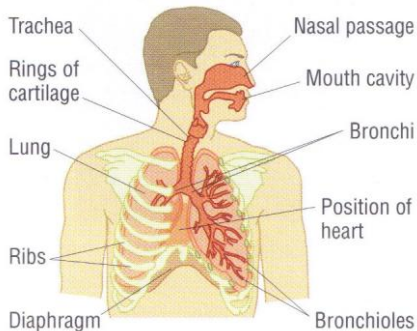


2.2

EXCHANGE IN THE LUNGS

The lungs as an organ of exchange of materials



The mammalian respiratory system consists of the airways and lung tissue. Air is most often breathed through the nose because then it is warmed, moistened and filtered.

Air travels through the breathing tubes: **trachea**, **bronchi** and **bronchioles**, and ends up in the air sacs or **alveoli**. The alveoli are a specially-adapted area for exchange, with over 700 million in a human making 70m^2 in total. They are made of **squamous epithelia** and are **vascularised** (richly supplied with blood).

The lungs are in the chest cavity and are protected by the ribs which surround them. Each lung is covered by **pleural membranes** which secrete a lubricating fluid, allowing the lungs to inflate and deflate without rubbing against the walls of the ribcage. There are **intercostal muscles** in between the ribs. The **external** intercostal muscles can contract to raise the ribcage, and the **internal** muscles can contract to lower the ribcage. There is a muscular **diaphragm** separating the lungs from the abdomen, which is usually domed shape, but it flattens when it contracts.

Essentially only different in size, the trachea and the bronchi are structurally similar. The inner surface is covered in **ciliated epithelia** which have a rhythmic wave-like movement. Goblet cells are also present which secrete mucus containing glycoproteins and **lysozyme** (the enzyme in lysosome which causes **lysis** – the breakdown of bacteria).

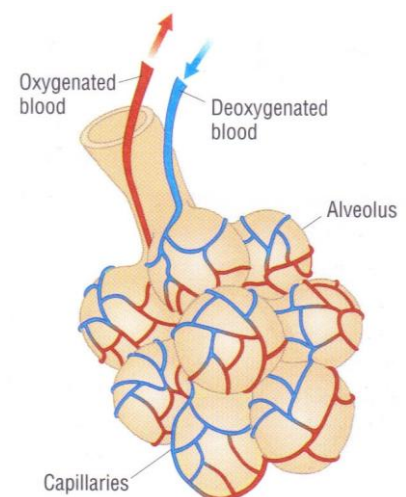
Smooth Muscle - found around many internal organs, these muscles are under involuntary control

There are rings of **cartilage**, which is strong and flexible helping to hold the airways open during inhalation. In the trachea, the cartilage bands are incomplete (C-shaped). This allows food to pass down the **oesophagus** which runs behind the trachea. Inside the cartilage is **loose tissue** which is made of **smooth muscle**.

Gases pass both ways through the thin walls of the alveoli. Oxygen passes from the air in the alveoli to the blood in the capillaries. Carbon dioxide passes from the blood to the air in the alveoli.

For diffusion to be rapid, a steep diffusion gradient is needed, as was one of the criteria for a good exchange surface, outlined in 2.1 Special Surfaces for Exchange. This means a high concentration of molecules is needed on the supply side, and a low concentration on the demand side. This is achieved via the action of the blood transport system and breathing movements (**ventilation**).

The blood brings carbon dioxide from the tissues to the lungs. This ensures that the concentration of carbon dioxide in the blood is higher than that in the air of the alveoli. It also carries oxygen away from the lungs. This ensures that the concentration of oxygen in the blood is kept lower than the concentration in the air inside the alveoli. The heart pumps the blood along the pulmonary artery to the lungs. In the lungs, the artery divides up to form finer vessels. These eventually carry blood into tiny capillaries that are only just wide enough for a red blood cell to squeeze through. These capillaries lie over the surface of the alveoli, as shown in the diagram.



The breathing movements of the lungs ventilate them. They replace the used air with fresh air. This brings more oxygen into the lungs and ensures that the concentration of oxygen in the air of the alveolus remains higher than the concentration in the blood. Ventilation also removes air containing carbon dioxide from the alveoli. This ensures that the concentration of carbon dioxide in the alveoli remains lower than that in the blood.

This constant supply of gas to one side of the exchange surface and its removal from the other side ensures that diffusion, and therefore exchange, can continue.

When a human breathes in (**inspiration**)...

- diaphragm contracts to become flattened and pushes digestive organs down
- external intercostal muscles contract to raise ribs
- volume of chest cavity increases
- air moves into the lungs

When a human breathes out (**expiration**)...

- diaphragm relaxes and is pushed up by displaced organs underneath
- external intercostal muscles relax and ribs fall
- volume of chest cavity decreases
- air moves out of the lungs

