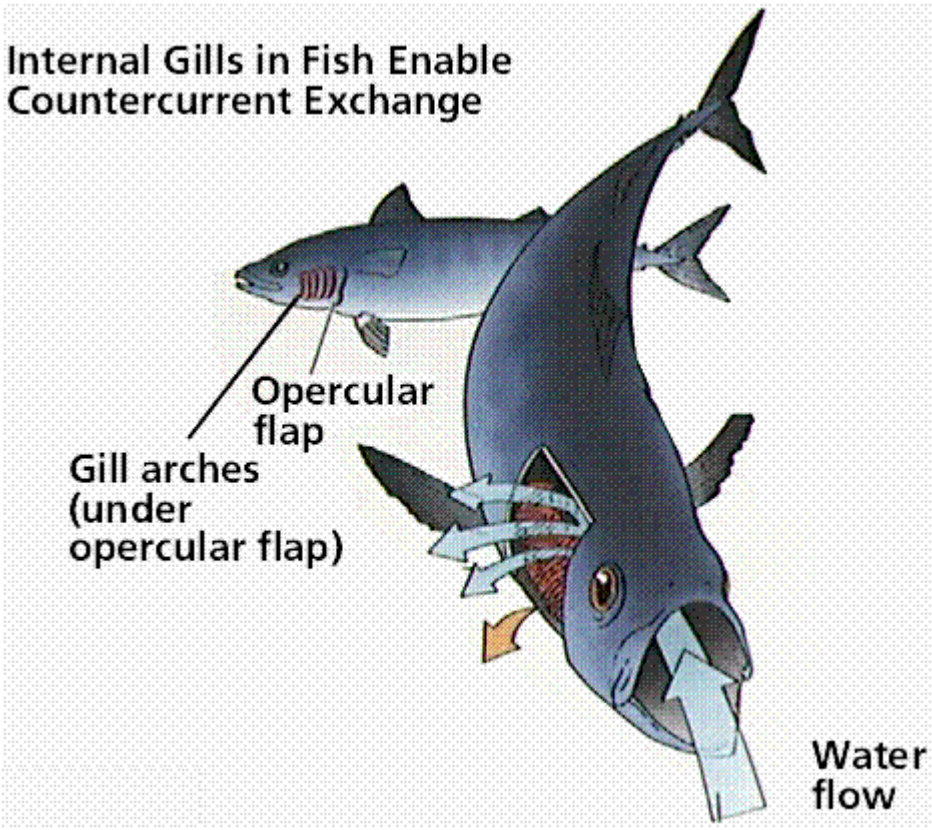
Amphibians use their skin as a respiratory surface. Frogs eliminate carbon dioxide 2.5 times as fast through their skin as they do through their lungs. Eels (a fish) obtain 60% of their oxygen through their skin. Humans exchange only 1% of their carbon dioxide through their skin. Constraints of water loss dictate that terrestrial animals must develop more efficient lungs

