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Make notes as you study each section, and interact fully with the activities – watch the animations and complete the quizzes.

Take a break at the end of each section – resting your eyes from the computer screen, getting some fresh air or taking a coffee break will improve your ability to focus on your study and take in information.

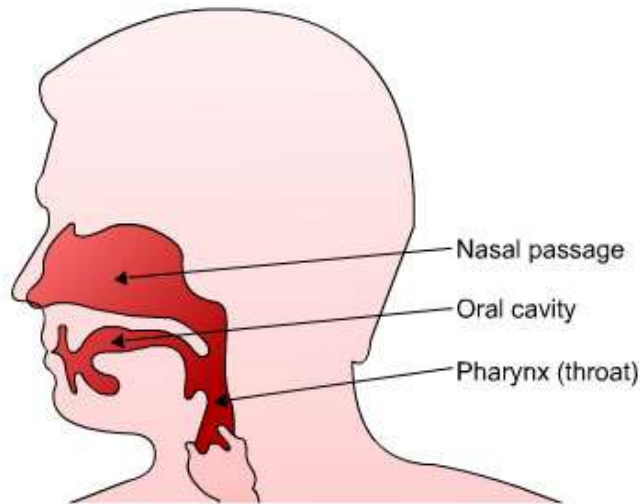
Give yourself time to think about what you have learned, and time to absorb and understand it.

Anatomy of the respiratory system

The organs of the respiratory system are divided into the upper and lower respiratory tracts as shown.

Upper respiratory tract

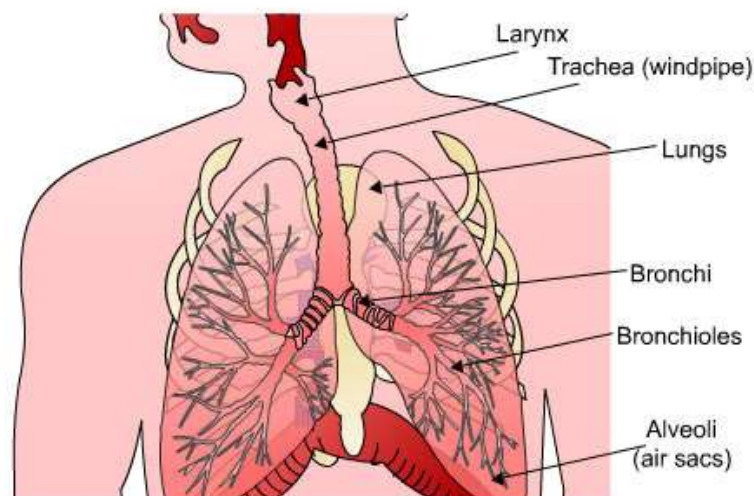
- Nose - nasal passage
- Mouth - oral cavity
- Pharynx (throat)



(files/images/upper-respiratory-tract.jpg?1613388437090)UHI / CC0

Lower respiratory tract

- Larynx
- Trachea (windpipe)
- Bronchi and bronchioles
- Lungs
- Alveoli (air sacs)