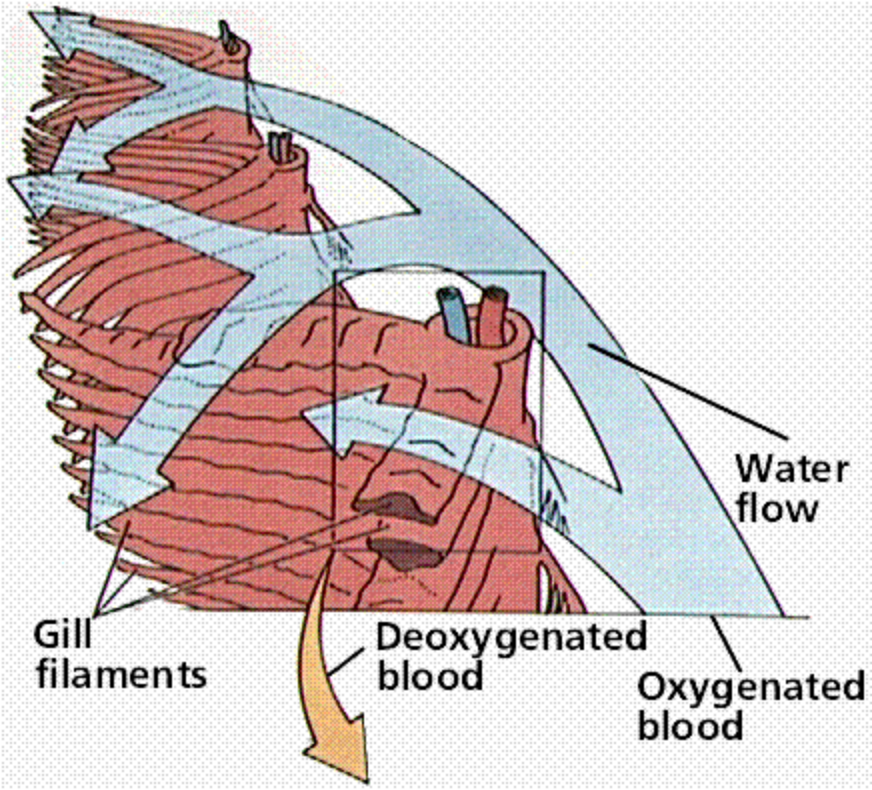
Gills

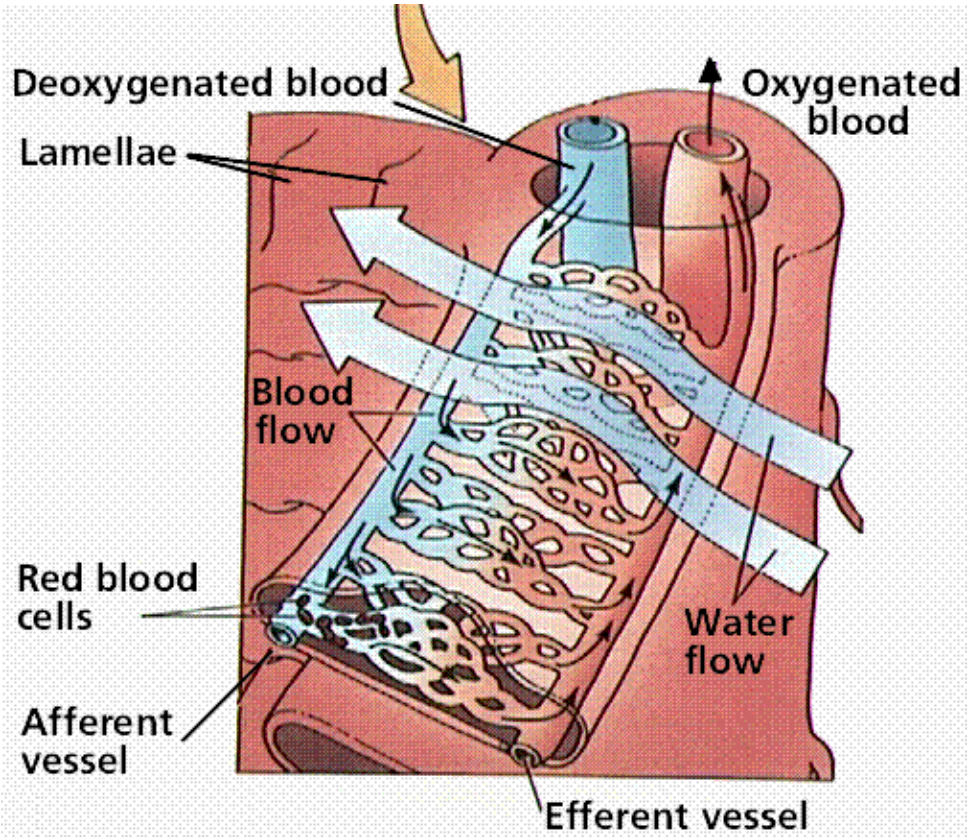
Gills greatly increase the surface area for gas exchange. They occur in a variety of animal groups including arthropods (including some terrestrial crustaceans), annelids, fish, and amphibians. Gills typically are convoluted outgrowths containing blood vessels covered by a thin epithelial layer. Typically gills are organized into a series of plates and may be internal (as in crabs and fish) or external to the body (as in some amphibians).