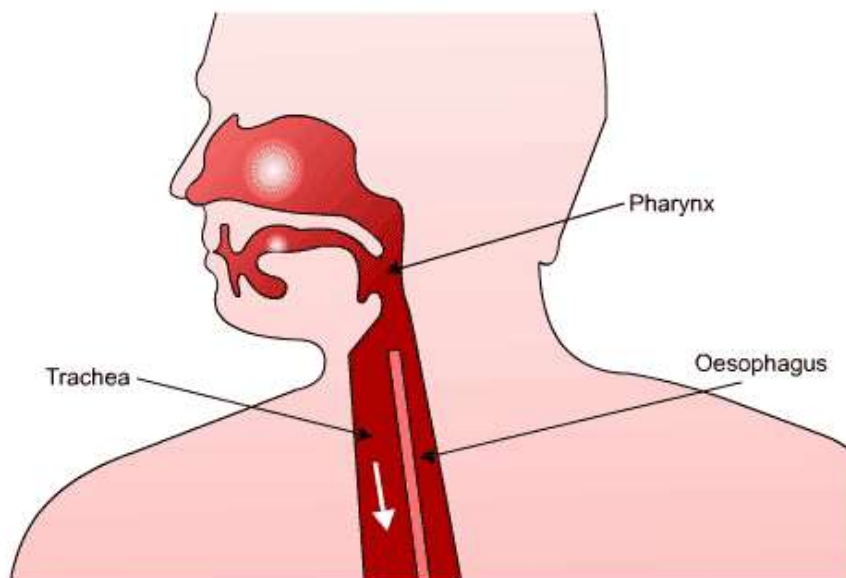


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The upper respiratory tract

Air is breathed through the nose or mouth, and as it passes through the air passageways in the respiratory system it is warmed to body temperature, moistened and cleaned. Air passes through the pharynx and down the trachea (windpipe). The trachea lies immediately in front of the oesophagus, which is where food and drink is directed into the digestive system. A flap of cartilage called the epiglottis closes over trachea when we swallow, preventing food or drink from entering the lungs.

Air is breathed in and the epiglottis is open...



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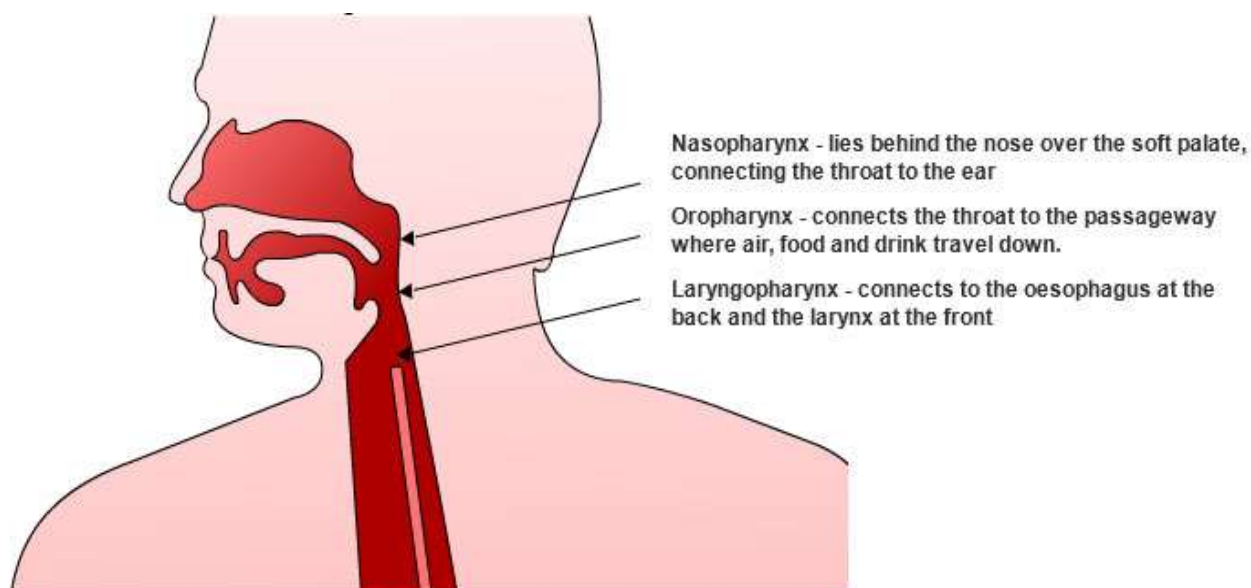
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Text

Air is breathed in and the epiglottis is open. Food is consumed and the epiglottis closes over the trachea so food travels down the oesophagus instead.

The nose

At the start of the upper respiratory tract is the **nasal cavity** which warms, moistens and filters the air we breathe in. The nose is lined with **ciliated epithelium** which contains **mucus secreting cells**. The hairs trap the larger particles, and dust and any microbes stick to the mucus. The **cilia** beat rhythmically which moves the mucus up to the throat where it is swallowed or spat out. The moist **mucus** also humidifies the inhaled air.