Gills are very efficient at removing oxygen from water: there is only 1/20 the amount of oxygen present in water as in the same volume of air.

Water flows over gills in one direction while blood flows in the opposite direction through gill capillaries. This countercurrent flow maximizes oxygen transfer.

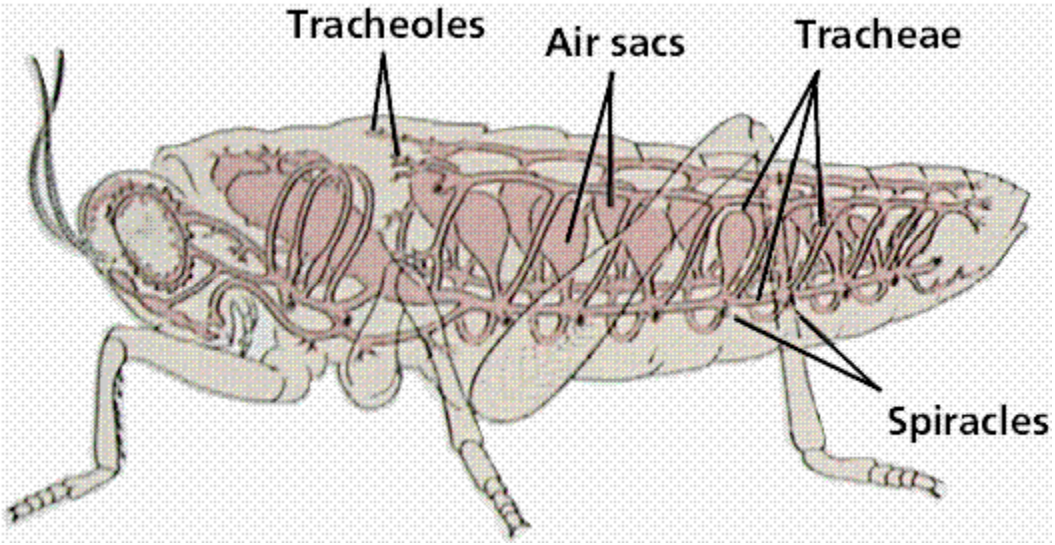



Water flow
Gill filaments
Deoxygenated blood
Oxygenated blood


Deoxygenated blood
Oxygenated blood
Lamellae
Blood flow
Red blood cells
Water flow
Afferent vessel
Efferent vessel