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Text

Nasopharynx - lies behind the nose and over the soft palate, connecting the throat to the ear

Oropharynx - connects the throat to the passageway where air, food and drink travel down

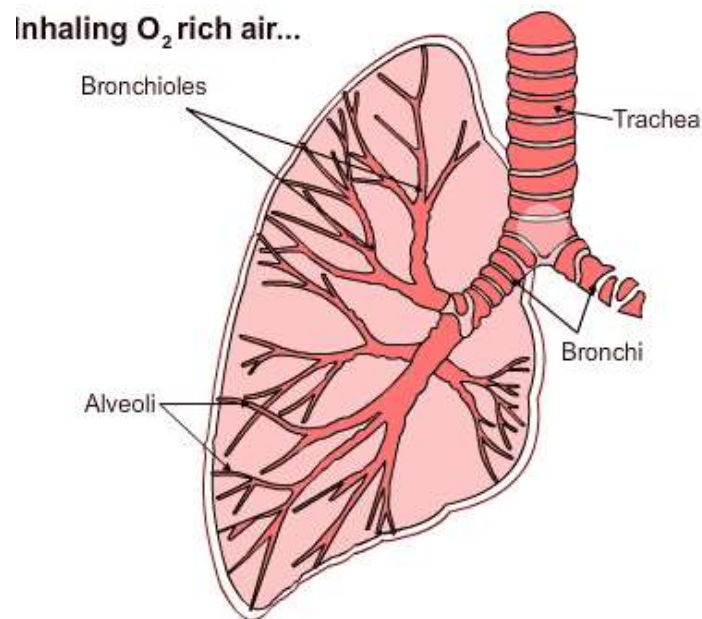
Laryngopharynx - connects to the oesophagus at the back and the larynx at the front

The pharynx (throat)

The pharynx is a 13 cm tube consisting of three parts: the **nasopharynx**, the **oropharynx** and the **laryngopharynx**.

The lower respiratory tract

The larynx is also called the voice box, and it connects the laryngopharynx with the trachea. Air passes from the **trachea** to the **bronchi** and bronchioles in the lungs. The bronchioles split many times to create a network of vessels throughout the lungs, and at the end of each bronchiole, there are a number of air sacs called **alveoli**. It is through these air sacs that oxygen diffuses from the lungs via the alveoli into the bloodstream and simultaneously, carbon dioxide diffuses from the blood into the alveoli to be breathed out. The inhaled oxygen is then passed into the blood system where it is transported to the rest of the body.



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Text

Inhaling O₂ rich air: air travels down trachea and bronchi to bronchioles and alveoli.

Exhaling CO₂ rich air: air travels from bronchioles and alveoli up through the bronchi and trachea.

The trachea

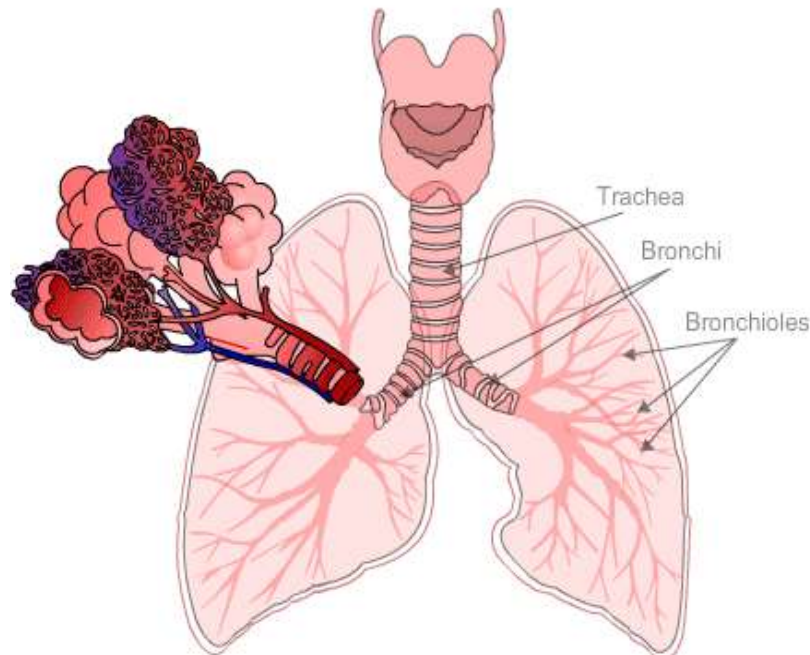
The trachea or windpipe is composed of cartilage which provides rings of support and prevents it from collapsing. The epiglottis is made of cartilage; it closes off the larynx during swallowing and protects the lungs from inhaling foreign objects such as water or food.