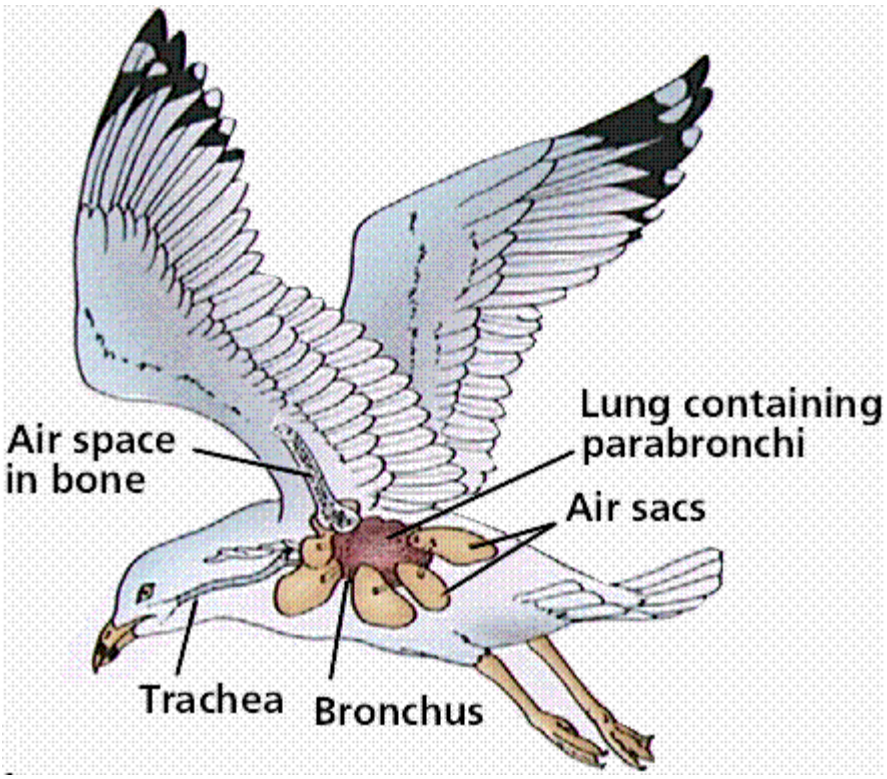
Tracheal Systems

Many terrestrial animals have their respiratory surfaces inside the body and connected to the outside by a series of tubes. Tracheae are these tubes that carry air directly to cells for gas exchange. Spiracles are openings at the body surface that lead to tracheae that branch into smaller tubes known as tracheoles. Body movements or contractions speed up the rate of diffusion of gases from tracheae into body cells. However, tracheae will not function well in animals whose body is longer than 5 cm.

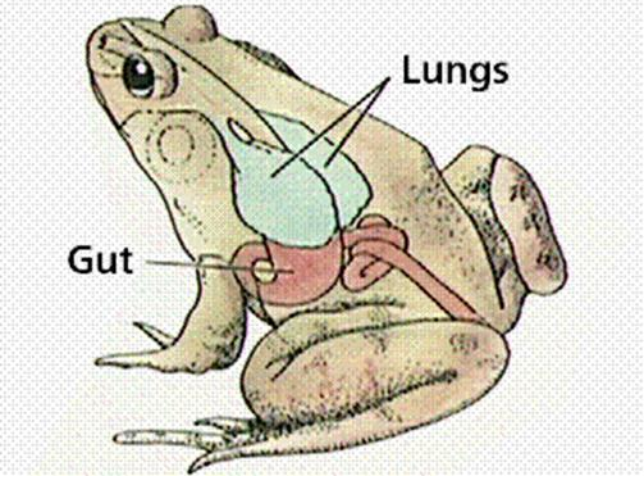


Lungs

Lungs are ingrowths of the body wall and connect to the outside by as series of tubes and small openings. Lung breathing probably evolved about 400 million years ago. Lungs are not entirely the sole property of vertebrates, some terrestrial snails have a gas exchange structures similar to those in frogs.