The trachea carries air from the larynx and then divides into two tubes called bronchi. It also contains ciliated epithelium which contains mucus secreting goblet cells. These cells trap microbes and dust and waft it upwards via the cilia to the throat where it can be swallowed.

The bronchi

The trachea divides into two bronchi which contain the same epithelium lining and goblet cells as before.

Each branch of the bronchus subdivides into smaller tubes called bronchioles and finally terminates at the alveolar ducts where the alveoli (air sacs) end the respiratory tract. These are surrounded by capillaries which transfer oxygen and carbon dioxide in and out of the blood.

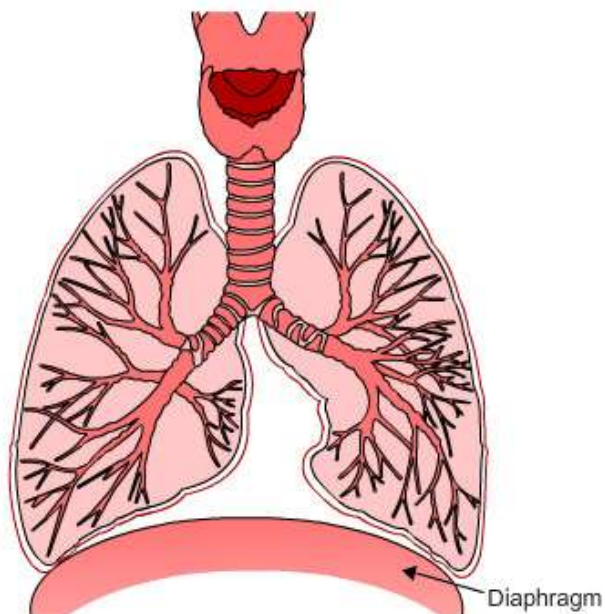


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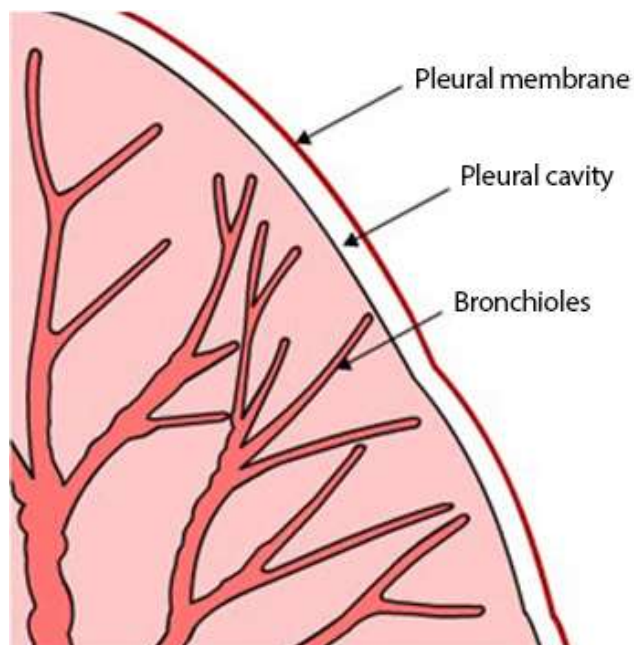
The Lungs

There are two lungs which lie within the ribcage, extending from the **diaphragm** to just below the clavicle. The base of each lung is concave and fits over the **convex** area of the diaphragm.

The **pleural membrane** encloses and protects each lung. Between the membrane and the lung is a **fluid-filled space** called the **pleural cavity** which lubricates and reduces friction between the membranes.



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(files/images/lungs close up.jpg?1613406174811)UHI / CCO

Text

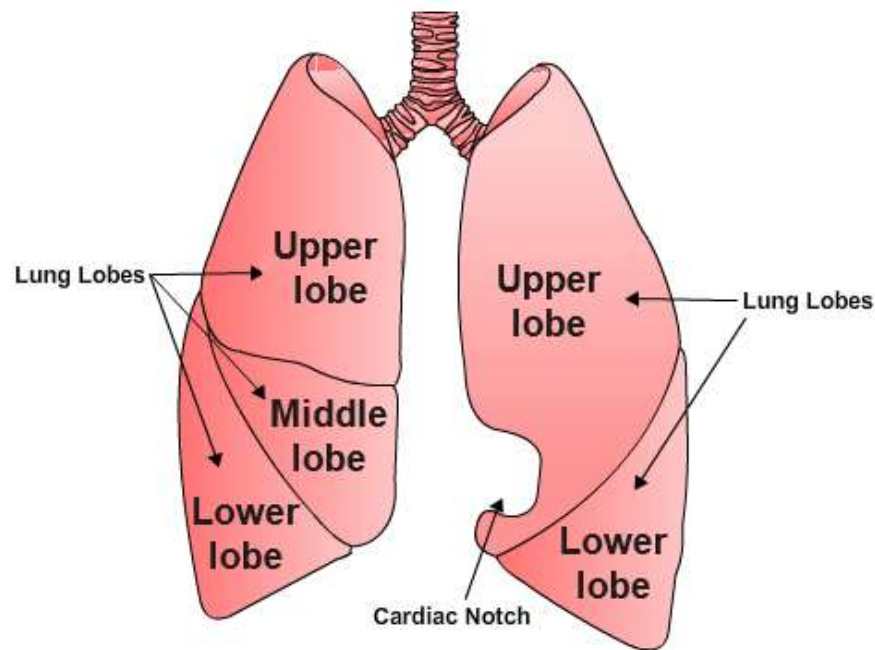
Pleural membrane

Pleural cavity

Bronchioles

The inner (medial) surface of each lung has an area called the hilus through which bronchi, **pulmonary blood vessels**, nerves and lymphatic vessels enter and leave the lungs. The lungs are conical in shape and are separated by the heart in the thoracic cavity into two distinct chambers.

The left lung has a concave area called the **cardiac notch** which creates space for the heart. Each lung has a separate bronchus and is divided into **lobes** which have many compartments called **lobules**. Each lobule is served by its own lymphatic vessel, arteriole, venule and a branch from a terminal bronchiole, which then divides into the **alveoli**.