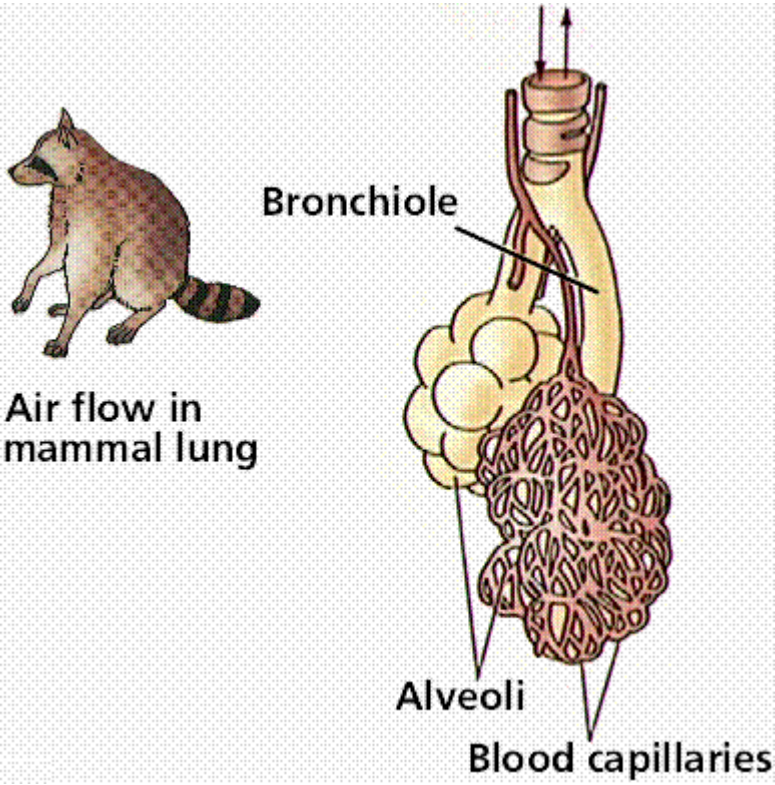


Amphibian lungs are ventral outpocketings of the gut, though they lie dorsal to it



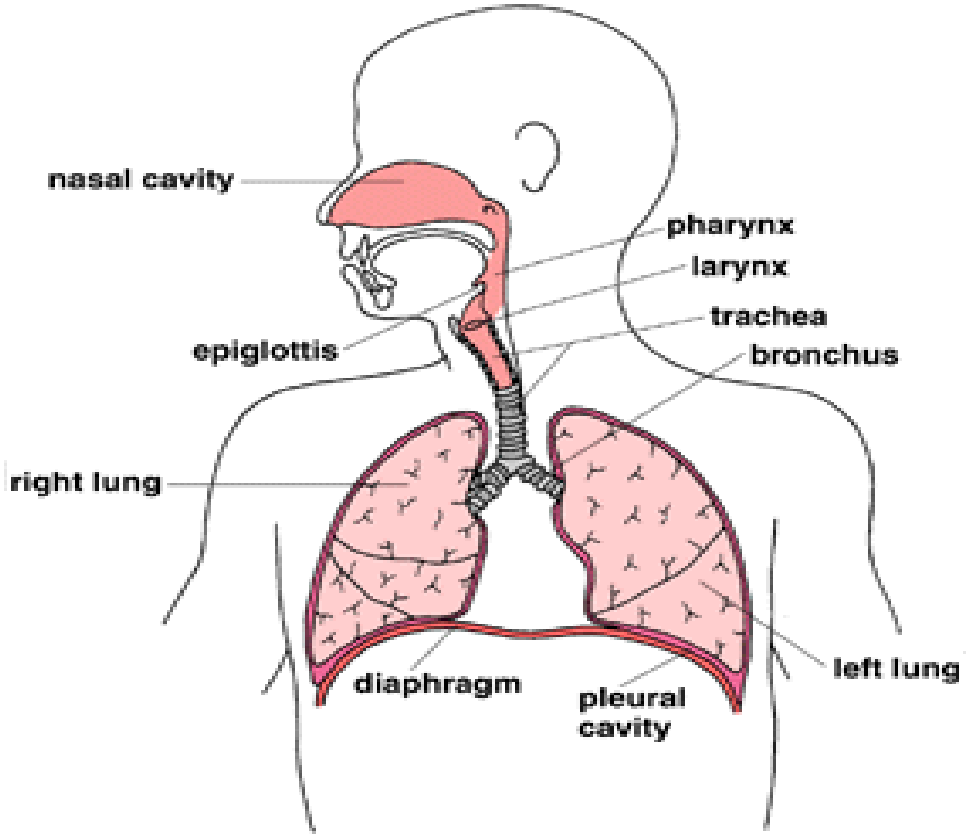
Respiratory System Principles

- Movement of an oxygen-containing medium so it contacts a moist membrane overlying blood vessels.
- Diffusion of oxygen from the medium into the blood.
- Transport of oxygen to the tissues and cells of the body.
- Diffusion of oxygen from the blood into cells.
- Carbon dioxide follows a reverse path.



The Human Respiratory System

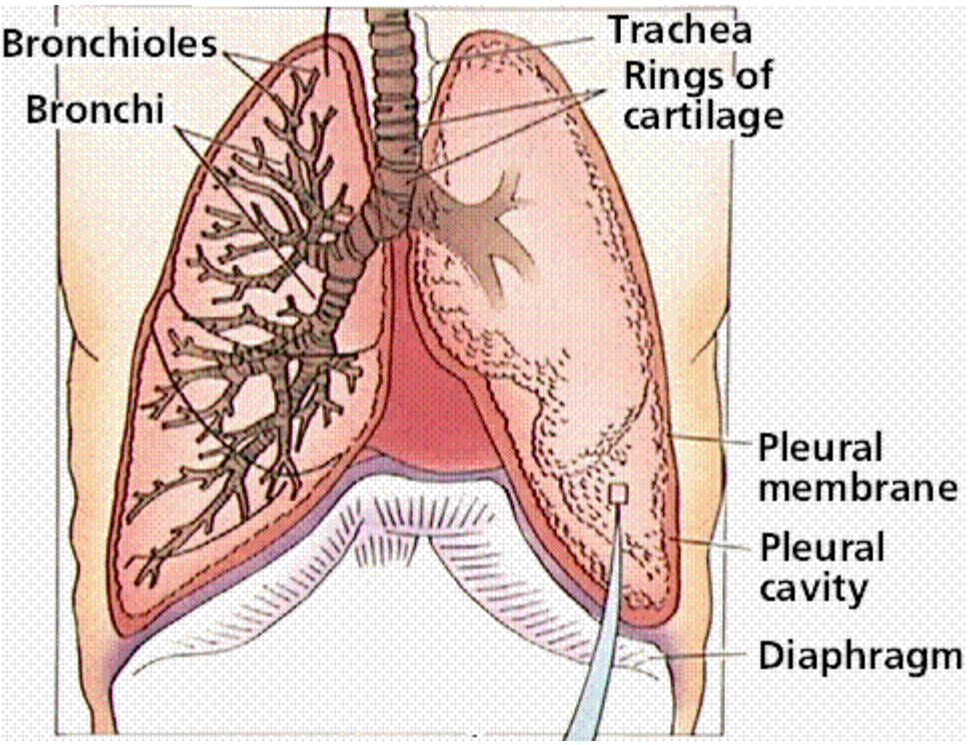
This system includes the lungs, pathways connecting them to the outside environment, and structures in the chest involved with moving air in and out of the lungs.



The Pathway Air enters the nostrils passes through the nasopharynx,the oral pharynx through the glottis into the trachea into the right and left bronchi, which branches and rebranches into bronchioles, each of which terminates in a cluster of alveoli.