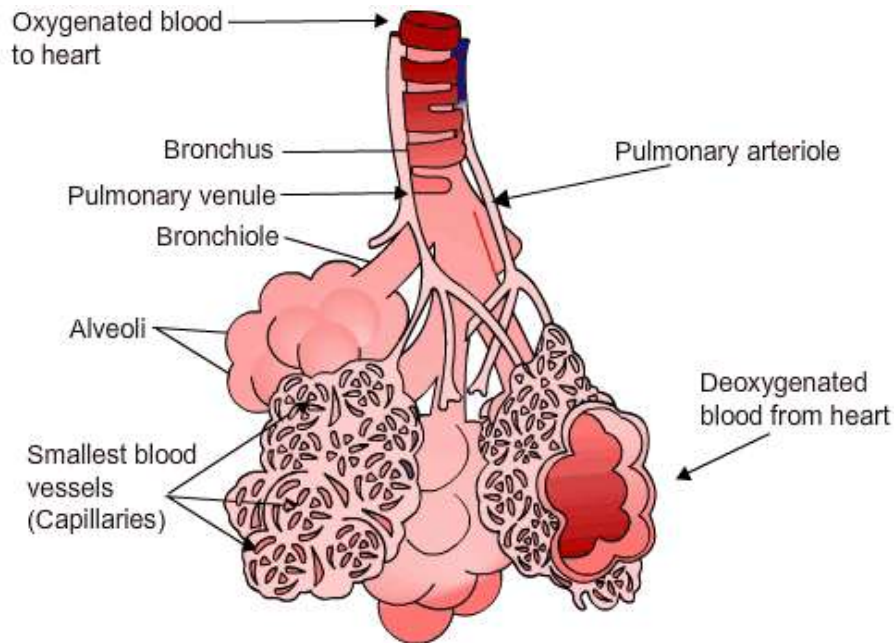
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The alveoli

There are different types of alveoli; whilst most are ideally adapted for **gaseous exchange**, others secrete **alveoli fluid** which keeps the alveolar cells moist. Moisture reduces surface tension, making inflation easier and facilitating gaseous exchange.

Each lobule arteriole and venule disperses into a dense capillary network which covers the outer wall of each alveoli. With only a single layer of **endothelial cells** and a basement membrane creating the capillary wall, **diffusion of gases** from and to the blood is easily facilitated.

Note that the pulmonary arterioles carry deoxygenated blood from the heart, and the pulmonary venules carry oxygenated blood back to the heart – everywhere else in the body arteries carry oxygenated blood and veins carry deoxygenated blood, but the pulmonary circuit between the heart and lungs is different.



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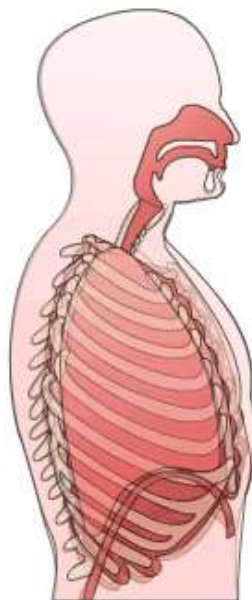
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Text

The pulmonary arterioles carry deoxygenated blood from the heart, inside the alveoli are the smallest blood vessels (capillaries) here the gaseous exchange takes place and then the pulmonary venules carry oxygenated blood back to the heart

Muscles of the respiratory system

The muscles which are involved in breathing are the internal and external intercostal muscles, and the diaphragm.



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Text

Sternum, intercostal muscles, lung and diaphragm

Inhalation - Diaphragm contracts

Exhalation - Diaphragm relaxes

Quiz

Now have a go at identifying the organs of the respiratory system. Match the organ names to the corresponding parts.

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Functions of the respiratory system

The function of the respiratory system is to provide oxygen for our cells and remove waste products such as carbon dioxide from the body.

We need to breathe in oxygen for all the body's chemical reactions to take place and to produce energy. Releasing energy from foodstuffs releases carbon dioxide (CO₂), and as this is toxic to cells we need to eliminate it as quickly as possible. The respiratory system enables us to take in oxygen via the air we breathe in and expel carbon dioxide as we breathe out.

Respiration and ventilation

Respiration is the exchange of gases between the atmosphere, blood and cells. Inhalation, also known as inspiration, is breathing in;

Exhalation (expiration) is breathing out.

The combination of inhalation and exhalation is also known as ventilation.

Muscles of the respiratory system

These muscles receive nervous impulse messages from the brain, contracting to initiate inhalation, and relaxing to begin exhalation.

The intercostal muscles are between the ribs - these muscles move the ribcage when we breathe.

The diaphragm is a sheet of muscle beneath the lungs. When the diaphragm is relaxed (during exhalation) it is dome-shaped. During inhalation the diaphragm becomes more flattened.