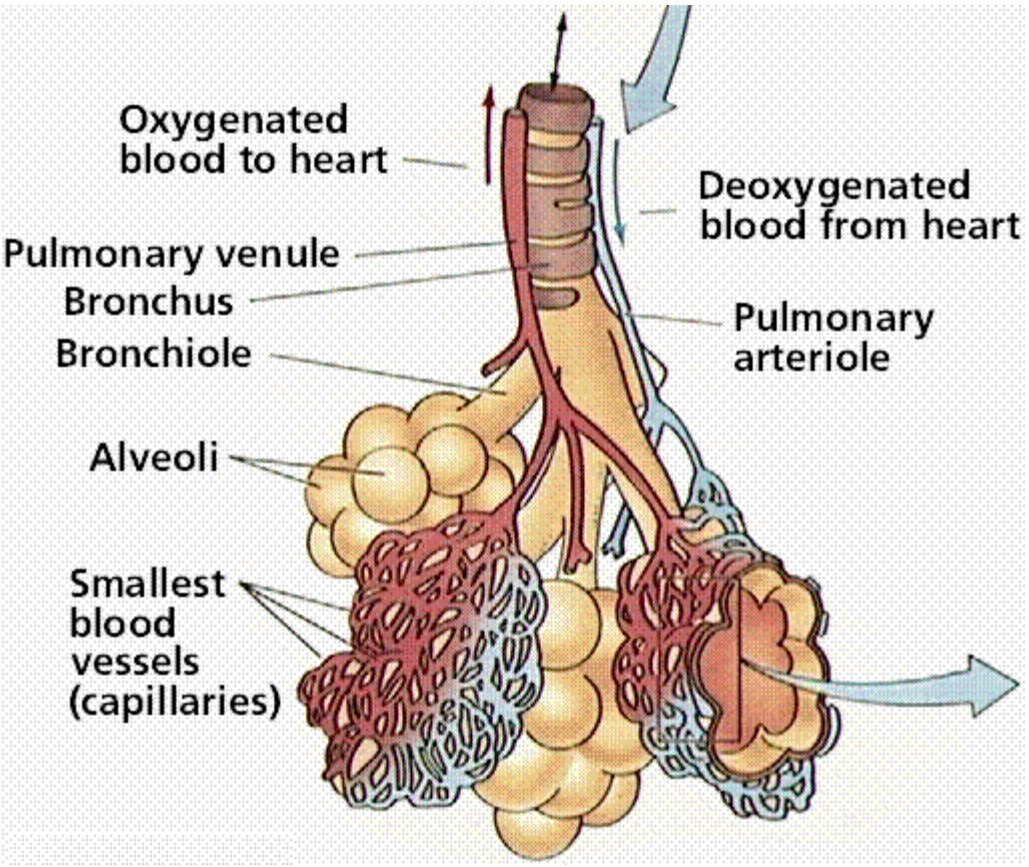
Air enters the body through the nose, is warmed, filtered, and passed through the nasal cavity. Air passes the pharynx (which has the epiglottis that prevents food from entering the trachea).

The upper part of the trachea contains the larynx. The vocal cords are two bands of tissue that extend across the opening of the larynx. After passing the larynx, the air moves into the bronchi that carry air in and out of the lungs.

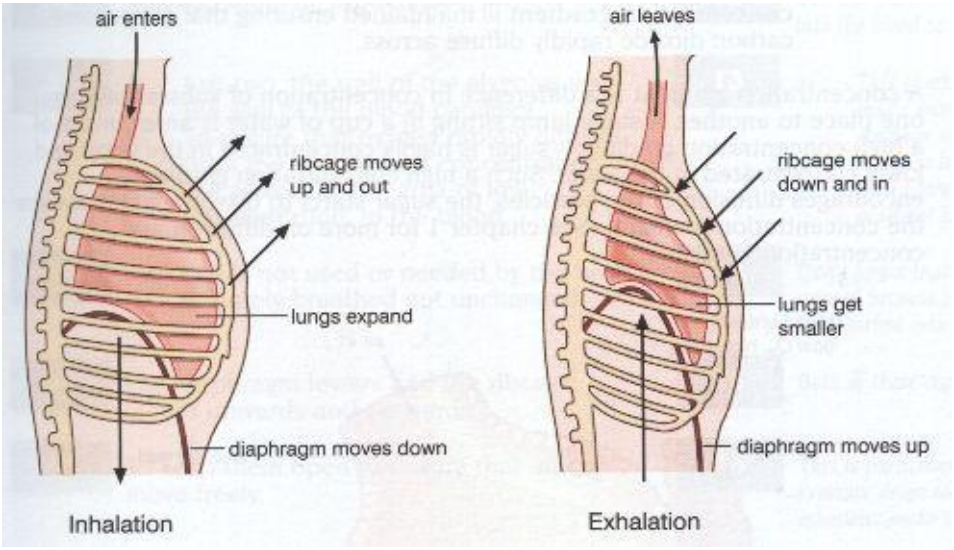


Bronchi are reinforced to prevent their collapse and are lined with ciliated epithelium and mucus-producing cells. Bronchi branch into smaller and smaller tubes known as bronchioles. Bronchioles terminate in grape-like sac clusters known as alveoli. Alveoli are surrounded by a network of thin-walled capillaries. Only about 0.2 µm separate the alveoli from the capillaries due to the extremely thin walls of both structures. Gas exchange across capillary and alveolus walls.

The lungs are large, lobed, paired organs in the chest (also known as the thoracic cavity). Thin sheets of epithelium (pleura) separate the inside of the chest cavity from the outer surface of the lungs. The bottom of the thoracic cavity is formed by the diaphragm. Ventilation is the mechanics of breathing in and out. When you inhale, muscles in the chest wall contract, lifting the ribs and pulling them, outward. The diaphragm at this time moves downward enlarging the chest cavity. Reduced air pressure in the lungs causes air to enter the lungs. Exhaling reverses these steps.

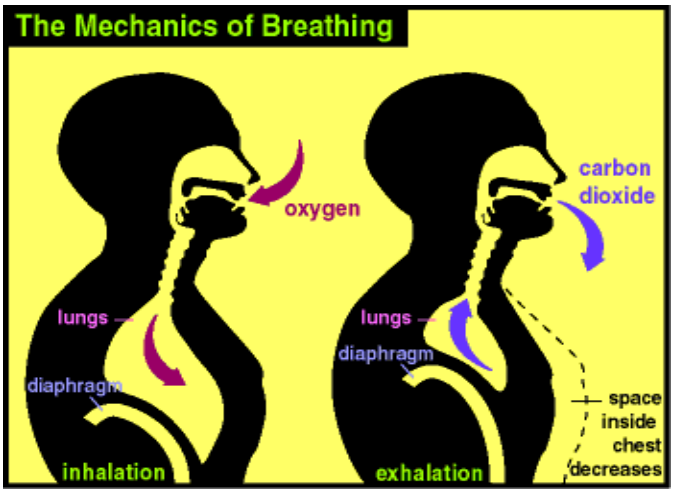


During inspiration (inhaling), The external intercostal muscles contract, lifting the ribs up and out.The diaphragm contracts, drawing it down .



During expiration (exhaling), these processes are reversed and the natural elasticity of the lungs returns them to their normal volume. At rest, we breathe 15–18 times a minute exchanging about 500 ml of air.

In more vigorous expiration, the internal intercostal muscles draw the ribs down and inward. The wall of the abdomen contracts pushing the stomach and liver upward.Under these conditions, an average adult male can flush his lungs with about 4 liters of air at each breath. This is called the vital capacity. Even with maximum expiration, about 1200 ml of residual air remain.



Control of Respiration

Your respiratory rate changes. When active, for example, your respiratory rate goes up; when less active, or sleeping, the rate goes down. Also, even though the respiratory muscles are voluntary, you can't consciously control them when you're sleeping. So, how is respiratory rate altered & how is respiration controlled when you're not consciously thinking about respiration?

The rhythmicity center of the medulla: controls automatic breathing consists of interacting neurons that fire either during inspiration (I neurons) or expiration (E neurons)I neurons - stimulate neurons that innervate respiratory muscles (to bring about inspiration)E neurons - inhibit I neurons (to 'shut down' the I neurons & bring about expiration)

Apneustic center (located in the pons) - stimulate I neurons (to promote inspiration)
Pneumotaxic center (also located in the pons) - inhibits apneustic center & inhibits inspiration

Factors involved in increasing respiratory rate

Chemoreceptors - located in aorta & carotid arteries (peripheral chemoreceptors) & in the medulla (central chemoreceptors)

Chemoreceptors (stimulated more by increased CO_2 levels than by decreased O_2 levels) > stimulate Rhythmicity Area > Result = increased rate of respiration

Diseases of the Respiratory System

The condition of the airways and the pressure difference between the lungs and atmosphere are important factors in the flow of air in and out of lungs. Many diseases affect the condition of the airways.

Asthma narrows the airways by causing an allergy-induced spasms of surrounding muscles or by clogging the airways with mucus.

Bronchitis is an inflammatory response that reduces airflow and is caused by long-term exposure to irritants such as cigarette smoke, air pollutants, or allergens.

Cystic fibrosis is a genetic defect that causes excessive mucus production that clogs the airways.